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Advanced Electric Heat Pump Market and Business Analysis

Final Report

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Report Prepared by

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R&D Center
1310 Beulah Road
Pittsburgh, Pennsylvania 15235

under

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FINAL REPORT

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1.0 ABSTRACT

ADVANCED ELECTRIC HEAT PUMP
MARKETING AND BUSINESS ANALYSIS

As part of a Department of Energy contract to the Westinghouse Electric Corporation, the Heating and Cooling Business Unit (with the assistance of Marketing/Management Studies) undertook a marketing and business analysis of the Advanced Electric Heat Pump, i.e., a heat pump with an annual energy efficiency at least 20% better than the most efficient unit available in the market place in 1979. This study consisted of the following subtasks:

1. Market Study of Currently Available Heat Pumps - Using secondary research sources the market position of currently available heat pumps was established. This information provided baseline data for estimating how well the system under design will sell.

2. Marketability Analysis for Advanced Electric Heat Pumps - Primary research techniques (personal interviews, mail and telephone surveys) were used to assess the market potential of an Advanced Electric Heat Pump.

3. Sales Forecast for Advanced Electric Heat Pumps Through 1990 - Utilizing the findings of the above, a (W) proprietary computer-based model was revised to project Advanced Electric Heat Pump unit sales volume. This model incorporated data on the following variables: heating/cooling load requirements, central forced air heating/cooling shipments, respective system capital and operating costs, consumer payback period requirements, and fuel costs and availability.

The major study objective was to determine the sales potential of an Advanced Electric Heat Pump. This includes identifying the climatic region to which this product is most applicable and whether it is a commercially viable product, i.e., whether the unit can be produced and sold in sufficient volume to generate an acceptable return to the manufacturer.

Due to a recent change in the scope of the project, the following subtasks are not included in this report: 4. Preliminary Venture Analysis for Advanced Electric Heat Pumps; 5. Rating Method to Determine Technology Species.

2.0 SUMMARY

2.1 MAJOR FINDINGS

2.1.1 Market Study

Preliminary projections of currently available heat pumps show strong increases, especially beyond 1985 due to higher saturation of new housing and increased shares of the replacement, retrofit, and add-on markets because of rising fuel prices which will make the heat pump more economically attractive to customers.

The distribution of residential to commercial heat pump installations will remain relatively stable through 1990, based on growth projections for the residential and commercial markets, although the percentage of new residential shipments is expected to drop somewhat and commercial applications will increase.

The trend of declining average unit capacities for all heat pumps shipped is expected to continue (with the two ton unit most popular by 1990), as is the trend of increasing average EER's for heat pump units installed. By 1990 it is estimated that 64% of all heat pumps shipped will have an EER above 8.4.

Overall, there will be significant shifts in the relative volumes of the various heat pump market segments during the 1980's. The percentage of heat pumps used in new construction will decline while add-on/retrofit applications will grow.

2.1.2 Marketability Analysis

The major barriers to be overcome in commercializing the Advanced Electric Heat Pump are: 1) Consumer product awareness - almost half (45%) of the consumers surveyed did not know what a heat pump is 2) Cost competitiveness - a currently available heat pump costs more to own and operate than a gas warm air furnace with central air conditioning 3) Price and availability of natural gas - the continued availability of natural gas and the relative prices of natural gas and electricity make

it difficult for heat pumps to economically compete, at present. However, as energy costs rise, the demand for more efficient heating/cooling systems, and therefore the market for an Advanced Electric Heat Pump will increase.

The use of simple payback period analysis by consumers (a rough calculation of the amount of time necessary to recover initial system cost) as a purchase criterion was a key research finding of a mail survey of 500 families (conducted by National Family Opinion, Inc.). Most builders of new homes choose the heating/cooling system that requires the least initial investment, but they will consider systems that payback initial costs within three years. With consumers or homeowners energy efficiency (operating cost) is the chief criterion, followed by purchase price. Fifty-six percent of the homeowners surveyed will accept a higher purchase price for a more efficient system which will payback original cost in four years as shown in Figure 2.1-1.

2.1.3 Market Forecast

Applying data from both the consumer and builder acceptability curves, previously developed, along with inputs on key variables, the revised (W) proprietary computer-based model generated forecasts of Advanced Electric Heat Pump sales for varying economic scenarios as summarized in Figure 2.1-2.

The Base Case, which assumes that natural gas prices will escalate faster than electricity prices due to the deregulation of natural gas, forecasts a market for Advanced Electric Heat Pumps rising from three hundred sixty-one thousand units in 1985 to just under two million units in 1990.

The Case 5 forecast which assumes more competitive pricing between gas and electricity and a 10% higher installed cost for the Advanced Electric Heat Pump, shows a potential market of one hundred fifty-four thousand units in 1985 and six hundred eighty thousand units in 1990.

Case 5 was chosen as the most likely scenario because it is believed that gas companies will price competitively to protect their market position. Figure 2.1-3 depicts the impact of the Advanced Electric Heat Pump on the residential central heating/cooling market for the forecast period 1980 to 1990.

Alternate cases for varying electric and gas rates are discussed in detail in Section 4.3.2 (pages 67-68).

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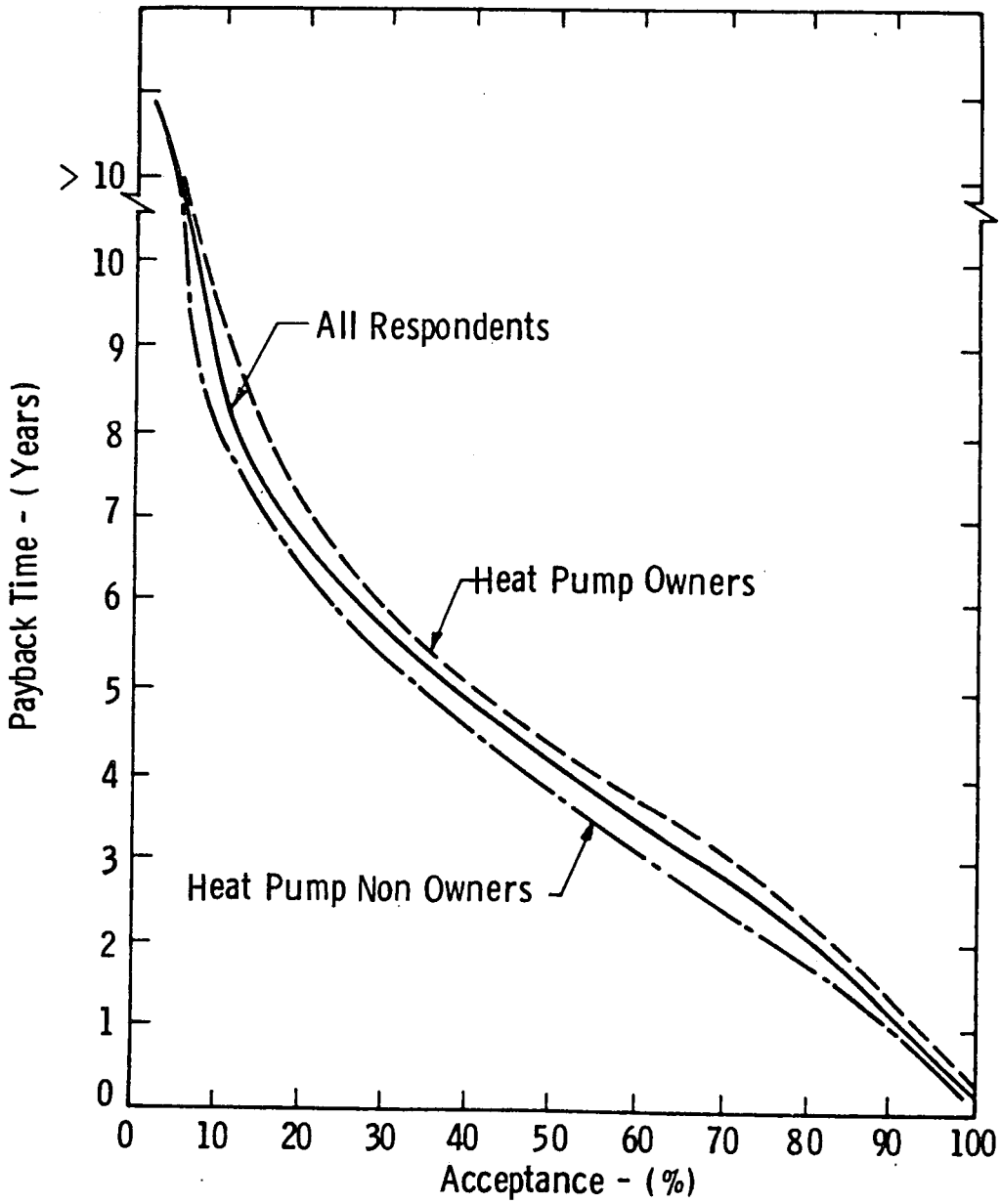
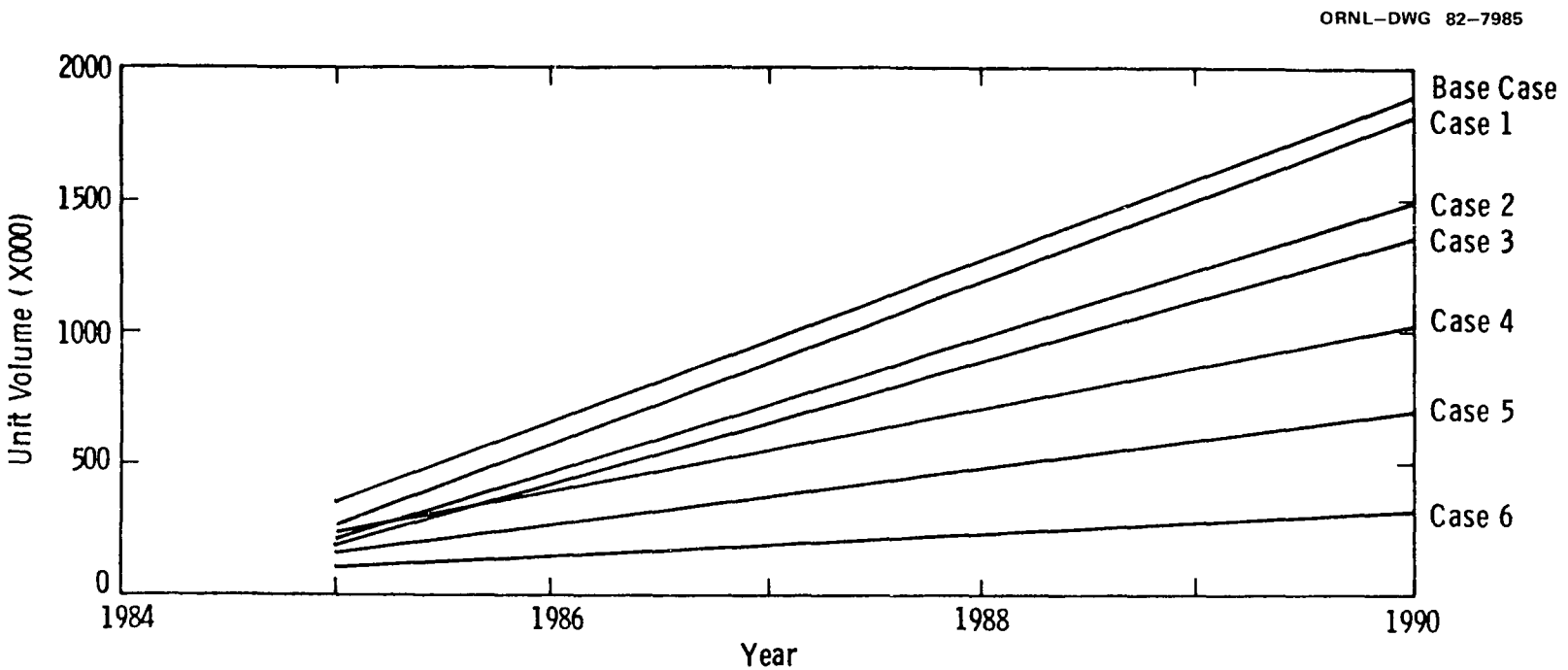


Source: National Family Opinion Inc. Mail Survey
Summer 1980
See Table 4. 2-1 for Details

Fig. 2. 1-1—Consumer acceptance of added system cost



Source: Ⓦ Proprietary Computer Model

Fig. 2.1-2—Advanced electric heat pump annual sales (alternative forecasts)

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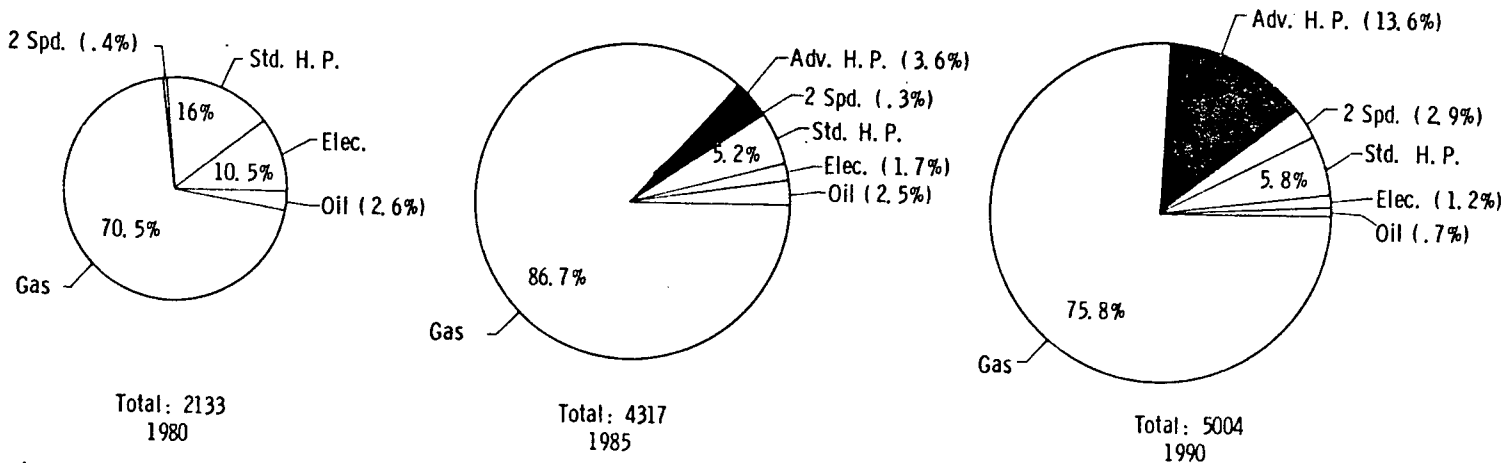
Volume (X000)

Case 5



Assumptions:

1) Electric Rates Increase at 4 % Annual Compound Real Growth Rate

2) Advanced Electric Heat Pump Installed System Cost Increased 10%

Fig. 2.1-3—Residential heating/cooling system sales (most likely market forecast)

3.0 INTRODUCTION

3.1 SCOPE

The primary focus of this study was the Electric Heat Pump (conventional as well as Advanced) in comparison to the following central forced air systems:

1) Gas Warm Air Furnace
2) Oil Warm Air Furnace
3) Electric Warm Air Furnace
4) Gas Warm Air Furnace/Central Air Conditioning
5) Oil Warm Air Furnace/Central Air Conditioning
6) Electric Warm Air Furnace/Central Air Conditioning

Other, non-forced air systems were eliminated from the scope of the study due to incompatability and difficulty of comparison, as well as time and financial constraints. Since the majority (over 60%) of residential central heating/cooling systems are forced air systems, these omissions are not detrimental to the study.

Key domestic (U.S. *) market segments analyzed were:

1) New Construction - all new residential construction (builder, speculative and custom)

2) Replacement - replacement of existing systems with similar systems

3) Retrofit - replacement of existing systems with different systems.

4) Add-on - addition to existing systems

* The International market is not within the scope of this study.

3.2 OBJECTIVE AND METHODOLOGY

The major study objective was to determine the sales potential for an Advanced Electric Heat Pump, i.e. a heat pump with an annual energy efficiency at least 20% better than the most efficient unit available in 1979. This includes identifying the climatic region to which the Advanced Electric Heat Pump is most applicable and whether it is commercially viable product, i.e., whether the unit can be produced and sold in sufficient volume to generate an acceptable return to the manufacturer. To accomplish this overall objective the study was divided into the following parts:

3.2.1 MARKET STUDY - CURRENTLY AVAILABLE HEAT PUMPS (FIFTEEN TONS OR LESS)

First, the market position of currently available heat pumps was established using the following secondary research sources: the Gas Appliance Manufacturers Association, the Air Conditioning and Refrigeration Institute, Housing Industry Dynamics, and the U.S. Bureau of the Census. Historical and forecasted heat pump shipments were examined by volume, system type, unit capacity, energy efficiency, region, application (new construction, add-on, replacement, retrofit), and customer (residential, commercial). A key question to be answered was: what is the trend in energy efficiency ratios (EER's) for heat pumps currently sold? The above information provided baseline data for estimating how well the system under design will sell.

3.2.2 MARKETABILITY ANALYSIS - ADVANCED ELECTRIC HEAT PUMP

The Advanced Electric Heat Pump marketability analysis used the primary research techniques of personal interviews, mail and telephone surveys of consumers, builders, and dealers to assess the market potential of an Advanced Electric Heat Pump. This analysis determined the following marketing factors: purchase criteria, including payback period

requirements, desired product features, barriers to commercialization, and applicability to market segments. A key objective of this analysis was to determine customer acceptance or attitude toward an Advanced Electric Heat Pump system that meets specified payback requirements.

3.2.3 MARKET FORECAST FOR ADVANCED ELECTRIC HEAT PUMP THROUGH 1990

A (W) proprietary computer-based model was then revised utilizing the findings of both the market study and marketability analysis to project the unit sales volume of the Advanced Electric Heat Pump under varying economic assumptions. This model incorporated data on the following variables: heating/cooling load requirements, central forced air heating/cooling system shipments, respective system capital and operating costs, previously determined consumer payback period requirements, and fuel cost and availability.

3.3 INFORMATION RESOURCES, METHODS, PRINCIPAL PARTICIPANTS

Table 3.3-1 which follows provides a project overview and illustrates the three subtasks described above including the information resources used for each subtask, the method employed, and the principal Westinghouse participants.

All data analysis for figures and charts was based on regional census reports since most of the data acquired from secondary sources was available only in that form. Figure 3.3-1 identifies the regions used by the U.S. Bureau of the Census.

TABLE 3.3-1

MARKET AND BUSINESS ANALYSIS

INFORMATION RESOURCES	SUBTASKS	METHODS	(W) PRINCIPAL PARTICIPANTS
Secondary Research • Gas Appliance Mfgrs. Assoc. • Air Conditioning & Refrigeration Inst • Housing Industry Dynamics • Bureau of the Census	1. Market Study	(W) Forecast Models	Heating & Cooling Business Unit Planning Ron Lawrence Corporate Marketing/Management Studies Ralph Hofmann
Primary Research • Focus Group-Consumer • Multicard Survey-Consumer - NFO • Mail Survey-Consumer - NFO • Personal Interview -Builders -Distributors -Electric Util. • Phone Survey-Dealers	2. Marketability Analysis	Research & Analysis	Corporate Marketing/Management Studies Ralph Hofmann {Portions subcontracted to NFO (National Family Opinion, Inc.)}
	3. Sales Potential Analysis	Simple payback model based on consumer acceptability	Research & Development Technical Assessment Ed Federmann Corporate Productivity Center Shassi Putram Heating & Cooling Business Unit Planning - Ron Lawrence Research & Development Heat Exchanger Systems Steve Veyo

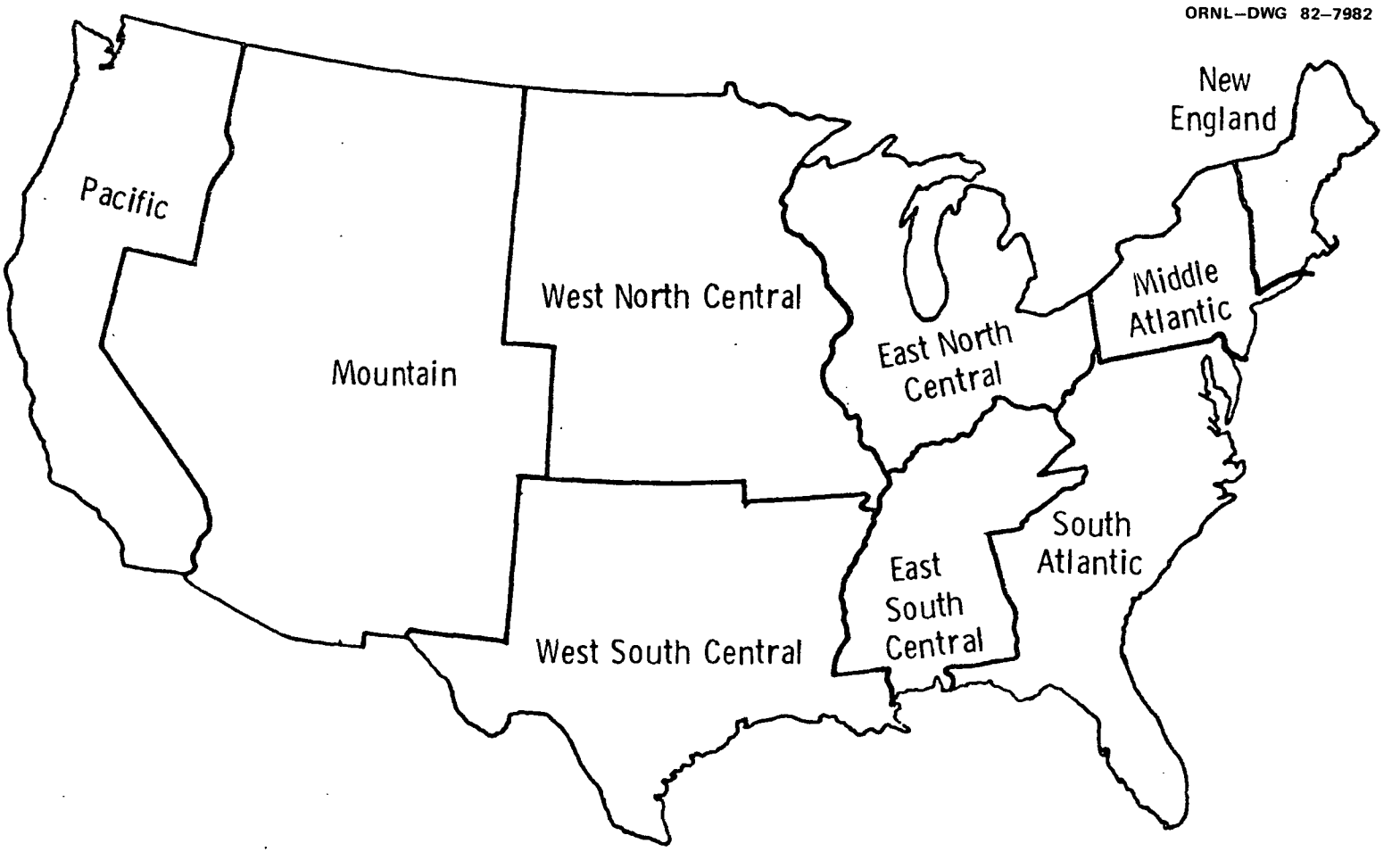


Figure 3.3-1 U. S. Census Divisions and DRI Energy Model Regional Definition

4.1 MARKET STUDY OF CURRENTLY AVAILABLE HEAT PUMPS

4.1.1 SUMMARY

4.1.2 STUDY METHOD

4.1.3 TOTAL VOLUME OF ELECTRIC HEAT PUMP SHIPMENTS

4.1.4 SPLIT VS PACKAGE UNIT SHIPMENTS/APPLICATIONS

4.1.5 RESIDENTIAL VS COMMERCIAL HEAT PUMP INSTALLATIONS BY CHANNEL OF DISTRIBUTION

4.1.6 HEAT PUMP SHIPMENTS BY UNIT CAPACITY

4.1.7 TRENDS IN ENERGY EFFICIENCY RATIOS (EER'S) FOR HEAT PUMPS

4.1.8 HEAT PUMP SHIPMENTS BY CENSUS REGION

4.1.9 TOTAL RESIDENTIAL CENTRAL HEATING/COOLING SYSTEM INSTALLATIONS BY REGION

4.1.10 HEAT PUMP SHIPMENTS BY MARKET SEGMENT (NEW CONSTRUCTION, REPLACEMENT, RETROFIT AND ADD-ON)

4.1.1 SUMMARY - MARKET STUDY OF CURRENTLY AVAILABLE HEAT PUMPS

The objective of the market study was to examine the past and present heating/cooling system market with particular focus on conventional heat pumps. This secondary research provides a basis for the forecast of Advanced Electric Heat Pump sales developed as the final part of this project.

In some instances preliminary projections were developed based on the historical data or trends. Other forecasts were generated by a (W) proprietary computer model revised to project Advanced Electric Heat Pump sales. All forecasts or projections appearing in this section apply to existing conventional or high efficiency heat pump models. They do not assume the availability of an Advanced Electric Heat Pump.

A. TOTAL VOLUME OF HEAT PUMP SHIPMENTS

Projected shipments show very strong increases especially beyond 1985 due to the higher saturation of new housing and increased shares of the replacement, retrofit, and add-on markets because of rising fuel prices which will make the heat pump more economically attractive to customers.

B. SPLIT VS. PACKAGE UNIT SHIPMENTS/APPLICATIONS

Preliminary projections based on historical trends as well as historical and projected trends for single and multi-family housing show a continued dominance of split system installations (representing over 70% of all heat pump installations by 1990) in single family housing.

C. RESIDENTIAL VS. COMMERCIAL HEAT PUMP INSTALLATIONS

Residential applications have and will continue to represent a majority of all heat pump shipments/installations.

The distribution of residential to commercial installations will remain relatively stable through 1990, based on growth projections for the residential and commercial markets, although the percentage of new residential shipments is expected to drop somewhat and commercial applications will increase.

D. HEAT PUMP SHIPMENTS BY UNIT CAPACITY

Overall the data show a steady decline in the average capacity of all heat pumps shipped. This shift to smaller unit capacity has been the result of:

1. Smaller heating/cooling loads afforded by better insulation and the smaller size of new homes.

2. Increased use of zoning, i.e., using two smaller units in place of a larger unit.

E. TRENDS IN ENERGY EFFICIENCY RATIOS (EER'S) FOR HEAT PUMPS

Units in the EER range of 6.5 - 7.4 have accounted for most of the volume produced to date.

The average EER of heat pump units installed has steadily increased since 1975. This trend is expected to continue due to:

1. The need for heat pump EER's to match that of other high efficiency cooling systems (especially in moderate and warm regions) in order to compete in the marketplace.

2. Continued pressure from federal (Department of Energy) and local governments for minimum EER standards (7.5) for residential air conditioning.

3. Increasing consumer demand for better operating efficiency because of rising fuel prices.

F. HEAT PUMP SHIPMENTS BY CENSUS REGION

The South Atlantic Region has accounted for the largest cumulative percentage of shipments for the period 1971 through 1979, representing

37.4% of all heat pumps shipped. This area's dominance has been due to: 1) Moderate heating loads 2) The need for air conditioning 3) Natural gas curtailments and availability and 4) Low electricity rates.

The East South Central Region ranks second, accounting for 14.7% of all current shipments.

G. TOTAL RESIDENTIAL HEATING/COOLING SYSTEMS INSTALLATIONS BY REGION

In 1979, the East North Central (with 10.6 million) and the South Atlantic (with 8.9 million) Regions had the major concentrations of cumulative residential central forced air system installations.

Nationwide, a total of 2.2 million heat pumps have been installed in existing housing, representing less than 5% saturation of total housing stock in 1979. The greatest number of heat pump installations has occurred in the South Atlantic Region, accounting for 32% of all installed heat pump systems.

H. HEAT PUMP SHIPMENTS BY MARKET SEGMENT (NEW CONSTRUCTION, REPLACEMENT, ADD-ON AND RETROFIT

Overall, there will be significant shifts in the relative volumes of the various heat pump market segments during the 1980's. The percentage of heat pumps used in new construction will decline, while Add-on/Retrofit applications will grow. This trend will primarily result from rising fuel prices which will increase demand for more efficient heating/cooling systems.

4.1.2 STUDY METHOD

Using the following secondary research sources: the Gas Appliance Manufacturers Association, the Air Conditioning and Refrigeration Institute, Housing Industry Dynamics, and U.S. Bureau of the Census, the market position of currently available heat pumps (both conventional and high efficiency models) was established.

Historical and current data on heat pump shipments by volume, split vs package systems, customer (residential or commercial), unit capacity, energy efficiency, region, and application (new construction, replacement, retrofit, add-on) were examined. Preliminary projections were developed by using either the trend shown in past data or the same (W) proprietary computer-based model revised for sales projections of the Advanced Electric Heat Pump. Key variables considered were: residential construction, fuel prices and availability, government regulation, and consumer attitudes toward energy efficiency. These projections apply solely to existing conventional and high efficiency heat pumps; they do not assume the existence of an Advanced Electric Heat Pump.

4.1.3 TOTAL VOLUME OF HEAT PUMP SHIPMENTS

Historical statistics on electric heat pump shipments show a gradual increase in volume from 1965 through 1975 followed by strong increases in 1976, 1977, and 1978 due to an upturn in housing starts and increased saturation of the new housing market because of natural gas curtailments. During the period from 1969 to 1979 the number of heat pumps shipped grew from less than one hundred thousand to more than a half million units. By 1979 shipments decreased with a downturn in the housing cycle and decreased saturation of new housing due to the increased availability of natural gas. In 1980 housing starts bottomed out and heat pump shipments dropped below the 1979 level to approximately four hundred thousand units.

Using the same (W) proprietary computer-based model developed for the Advanced Heat Pump sales forecast, conventional heat pump sales were projected as shown by the dotted line in FIGURE 4.1-1. This projection employing the Base Case assumptions (See Section 4.3.2) and Data Resources Inc. (DRI) Energy Forecast shows that shipments will increase through 1990, reaching above 1978 levels, with the volume passing the one million mark around 1986. This increase will be due to higher saturation of new housing and an increased share of the replacement, retrofit, and add-on markets because of rising fuel prices.

Table 4.1-1 shows historical and forecasted heat pump saturation of the new housing market. Between 1975 and 1978 the greatest number of heat pumps were installed in new housing, reaching a saturation high of 22% in 1978. Saturation starts to decline in 1979 continuing through 1985 due to increased availability of natural gas and its aggressive marketing. But, assuming that the price of natural gas beyond 1985 will increase reflecting current exploration costs (as the major econometric models do), heat pumps will become more economically attractive, reaching a projected fifty-one percent saturation of new housing by 1990.

Figure 4.1-1

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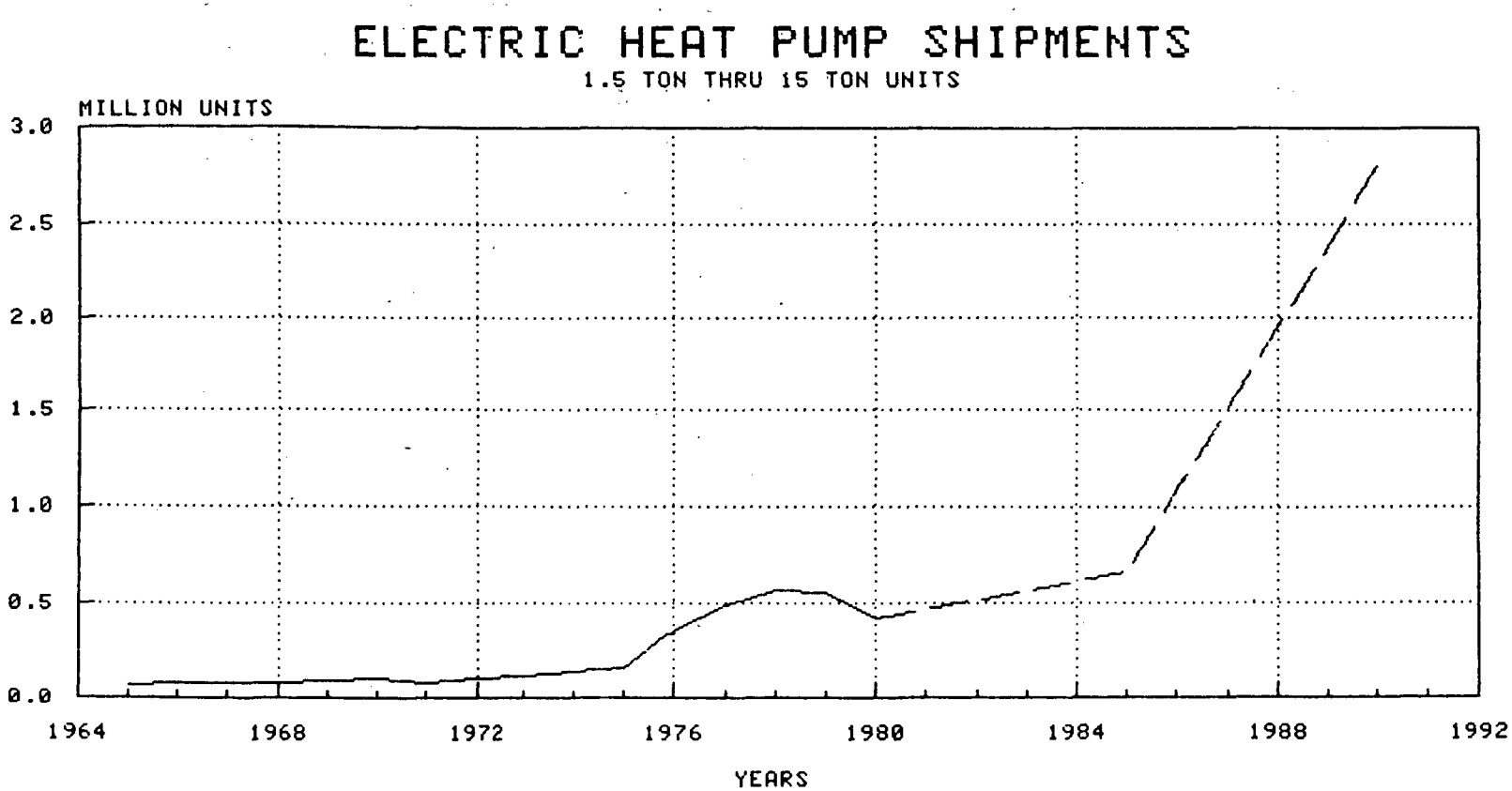


Source: Air Conditioning and Refrigeration Institute, Annual Shipment of Manufactures (W) Proprietary Computer Model for Base Case

— — — Projected Shipments

TABLE 4.1-1

HOUSING STARTS AND HEAT PUMP SATURATION

	HISTORICAL STATISTICS				
	1975	1976	1977	1978	1979
Housing Starts (Millions)	1.2	1.5	2.0	2.0	1.7
Saturation of Heat Pumps in New Housing	12%	14%	19%	22%	21%
Heat Pump shipments in New Housing (000)	144	210	380	440	357
Total Heat Pump Shipments (000) (Including commercial)	161	313	482	559	548
Heat Pumps in New Housing as Percent of Total	89%	67%	79%	79%	65%

	FORECAST		
	1980	1985	1990
Housing Starts (Millions)	1.3	2.1	2.2
Saturation of Heat Pumps in New Housing (Percent)	19%	15%	51%
Heat Pump Shipments in New Housing (000)	247	315	1,122
Total Heat Pump Shipment (000) (Including commercial)	420	649	2,813
Heat Pumps in New Housing as Percent of Total	59%	49%	40%

Source: Housing Industry Dynamics, Air Conditioning and Refrigeration Institute (ARI)

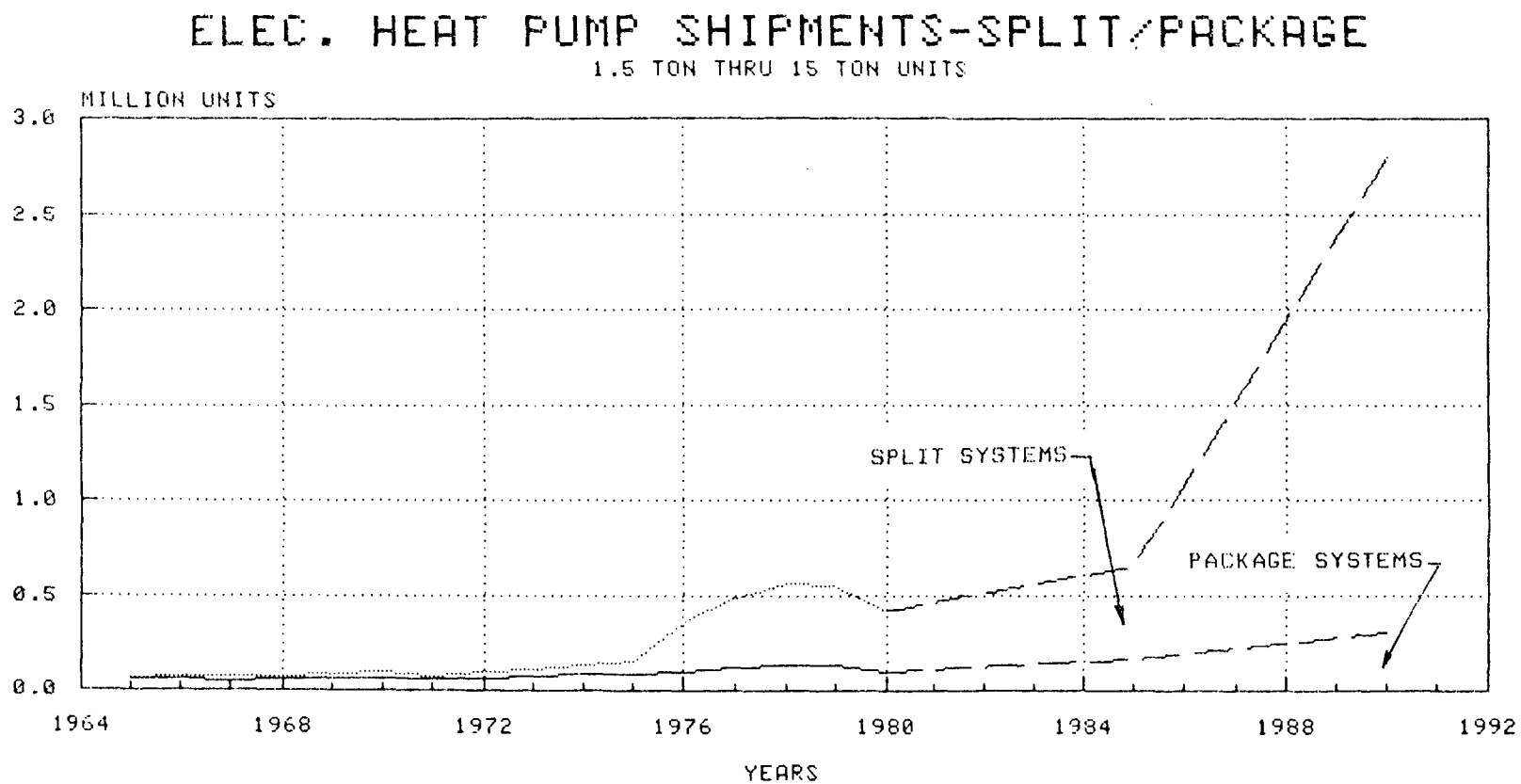
4.1.4 SPLIT VS PACKAGE UNIT SHIPMENTS/APPLICATIONS

Packaged heat pump systems, i.e., units in which the compressor and air handling sections are combined, dominated heat pump shipments during the slow growth period through 1975 when the majority of heat pumps were used in light commercial, some multi-family, and condominium applications (which favor packaged products). Split systems, i.e., units in which the compressor and air handling section are independent, became dominant in 1976 with the dramatic increase in heat pump usage for single family housing (which favors split system applications).

Preliminary projected applications based on the historical trend of split and packaged systems and the historical and projected trends for single and multi-family housing show a continued dominance of split system installations (representing over 70% of all heat pump installations by 1990) in single family housing. FIGURE 4.1-2 illustrates both historical and forecasted relative volumes of split and packaged heat pump shipments/applications.

FIGURE 4.1-2

ORNL-DWG 82-7987



Source: ARI Annual Shipment
of Manufacturers
(W) Proprietary Computer Model

— — —
Projected
Shipments

4.1.5 RESIDENTIAL VS COMMERCIAL HEAT PUMP INSTALLATIONS

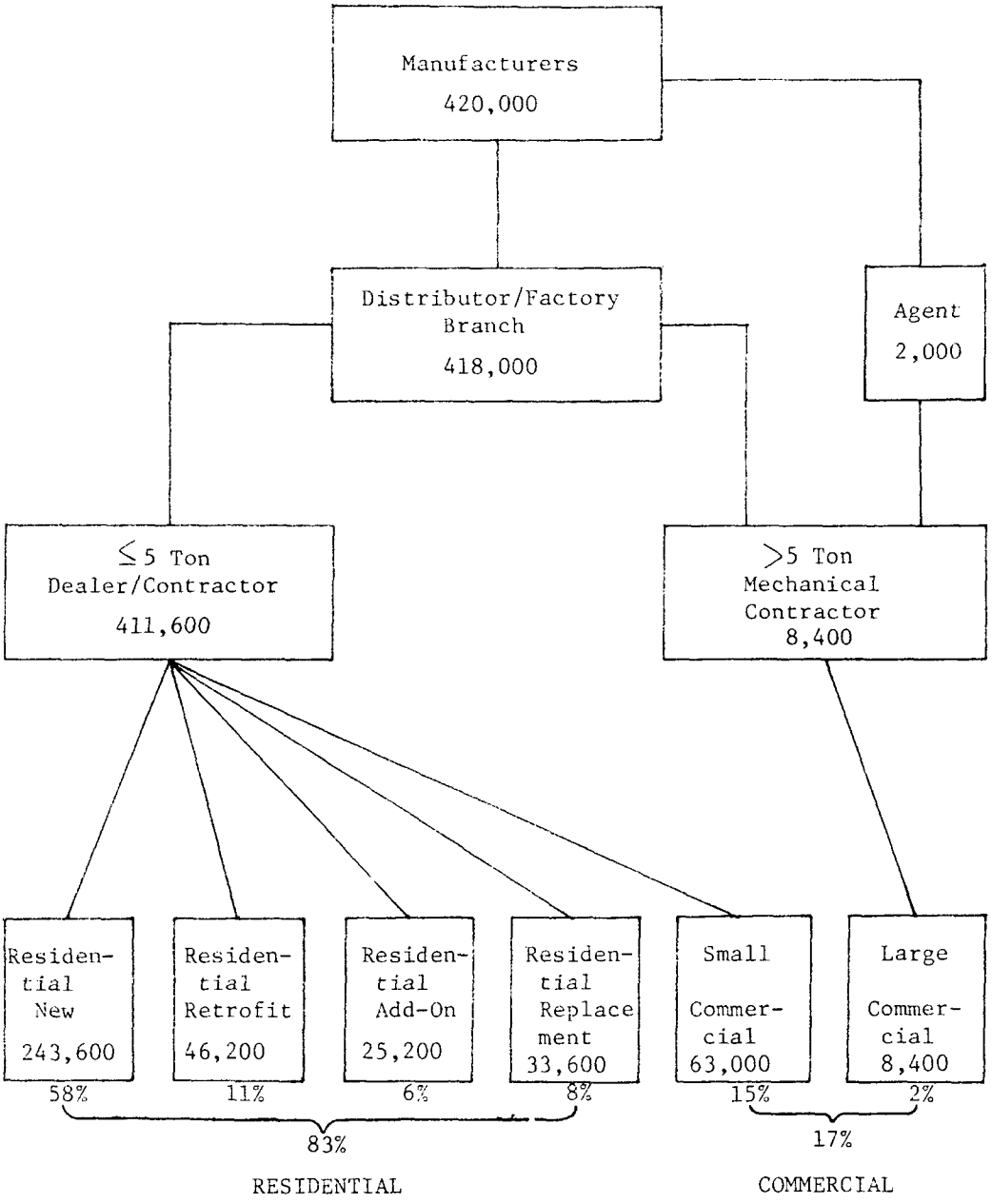
Residential applications have and are expected to continue to represent a majority of all heat pump shipments/installations. For example, in 1980, 83% of all heat pumps were distributed to residential customers, the largest part of this group being new residential construction customers (58%). The remaining 17% of all shipments went to commercial customers as shown in TABLE 4.1-2.

The distribution of installations is expected to remain relatively stable through 1990 based on growth projections for the residential and commercial markets, although the percentage of new residential shipments is expected to drop somewhat, and commercial applications will grow due to the increased energy cost-consciousness of building owners and managers.

TABLE 4.1-2

ELECTRIC HEAT PUMP SHIPMENTS DISTRIBUTION - 1980

U.S. ONLY



Sources:
1) Housing Industry Dynamics
2) NFO Multicard and Mail Surveys
3) Dealer/Distributor Interviews
4) Builder Estimates based on reports of Distributors and Sales Personnel
5) Other Secondary Sources - ARI, Honeywell, etc.

4.1.6 HEAT PUMP SHIPMENTS BY UNIT CAPACITY

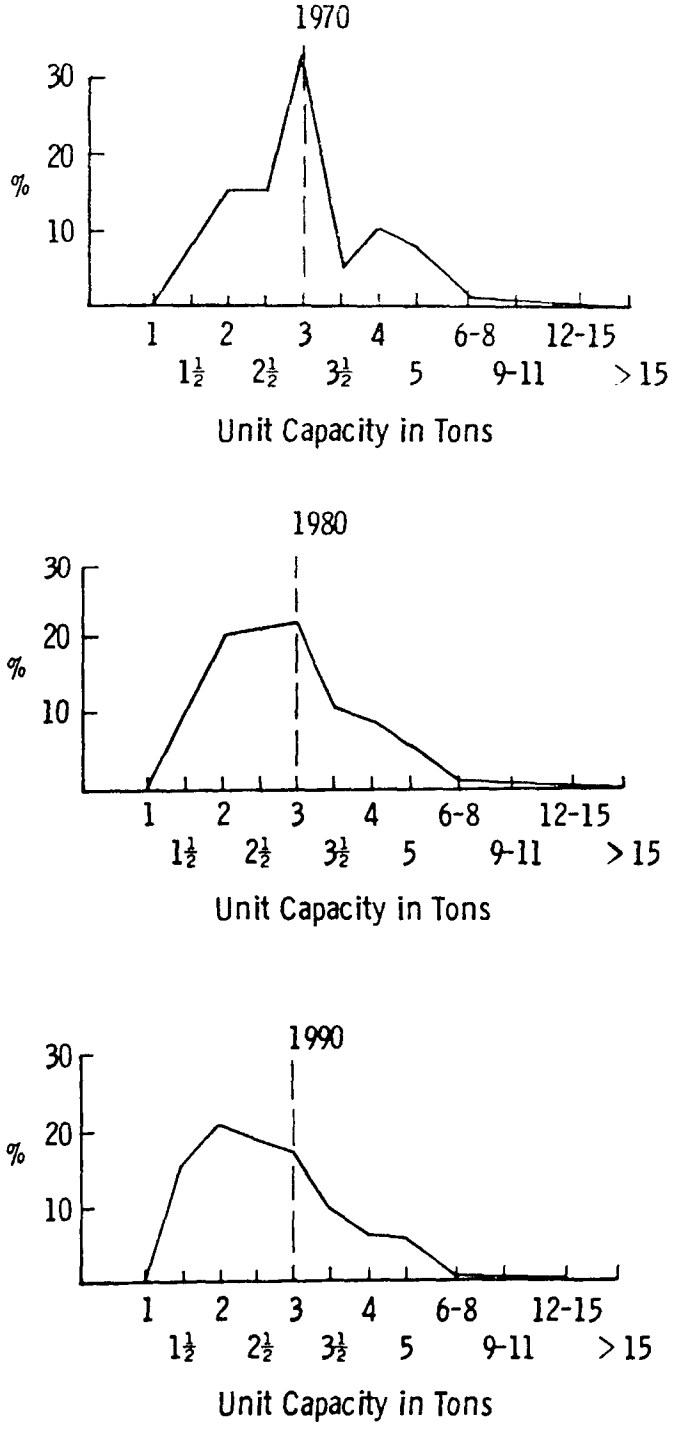
FIGURE 4.1-3 shows the distribution of heat pump shipments by unit capacity for 1970, 1980, and projected for 1990. In 1970 the three ton unit was the dominant size sold, accounting for 33% of total sales. The two and two and a half ton units together accounted for another third, while the three and a half ton unit was relatively insignificant.

By 1980 an almost equal number of two, two and a half, and three ton units were being shipped. Based on the historical-trend these three size units will continue to comprise over 60% of the total volume sold.

Preliminary projections show that by 1990 the two ton unit will be the most popular, and the one and a half ton unit will increase in significance. The two and a half and three ton units will each maintain almost a 20% share of the market.

Overall, there will be a steady decline in the average capacity of all heat pumps shipped. This shift to smaller unit capacity will be the result of smaller heating/cooling loads afforded by better insulation and the smaller sizes of new homes. Two half-capacity units (two tons) can also be substituted for a full-capacity four ton unit offering the options of a back up system as well as an opportunity for zoning.

ORNL-DWG 82-7988



Source: Air Conditioning and Refrigeration Institute
Ⓦ Proprietary Computer Model

Fig. 4.1-3—Distribution of heat pump unit capacities

4.1.7 TRENDS IN ENERGY EFFICIENCY RATIOS (EER) FOR HEAT PUMPS

Since industry energy efficiency data is primarily available in the form of EER ratings for the cooling function, coefficient of performance (COP) trends will not be addressed in this section. However, average COP's based on manufacturers' published data will be addressed in the sales potential section.

Historical and forecasted heat pump shipments by EER trend are graphed in Figure 4.1-4. According to the data supplied by the Air Conditioning and Refrigeration Institute most manufacturers discontinued production of units with EER's of 6.4 or less by 1980. Units in the EER range of 6.5 - 7.4 have accounted for most of the volume produced to date.

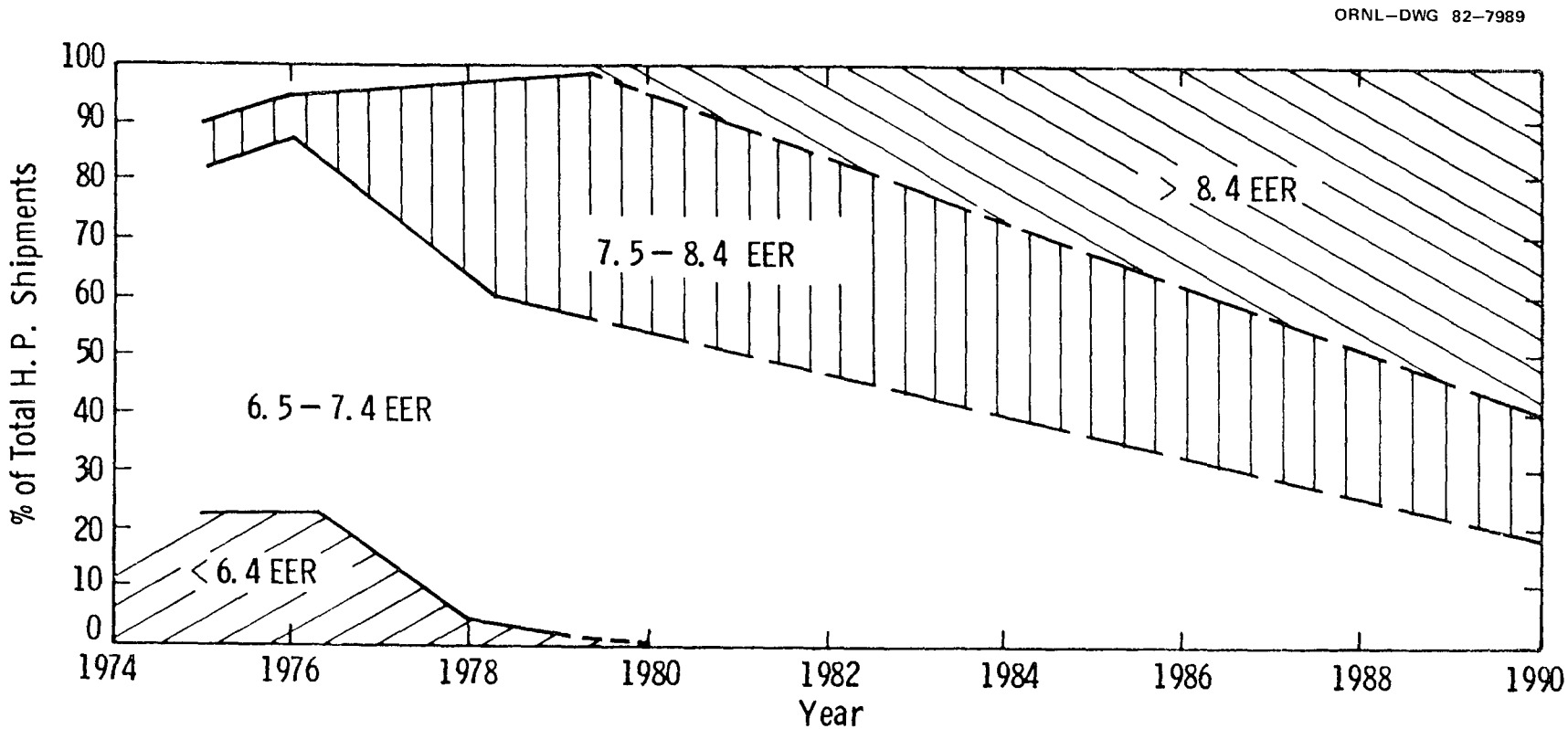
The average EER of heat pump units installed has steadily increased since 1975. This trend is expected to continue due to:

1) The need for heat pumps to match the EER's of other high efficiency cooling systems (especially in moderate and warm regions) in order to compete in the market.

2) Continued pressure from federal (Dept. of Energy) and local governments for minimum EER standards (7.5) for residential air conditioning (although no government legislation is currently in effect).

3) Increasing consumer demand for better operating efficiency because of rising fuel prices.

As a result of the above factors, it is projected that by 1990 64% of all heat pumps shipped will have EER's exceeding 8.4. Table 4.1-3 gives a breakdown of the percentage of heat pumps shipped according to EER for 1980, 1985, and 1990. Projections were based on current and historical EER trends.



Data Source: Air Conditioning and Refrigeration Institute ---- Westinghouse Projections

Fig. 4.1-4–U. S. heat pump EER trend (1975-1990)

TABLE 4.1-3

U.S. HEAT PUMP EER TREND
1980 - 1990 SHIPMENTS

(Including Commercial)

Units in Thousands

	1980		1985		1990	
	UNITS	%	UNITS	%	UNITS	%
≤ 6.4 EER	0	0	0	0	0	0
6.5 - 7.4 EER	231	55	227	35	563	20
7.5 - 8.4 EER	181	43	123	19	450	16
> 8.4 EER	8	2	229	46	1,800	64
TOTAL	420	100%	649	100%	2,813	100%

Sources: Air Conditioning and Refrigeration Institute
Westinghouse Projections

4.1.8 HEAT PUMP SHIPMENTS BY CENSUS REGION

Figure 4.1-5 and Table 4.1-4 document the cumulative regional percentages and volumes of heat pump shipments for 1971 through 1979. The South Atlantic Region (Delaware, District of Columbia, Maryland, West Virginia and Virginia, North and South Carolina, Georgia and Florida) has accounted for the largest number of shipments, currently representing 37.4% of all heat pumps shipped. Moderate heating loads, the need for air conditioning, natural gas curtailments and availability*, and low rates for electricity have all contributed to this area's dominance of the market.

The East South Central region composed of Kentucky, Tennessee, Mississippi, and Alabama ranks second, accounting for 14.7% of all current shipments.

Together the South Atlantic, East South Central, and East North Central (Wisconsin, Illinois, Indiana and Ohio) regions which correspond to DOE climatic regions II, III, and IV, account for over 60% of all heat pump shipments.

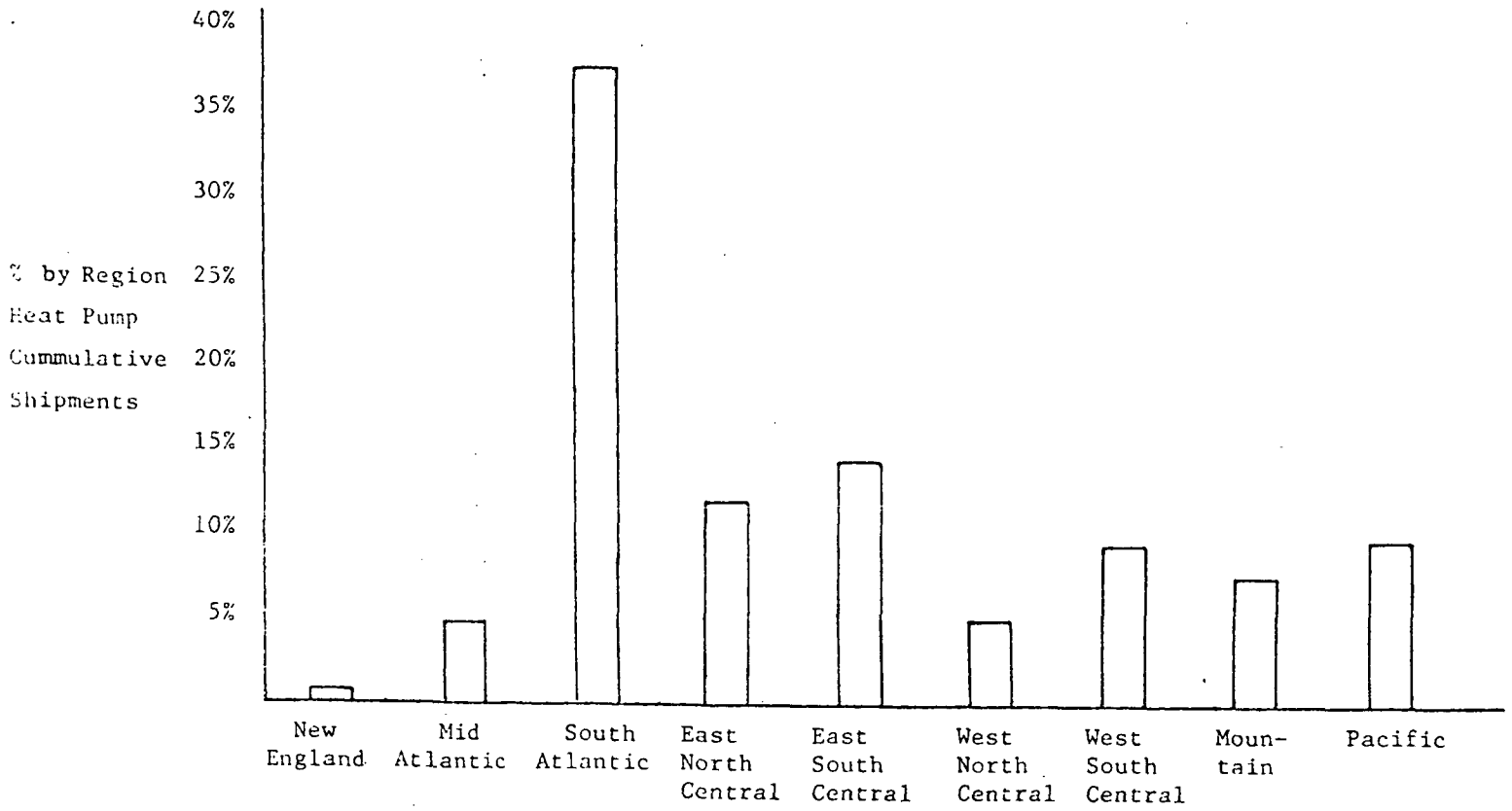
* In some areas, natural gas companies choose not to install gas pipelines to supply customers with natural gas because of the high cost of the pipeline and low customer demand.

FIGURE 4.1-5

ORNL-DWG 82-7990

REGIONAL SHARES OF HEAT PUMP SHIPMENTS

PERCENT OF CUMMULATIVE TOTAL - 1971 THRU 1979



Source: 1) Mfg. Reported Shipments by U.S. Trading Areas

2) Air Conditioning and Refrigeration Institute

TABLE 4.1-4

U.S. HEAT PUMP SHIPMENTS

BY CENSUS REGION

Units in Thousands

	NE	MA	SA	ENC	ESC	WNC	WSC	MTN	PAC	U.S. * TOTAL
1971	.5	1.0	27.0	1.1	7.4	.7	3.3	2.1	4.9	48.0
1972	.6	.8	27.1	2.1	9.0	.9	2.7	1.4	4.9	49.5
1973	.4	1.7	30.5	3.7	13.2	2.0	3.4	1.7	4.4	61.0
1974	.9	3.0	25.9	7.2	15.4	4.2	3.9	1.9	6.0	68.4
1975	1.1	4.1	34.6	14.6	18.8	6.0	5.4	4.0	7.4	96.0
1976	1.6	8.9	71.7	29.3	35.5	12.1	12.9	9.1	14.2	195.3
1977	4.1	20.4	146.1	63.7	61.8	27.5	38.3	22.7	32.1	416.7
1978	3.4	27.7	180.7	60.8	66.3	28.0	54.2	40.5	49.6	511.2
1979	4.8	28.6	196.4	45.1	63.3	17.6	52.5	55.2	69.4	532.9
CUMULATIVE TOTALS	17.4	96.2	740.0	227.6	290.7	99.0	176.6	138.6	192.9	1,979.0
% BY REGION	.9	4.9	37.4	11.5	14.7	5.0	8.9	7.0	9.9	100%

Source: 1) Mfg. Reported Shipments by U.S. Trading Areas

2) Air Conditioning and Refrigeration institute

* U.S. Total does not agree with Mfg. Total reported shipments because all mfgs. do not report by Trading Area.

4.1.9 TOTAL RESIDENTIAL CENTRAL HEATING/COOLING SYSTEM INSTALLATIONS BY REGION

Table 4.1-5 gives a detailed breakdown of the total stock of residential central heating/cooling systems by census region.

In 1979 the East North Central (with 10.6 million) and the South Atlantic (with 8.9 million) Regions had the major concentrations of cumulative residential central forced air system installations.

Nationwide a total of 2.2 million heat pumps has been installed in existing housing, representing less than 5% of all residential forced air systems and less than 5% saturation of total housing stock in 1979. The greatest number of heat pump installations occurred in the South Atlantic Region which accounted for 32% of all installed systems.

TABLE 4.1-5

CENTRAL HEATING AND AIR CONDITIONING SYSTEMS
IN
1979 HOUSING STOCK (MILLION)

	NATIONAL	NE	MA	ENC	WNC	SA	ESC	WSC	MTN	PAC
Heat Pump	2.22	.02	.14	.25	.15	.71	.27	.21	.27	.20
Gas WAF	28.40	.45	2.23	7.32	3.86	2.73	1.39	4.08	1.89	4.45
Oil WAF	9.89	1.24	2.61	2.02	.75	2.63	.12	.12	.18	.22
Elec. WAF	7.41	.11	.21	.74	.32	2.64	.74	1.59	.32	.74
Yr. Rnd. Gas A/C	2.50	.05	.09	.29	.11	.23	.19	.25	.23	1.06
	50.42	1.87	5.28	10.62	5.19	8.94	2.71	6.25	2.89	6.67
HEATING AND COOLING										
Heat Pump	2.22	.02	.14	.25	.15	.71	.27	.21	.27	.20
Gas WAF	9.45	.09	.71	1.83	1.24	1.61	.75	2.45	.32	.45
Oil WAF	3.72	.32	.73	.65	.30	1.42	.07	.08	.08	.07
Elec. WAF	4.04	.04	.07	.30	.13	1.66	.44	1.08	.13	.19
Yr. Rnd. Gas AC	2.50	.05	.09	.29	.11	.23	.19	.25	.23	1.06
	21.93	.52	1.74	3.32	1.93	5.63	1.72	4.07	1.03	1.97
HEATING ONLY										
Gas WAF	18.95	.36	1.52	5.49	2.62	1.12	.64	1.63	1.57	4.00
Oil WAF	6.17	.92	1.88	1.37	.45	1.21	.05	.04	.10	.15
Elec. WAF	3.37	.07	.14	.44	.19	.98	.30	.51	.19	.55
	28.49	1.35	3.54	7.30	3.26	3.31	.99	2.18	1.86	4.70

* Excludes Hydronic Central Systems and All Room Units because retrofit and add-on economic analysis assume existing ductwork. WAF signifies warm air furnace.

Data Sources: Air Conditioning and Refrigeration Institute
Gas Appliance Manufacturers Association
Housing Industry Dynamics 1979 Survey
U.S. Bureau of the Census - C25 Construction Report 1978

4.1.10 HEAT PUMP SHIPMENTS BY MARKET SEGMENT (NEW CONSTRUCTION, REPLACEMENT, ADD-ON, AND RETROFIT)

Heat pump shipments are broken down according to market segment or application for 1980 with preliminary projections for 1985 and 1990 in Table 4.1-6. The majority of heat pumps are currently used in new residential construction. While the percentage of all heat pumps used in new construction is expected to drop from 59% in 1980 to a low of 40% in 1990 this will be offset by an increase in Add-on/Retrofit applications, which will grow from 16% in 1980 to 33% of all heat pumps shipped by 1990.

Add-on applications will occur primarily in conjunction with oil and gas furnace systems providing the following benefits:

1) An effective means of reducing fuel costs.
2) Allowing a back-up heating system.
3) A bonus of air conditioning ("free cooling")

Retrofit applications have primarily replaced oil and electric furnaces, but if projected fuel prices hold, gas installations will also be threatened. Replacement requirements have been minor in the past because the conventional heat pump has only been sold since the early 1960's. But, this market will increase in volume as original installations reach replacement age.

Overall, there will be significant shifts in the relative volumes of the various heat pump market segments during the 1980's. While new construction accounts for the largest percentage of current heat pump applications, this segment's percentage will decrease and Add-on/Retrofit applications will grow. The major factor influencing this trend is expected to be rising fuel prices which will increase demand for more efficient heating/cooling systems.

TABLE 4.1-6

HEAT PUMP SHIPMENTS
NEW CONSTRUCTION, REPLACEMENT, ADD-ON, RETROFIT MARKET SEGMENTS

Units in Thousands

	1980		1985		1990	
	UNITS	PERCENT	UNITS	PERCENT	UNITS	PERCENT
Residential						
New Construction	247	59%	315	49%	1,122	40%
Replacement	34	8	75	12	300	11
Add-on, Retrofit	68	16	151	23	922	33
Total Residential	349	83	541	83	2,344	83
Commercial	71	17	108	17	469	17
Heat Pump Total	420	100%	649	100%	2,813	100%

Sources:
1) Air Conditioning and Refrigeration Institute
2) Housing Industry Dynamics
3) NFO Multicard and Mail Surveys
4) Westinghouse proprietary computer forecast
5) Westinghouse Heating and Cooling Unit estimates

4.2 MARKETABILITY ANALYSIS FOR ADVANCED HEAT PUMP

4.2.1 SUMMARY

4.2.2 STUDY METHOD

4.2.3 DECISION MAKERS

4.2.4 PURCHASE CRITERIA

4.2.5 DECISION METHOD

4.2.6 DESIRED PRODUCT FEATURES

4.2.7 BARRIERS TO COMMERCIALIZATION

4.2.8 PRESENT APPLICABILITY TO MARKET SEGMENTS (NEW CONSTRUCTION, REPLACEMENT, RETROFIT, AND ADD-ON)

4.2.1 SUMMARY - ADVANCED ELECTRIC HEAT PUMP MARKETABILITY

The primary objective of the Advanced Heat Pump marketability analysis was to assess the market potential of this product by using primary research techniques to identify:

1) Key individuals or groups who influence the decision to purchase zero to fifteen ton heating/cooling systems in the current (residential) new construction, replacement, retrofit and add-on markets. (New residential construction accounts for the largest number of current conventional heat pump installations).

2) The evaluation process or specific criteria considered by these groups in making the purchase decision.

3) The strengths and weaknesses of an Advanced Electric Heat Pump against alternative heating/cooling systems in meeting the criteria identified above.

Based on heat pump shipments for 1979 builders of new homes were the key decision makers (accounting for 50% of all units sold) followed by consumers who accounted for 31% of all units sold. Data supplied by Housing Industry Dynamics also emphasizes the importance of the home builder. It is estimated that the choice of heating/cooling system in new residential construction is made by the home builder 85% of the time.

The use of simple payback period analysis by consumers (a rough calculation of the amount of time necessary to recover initial system cost) as a purchase criterion was a key research finding of a Mail Survey of 500 families (conducted by National Family Opinion, Inc.). Most builders of new homes choose the heating/cooling system that requires the least initial investment, but they will consider systems that payback initial costs within three years. With consumers or homeowners energy efficiency (operating cost) is the chief criterion followed by purchase price. Fifty-six percent of those surveyed will accept a higher purchase price for a more efficient system which will payback original cost in four years.

Heat pump features in order of their desirability to customers are: 1) Efficiency 2) Low Noise 3) Reliability 4) Even heat/humidification 5) Attractive appearance and 6) Serviceability (including availability of parts). Low noise level is the only significant feature which was not also identified as a purchase criteria. Efficiency, reliability, humidification, size, serviceability, style, and ease of installation were mentioned as both desired product features and purchase criteria.

The following are the major barriers to the commercialization of the Advanced Heat Pump:

1) Consumer product awareness - almost half (45%) of the consumers surveyed did not know what a heat pump is. Extensive education or promotion would be required to stimulate sales.

2) Cost competitiveness - Based on the current relative costs of natural gas and electricity, the conventional heat pump costs more to own and operate than a gas warm air furnace with central air conditioning.

3) Price and availability of natural gas - Gas curtailments in the late 1970's stimulated heat pump sales. Since there are currently few curtailments, the continued availability of natural gas and the relative prices of natural gas and electricity make it difficult for heat pumps to economically compete.

CONCLUSIONS

Overall, the position of an Advanced Electric Heat Pump (assuming its existence in the current market) would be weak against a natural gas system in all market segments. The market potential will depend primarily on the relative costs of gas, oil and electricity, in addition to the availability of natural gas. Consumers will accept an Advanced Electric Heat Pump system that meets specified payback requirements, i.e., 56% of the homeowners surveyed were willing to pay more for a more efficient heating/cooling system which will payback the additional cost in four years. As fuel prices rise the demand for more efficient heating and cooling systems, and therefore the market for an Advanced Electric Heat Pump will increase.

4.2.2 STUDY METHOD

This section is based on extensive primary research involving all parties who influence the purchase of zero to fifteen ton heating/cooling systems. Details of the research methods, the sources, the population, and the purposes are shown in Table 4.2-1. (See the Appendix, 5.0, for questionnaires used.)

Data were gathered in the following ways:

1) Consumers were polled through focus groups, a Multicard survey, and a mail survey.

2) Builders, Electric Utilities, and Heating/Cooling Equipment Distributors were surveyed through personal interviews.

3) Dealers (Contractors) were interviewed by telephone.

It was assumed that each of the above groups would play a role in some or all decisions involving the selection of a heating/cooling system.

The data collected were analyzed to determine the decision making process for selection of heating/cooling systems. Research for this section was conducted by Westinghouse Marketing/Management Studies. The Multicard and mail surveys were subcontracted to National Family Opinion,(NFO), Inc. which used the following methods:

1) Mail Survey - questionnaires were mailed to 400 families which included representative samples of both Heat Pump owners and nonowners. The returns of 360 families were tabulated.

2) Multicard Survey - A multicard was mailed to 15 NFO Panels* comprised of 15,000 families. The returns of 10,365 families were tabulated.

* An NFO Panel consists of 1,000 families previously selected to conform to the latest available U.S. Census data for the 9 geographic divisions and within each division by population density, age of homemaker, annual family income and family size.

TABLE 4.2-1

MARKETABILITY ANALYSIS - PRIMARY RESEARCH

RESEARCH METHOD	SOURCE	SAMPLE	PURPOSE
Focus Groups	Consumers	Two prescreened groups: 8 Heat Pump Owners and 8 Nonowners; in Cities of: Pittsburgh, Phoenix, Baltimore, Nashville, Charlotte and Minneapolis	Gain general insight into thinking of customers Develop questions for Mail Survey
Multicard Survey* Summer 1980	Consumers	Statistically balanced sample, Mailing of 15,000 (N=10, 365)**	Random identification of 200 Conventional Heat Pump owners for Mail Survey Gather Statistics on system incidence by region, etc.
Mail Survey* Summer 1980	Consumers	Statistically balanced sample 200 Heat Pump owners (N=176) 200 nonowners (N=148)	Determine consumer likes and dislikes about heat pumps Verify use of payback criteria Determine payback requirements
Personal Interviews	Builders Electric Utilities Heating/Cooling Equipment Distributors	25 in 18 major metro areas	Determine purchase criteria of builders Discuss promotional programs of electric utilities Obtain sales projections from distributors for Heat Pumps and advanced units.
Telephone Interviews	Dealers (Contractors)	175 in 18 major metro areas	Determine purchase criteria of consumers.

* Subcontracted to National Family Opinion, Inc. (NFO)

** N = Number of returned questionnaires

4.2.3 DECISION MAKER

Fifty percent of all heat pumps shipped in 1979 were estimated to have gone to builders of new homes as shown in Table 4.2-2. Consumers ranked second, making the purchase decision for a small percentage of new homes (15%), but for almost all residential replacement, retrofit, and add-on applications (90%). Contractors and dealers were minor factors.

The choice of heating/cooling system in new housing construction is made by the builder 85% of the time as shown in Table 4.2-3. This 85% includes speculative housing installations which comprise the majority of cases (75%), and installations in half of the semi-custom construction. The consumer is the primary decision maker for some semi-custom and all custom homes, accounting for the remaining 15% of new residential construction.

TABLE 4.2-2

1979
HEAT PUMP SHIPMENTS BY
DECISION MAKER AND MARKET SEGMENT

Units in Thousands

	INDUSTRY SHIPMENTS UNITS	% OF TOTAL IND. SHIPMENTS	MARKET SEGMENTS: NEW UNITS	NEW %	REPLACEMENT/ RETROFIT AND ADD-ON UNITS	REPLACEMENT/ RETROFIT AND ADD-ON %
Residential						
Builder	280	50%	280	85		
Consumer 2	175	31%	50	15	125	90
Dealer 3	15	3%			15	10
TOTAL	470	84%	330	100%	190	100%
Commercial[1]						
Owner Contractor/Dealer	90	16%	88	100%	2	100%
TOTAL	90	16%	88	100%	2	100%
TOTAL HEAT PUMPS	560	100%	418	75%	142	25%

Sources: NFO Survey (Summer 1980)
Air Conditioning and Refrigeration Institute
Housing Industry Dynamics

1 - Estimates by (W) Heating and Cooling Business Unit
Personal Interviews with Distributors and Utilities

2 - NFO Surveys of Consumers

3 - Telephone Survey of Dealers

TABLE 4.2-3

HEAT PUMP PURCHASE DECISION BY MARKET SEGMENT

	DECISION MAKER					
	BUILDER	(HOMEOWNER) CONSUMER	DEALER	BUILDING OWNER	CONTRACTOR/ DEALER	TOTAL
Residential						
New Construction	85%	15%				100%
Replacement Retrofit Add-on		90%	10%			100%
Commercial[1]						
New Construction				60%	40%	100%
Replacement				60%	40%	100%

Sources: National Family Opinion, Inc. (Summer 1980 Survey)
Air Conditioning and Refrigeration Institute Annual Estimate of Shipments by Market Segment
Mail Survey of Consumers

1: Heating and Cooling Business Unit Estimates
Personal Interviews with Distributors
Telephone Survey of Dealers

4.2.4 PURCHASE CRITERIA

Purchase criteria of consumers, builders, and dealers were ranked as shown in Table 4.2-4. Overall, energy efficiency and price were the most important factors together accounting for 60% of the total. For consumers energy efficiency was the chief criterion, with system price second. Recommendations from others also influence their decisions.

Builders base their choice of heating/cooling system on price first followed by energy efficiency. While dealers seldom actually make the purchase decision, they feel that energy efficiency is more important than price, reflecting consumer values.

Several other criteria were mentioned, none of which amounted to more than 5% of the total. The unweighted average was calculated to represent a composite rating for observational purposes.

TABLE 4.2-4

CRITERIA FOR CHOICE OF HEATING/COOLING SYSTEM

Unit in Percent

CRITERIA	CONSUMER MAIL SURVEY	CONSUMER MULTI-CARD	CONSUMER UNWEIGHTED AVERAGE	BUILDER PERSONAL INTERVIEW	DEALER PHONE SURVEY	UNWEIGHTED AVERAGE
Energy Efficiency	28	34	31	18	47	32
Price	23	19	21	38	25	28
Fulfilled Need	--	11	6	10	--	5
Reliability	7	6	7	5	3	5
Recommended	19	4	12	--	3	5
Fuel Availability	3	8	5	5	2	4
Installation	--	7	4	3	4	4
Dealer/Mfr. Reputation	5	--	2	--	5	3
Comfort	--	4	2	3	2	2
Economics	--	--	--	--	4	1
Clean	--	5	3	--	--	1
Quality	--	1	0	--	4	1
Service	3	--	1	--	1	1
Publications	5	--	3	--	--	1
Safety	1	--	1	--	--	--
Guarantee	3	--	1	--	--	--
Other	3	--	1	12	--	4
Total (*)	100	100	100	100	100	100

Sources: 1) NFO Multicard & Mail Surveys
2) Personal Interviews with Builders
3) Telephone Survey of Dealers

* Totals may not add up due to rounding

4.2.5 DECISION METHOD

When the decision maker chooses a heating/cooling system from alternatives of varying efficiencies and costs the evaluation is based on an analysis of simple payback, i.e., the amount of time needed to recover initial system costs. Before consumers were presented with alternatives they reported that their purchase criteria were efficiency, cost, and the recommendations of others. After being asked a question on how much more they would be willing to pay initially for a more efficient system, 45% said they had used a simple payback analysis to make their decision. The shift in purchase criteria shown in Table 4.2-5 clearly points out that consumers do make purchase decisions based on simple payback analysis using rough calculations of the costs involved over time. Use of payback analysis was first discovered through discussions with consumer focus groups.

Consumer or homeowner payback requirements were determined by asking how much over $2300 he/she would be willing to pay for a system which saves 20% or $160 per year on an utility bill of $800. Fifty-six percent of the respondents were willing to pay an additional cost for a more efficient system which would payback their initial investment in four years. Sixty-five percent would accept a system with a three year payback. Figure 4.2-1 illustrates the percentage of homeowners vs. acceptable payback period.

Most builders currently make their choice on the basis of initial system cost, however some are beginning to consider one and two year payback periods as the homeowner becomes more concerned with energy efficiency or operating cost.

TABLE 4.2-5

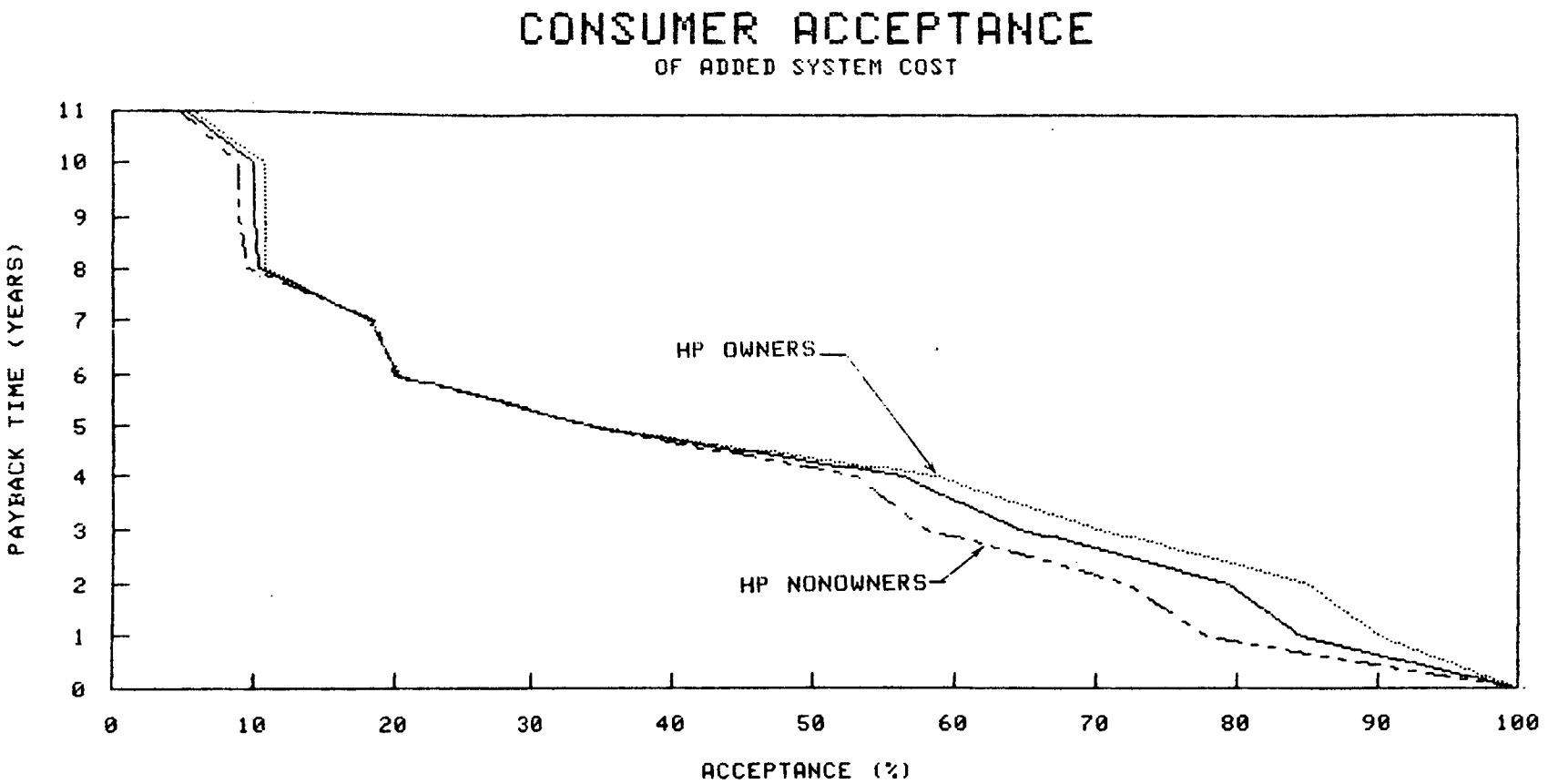
DECISION CRITERIA/METHOD FOR CHOICE OF HEATING/COOLING SYSTEM

	BEFORE PAYBACK QUESTION	AFTER PAYBACK QUESTION
Payback	0%	45%
Efficiency/Fuel Savings	28	15
Cost	23	14
Recommendations	19	3
Other	30	23
TOTAL	100%	100%

Source: National Family Opinion, Inc., Mail Survey of Consumers (Summer 1980)

FIGURE 4.2-1

ORNL-DWG 82-7991



SOURCE: National Family Opinion Mail Survey - Summer 1980
N= 324

4.2.6 DESIRED PRODUCT FEATURES

Desired product features in a heating/cooling system rated by consumers, builders and dealers are shown in Table 4.2-6. Low noise level is the only significant feature which was not also mentioned as a purchase criteria. Efficiency, reliability, humidification, size, serviceability, style, and ease of installation were mentioned as both desired product features and purchase criteria.

Heat pump features in order of their desirability to customers are: 1) Efficiency 2) Low noise 3) Reliability 4) Even heat/humidification 5) Attractive appearance and 6) Serviceability (including availability of parts). Heat pumps are preferred significantly more than other systems because of their efficiency. Overall system cost (capital and operating costs) was cited by consumers (both heat pump and non-heat pump system owners) as the major marketing disadvantage. Customers also perceive all heat pump brands as having comparable reliability.

TABLE 4.2-6

FEATURES DESIRED IN HEATING/COOLING SYSTEM

Units in Percent

	CONSUMER[1]		BUILDER[2]		DEALER[3]		AVERAGE	
	MAIL	MULTICARD	CONSUMER	BUILDER	CONSUMER	DEALER	WEIGHTED	UNWEIGHTED
*Efficiency	46	7	7	26	11	8	21	19
Low Noise	6	25	19	11	27	--	14	14
*Reliability	17	1	9	13	12	30	12	14
*Humidification	3	15	12	--	15	--	7	7
*Size	--	20	2	11	--	--	6	5
*Serviceability	--	--	5	8	--	10	4	4
*Style	--	1	12	--	7	--	3	3
*Ease of Installation	--	--	--	--	--	11	1	2
Parts Availability	--	--	--	3	--	7	1	2
Other	28	31	34	28	28	34	30	30
	100	100	100	100	100	100	99	100

* Also cited as criteris for purchase

Sources: 1) Multicard and mail surveys by National Family Opinion, Inc.
2) Personal interviews of builders
3) Telephone survey of dealers

4.2.7 BARRIERS TO COMMERCIALIZATION

Table 4.2-7 shows consumer disposition toward and awareness of heat pumps and other heating/cooling systems. Product awareness is a definite problem with almost half or 45% of those surveyed not knowing what a heat pump is. This finding has implications for the successful marketing of an Advanced Electric Heat Pump. A promotional or educational program would be necessary to inform consumers about heat pumps, both their general benefits and the particular advantages of the advanced model. Of those who know what a heat pump is, almost one half said they would consider buying one.

Climate and the cost of fuel were given as reasons for not buying heat pumps, mostly in colder climates. These answers reflect or reinforce the consumer demand for energy efficient products. Earlier efficiency was identified as both a purchase criterion and a desired product feature. Since the Advanced Electric Heat Pump will initially cost more than alternatives systems, its efficiency must not only be greater than that of other systems, but must be good enough to meet the payback requirements previously identified (four years on the average).

Few utilities currently promote the use of heat pumps because conventional heat pumps are less efficient in the air conditioning mode than most new standard air conditioners thus contributing to increases in the utility's summer peak demand. Most utilities do have programs promoting the use of high efficiency air conditioners to reduce their summer demand. (There are areas where electric resistance heating is widely used and utilities do promote heat pump use as a means of reducing winter peaks.)

Despite the favorable contribution of heat pumps to winter heating efficiency, most electric utilities stress energy conservation through better insulation by advertising for builders who meet their insulation standards and emphasizing to homeowners the savings to be gained through better insulation. (A few utilities in specific regions do have heat pump certification and promotional programs to reduce winter demand.)

However, utility interest in and support of heat pump usage is growing as evidenced by a recent announcement in the Wall Street Journal. The Electric Power Research Institute (EPRI) has launched an $11.7 million research and development effort in heat pump technology which will result in advanced heat pump models for residential and small commercial use.

This announcement indicates that at least one of the existing barriers to commercialization of an Advanced Electric Heat Pump, utility resistance, has lessened. An aggressive advertising campaign by heat pump manufacturers would be an effective means of increasing consumer awareness and would therefore be a major factor in overcoming another of the remaining barriers to both standard and Advanced Heat Pump sales.

TABLE 4.2-7

CONSUMER DISPOSITION TOWARD AND AWARENESS OF HEAT PUMPS

	HEAT PUMP OWNERS	ALL OTHER SYSTEMS	WEIGHTED TOTAL *
Don't know what it is	4%**	47%	45%
Would consider buying	82	26	29
Would not buy	14	27	26
TOTAL	100%	100%	100%

REASONS FOR NOT BUYING HEAT PUMP

	HEAT PUMP OWNERS	ALL OTHER SYSTEMS	WEIGHTED TOTAL*
Climate	1%	6%	6%
Cost of Fuel	1	4	4
Not Suited to House	1	3	3
Prefer Other System	1	3	2
All Other	10	11	11
TOTAL	14%	27%	26%

* Weighted by Heating/Cooling System incidence at 4.6% Heat Pumps and 95.4% all other systems.

** Discrepency probably due to one person in a household responding as a Heat Pump owner to the Multicard survey, then a different person filling out the follow-up Mail Survey.

Source: NFO Consumer Multicard and Mail Surveys

4.2.8 PRESENT APPLICABILITY TO MARKET SEGMENTS (NEW CONSTRUCTION, REPLACEMENT, RETROFIT, AND ADD-ON)

An Advanced Electric Heat Pump could be expected to have the following impact on the current residential heating/cooling system market:

A. NEW CONSTRUCTION

Heating/cooling system installations in new housing (the largest current market) are based on the builder's decision which is oriented toward lowest initial system cost or a very short payback period (one to two years). Given these criteria, a natural gas system will usually be chosen over the electric heat pump based on current relative fuel prices and the overall costs to own and operate both systems. In areas where natural gas is not available the Advanced Heat Pump may be the system of choice.

B. REPLACEMENT

In the replacement market there is currently a significant number of gas systems with central air conditioning due for replacement, but in most cases the replacement will probably be a gas system. There is not a significant accumulation of heat pumps coming up for replacement at the present time.

C. RETROFIT

A moderate number of electric and oil fuel systems will be retrofitted on the basis of cost-effectiveness.

D. ADD-ON

For most additions to existing gas or oil furnaces a conventional heat pump is appropriate. An Advanced Electric Heat Pump is unnecessary since fossil fuel, not electricity, would most likely be used in climates of extreme cold.

Overall, penetration of the present replacement, retrofit, and add-on markets would be slow or gradual.

The following section, U.S. Market Forecast for the Advanced Electric Heat Pump through 1990, will include an assessment of the Advanced Electric Heat Pump's impact on the above market segments in future years.

4.3 U.S. MARKET FORECAST FOR THE ADVANCED ELECTRIC HEAT PUMP THROUGH 1990

4.3.1 SUMMARY

4.3.2 STUDY METHOD

4.3.3 RESIDENTIAL MARKET FORECAST (ZERO TO FIVE TON CAPACITY)

- A. CENTRAL FORCED AIR HEATING AND COOLING SYSTEMS
- B. INSTALLED SYSTEM COST
- C. FUEL PRICE ANALYSIS
- D. HEATING/COOLING LOAD REQUIREMENTS
- E. NATURAL GAS AVAILABILITY
- F. BUILDER AND CONSUMER ACCEPTABILITY
- G. RESIDENTIAL MARKET FORECASTS

4.3.4 COMMERCIAL MARKET FORECAST (ZERO TO FIFTEEN TON CAPACITY)

4.3.5 TOTAL MARKET FORECAST (ZERO TO FIFTEEN TON CAPACITY)

4.3.1 SUMMARY

In response to escalating energy prices and increased government regulation of energy-related equipment, the HVAC industry has been providing an increasing number of high efficiency electric heat pumps. The objective of this section is to determine the sales potential for an Advanced Electric Heat Pump that can provide satisfying performance with an annual energy efficiency at least 20% better than the most efficient unit available in the market place in 1979.

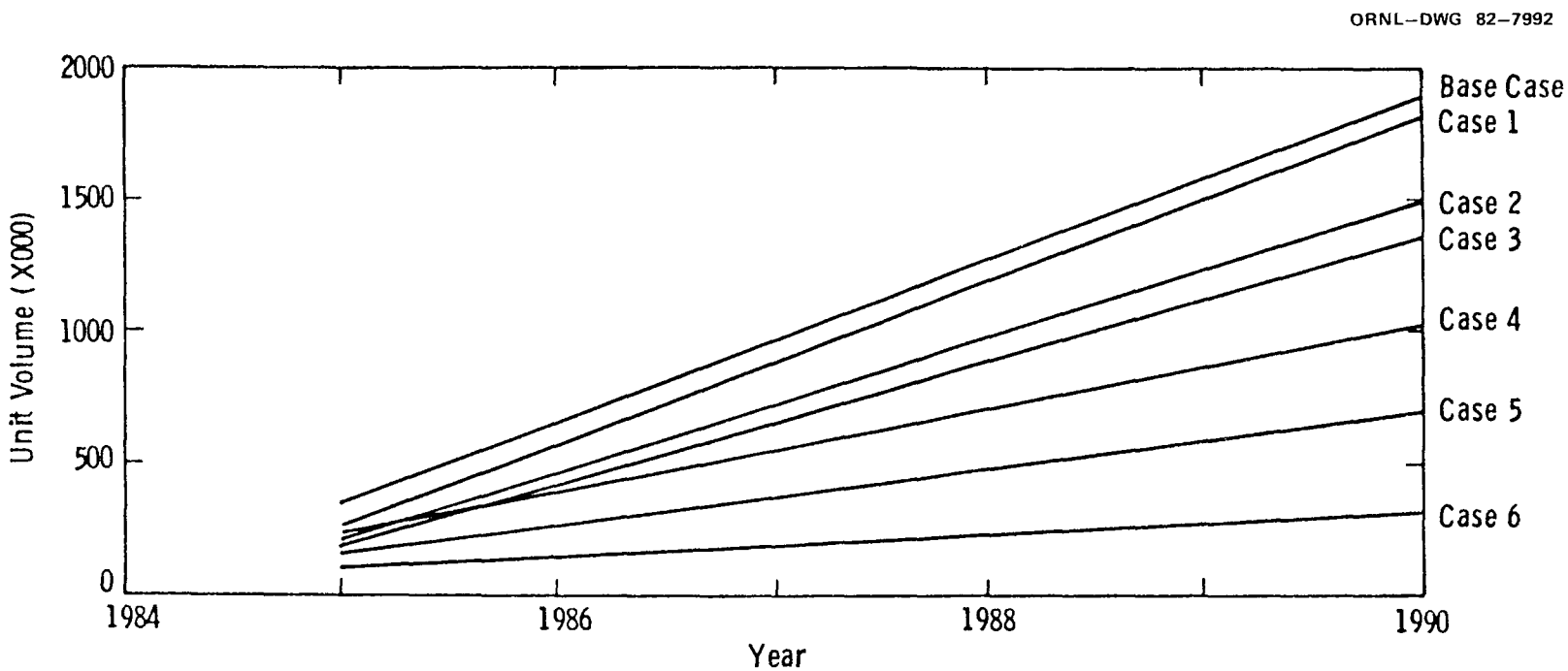
Applying data from both the consumer and builder acceptability curves, previously developed, along with inputs on key variables, a Westinghouse proprietary computer-based model generated residential market forecasts for a Base Case and six alternative cases. Results of this process are summarized in Figure 4.3-1. The Base Case which assumes that natural gas prices will escalate faster than electricity prices due to natural gas deregulation, shows an Advanced Electric Heat Pump potential market rising from three hundred sixty-one thousand units in 1985 to just under two million units in 1990.

The Case 5 forecast which assumes more competitive pricing between gas and electricity and a 10% higher installed cost for the Advanced Electric Heat Pump over the initial forecast price, shows a potential market of one hundred fifty-four thousand units in 1985, and six hundred eighty thousand units in 1990.

Case 6 represents the most conservative forecast which assumes that the home builder will accept only a zero pay back period and his selection is based primarily on initial cost. The market is therefore limited to replacement, retrofit and add-on applications and the forecast shows a potential market of one hundred thirty-eight thousand units in 1985 and three hundred four thousand units in 1990.

Case 5 was chosen as the most likely scenario because it is believed that gas utilities will price competitively to protect their market position as the majority of their sales continue to shift to the residential sector. Also, it is believed that the installed cost of the Advanced System will be higher than originally estimated at introduction due to the effect of the learning curve. Figure 4.3-2 depicts the forecasted impact of the Advanced Electric Heat Pump on the residential central heating and cooling market for the period 1980 to 1990.

A regional breakdown of the Advanced Electric Heat Pump market forecast for Case 5 is shown in Table 4.3-1. The South Atlantic and East North Central Regions represent 46% of forecasted shipments and therefore, are the best sites for product introduction.



Source: Ⓦ Proprietary Computer Model

Fig. 4. 3-1 –Advanced electric heat pump annual sales (alternative forecasts)

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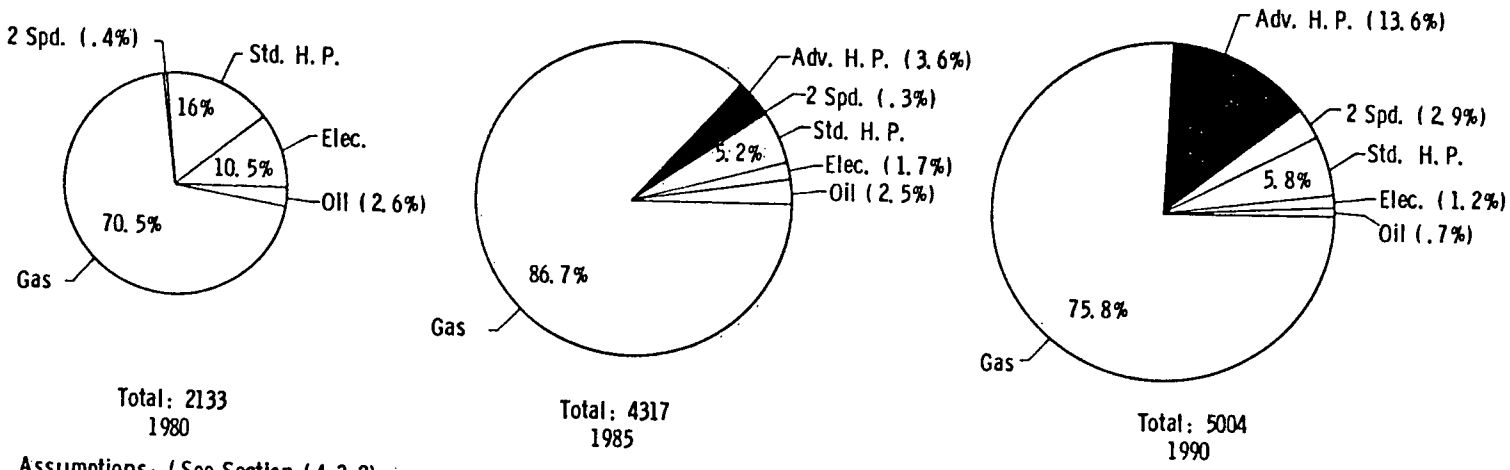
Volume (X000)

Case 5



Assumptions: (See Section (4.3-2)

1) Electric Rates Increase at 4 % Annual Compound Real Growth Rate

2) Advanced Electric Heat Pump Installed System Cost Increased 10%

Fig. 4.3-2–Residential heating/cooling system sales (most likely market forecast)

TABLE 4.3-1
U.S. HEAT PUMP RESIDENTIAL MARKET FORECAST*
BY CENSUS REGION, 1990

(IN THOUSANDS OF UNITS)

	N.E.	M.A.	E.N.C.	W.N.C.	S.A.	E.S.C.	W.S.C.	MTN	PAC.	TOTAL
Variable Speed H.P.	3	18	31	20	40	13	11	6	3	145
Conventional H.P.	8	17	61	44	53	23	18	26	42	292
Advanced H.P.	17	63	131	74	163	53	110	41	28	680
TOTAL	28	98	223	138	256	89	139	73	73	1117
Region % of Total	3%	8%	20%	12%	23%	8%	12%	7%	7%	100%

* Based on Case 5 Assumptions

4.3.2 STUDY METHOD

The consumer acceptability curve (developed in the previous section from the consumer mail survey response) and the homebuilder acceptability curve (developed from estimates given during personal interviews with homebuilders) were used as the primary parameters for revision of a Westinghouse proprietary computer-based model, to develop residential market forecasts for the Advanced Electric Heat Pump.

First, using existing Westinghouse computer-based market forecast models (developed by the Heating and Cooling Business Unit), a baseline forecast of total Central Forced Air[1] Heating and Cooling Systems (Table 4.3-2) was developed. This baseline forecast was primarily derived from historical trends, and projected the regional saturation of residential market segments (new construction, replacement, retrofit and add-on) by central forced air systems.

The builder acceptability curve (Figure 4.3-5) was used in all new residential construction market forecasts, since he is the major decision maker in that segment.

The consumer acceptability curve (Figure 4.2-1) was used in the market forecasts for the replacement, and retrofit/add-on segments since he is the major decision maker in those segments.

Using the acceptability curves for both builders and consumers, in conjunction with the revised Westinghouse proprietary computer-based model, varying economic assumptions were used to project Advanced Electric Heat Pump unit sales. The results are shown in Figure 4.3-1. Forecasts based on the following Base Case and six alternative cases were generated to determine these results:

NOTE 1 - See Introduction (3.1) for definition of Central Forced Air Systems.

A. BASE CASE FORECAST ASSUMPTIONS FOR ADVANCED ELECTRIC HEAT PUMP

a) Electricity prices increase at 1.9% annual compound real growth rate thru 1990.

b) Natural gas prices increase at 8.0% annual compound real growth rate thru 1990.

c) Fuel oil prices increase at 6.0% annual compound real growth rate thru 1990.

d) Zero gas curtailment is assumed over the forecast period, although gas availability will be limited in some areas based on Table 4.3-7.

e) Alternative heating/cooling system costs based on installed 1980 constant dollar estimates are used (Table 4.3-3).

f) Heating and cooling load requirements.

1985 load assumed to be 30% less than 1980 level
1990 load assumed to be 30% less than 1985 level

g) Forecast of Central Forced Air Heating/Cooling Systems (Table 4.3-2).

B. ALTERNATIVE FORECAST ASSUMPTIONS FOR ADVANCED ELECTRIC HEAT PUMP

Case 1 Assumptions

Uses the same assumptions as the Base Case except that electric rates are assumed to increase at 4.0% annual compound real growth rate.

Case 2 Assumptions

Uses the same assumptions as the Base Case except that natural gas rates are assumed to increase at 5.0% annual compound real growth rate.

Case 3 Assumptions (Combines Cases 1 and 2)

Uses Case 1 assumption for electric rates and Case 2 assumption for natural gas rates in conjunction with Base Case assumptions.

Case 4 Assumptions

Uses Base Case assumptions with the exception of the Advanced Electric Heat Pump Installed System cost (Table 4.3-3) which is increased 10% over the Base Case cost.

Case 5 Assumptions (Combines Cases 3 and 4)

a. Electric rates increase at 4.0% annual compound real growth rate.

b. Gas rates increase at 5.0% annual compound real growth rate.

c. Fuel oil prices increase at 6.0% annual compound real growth rate.

d. Zero gas curtailment. Gas availability will be limited in some areas based on TABLE 4.3-7.

e. Alternative heating/cooling system costs based on installed 1980 constant dollar estimates as shown in TABLE 4.3-3 except for the Advanced Electric Heat Pump installation cost which increases 10% over the Base Case cost.

F. Heating and cooling load requirements:
   1985 requirements assumed to be 30% less than 1980 level

   1990 requirements assumed to be 30% less than 1985 level

G. Forecast of central forced air heating/cooling systems (TABLE 4.3-2)

Case 6 Assumptions

Same assumptions as Case 5 except that the acceptability curve for the builder is modified so that the choice of heating/cooling system in new residential construction is based on the lowest installed cost only (or zero payback period). (The consumer acceptability curve remains the same as Case 5)

4.3.3 RESIDENTIAL MARKET FORECAST

Data on each of the following parameters was incorporated into the Westinghouse proprietary computer model used to generate residential market forecasts for the Advanced Electric Heat Pump:

A. CENTRAL FORCED AIR HEATING AND COOLING SYSTEMS

Saturation of new residential construction by central forced air systems reached 86% in 1980 (Figure 4.3-3). Of this 86%, 33% of the applications were for heating, and 53% for both heating and cooling. Saturation is projected* to increase to 93% by 1985 and will maintain that level through 1990. Heating applications, as a percent of total saturation, are expected to decline to 23% due to the increased demand for central air conditioning as a majority of new housing construction shifts to the Sunbelt and warmer climates. Central air conditioning alone, (i.e. central air conditioning with heating other than central forced air) has been excluded since preliminary estimates showed the Advanced Electric Heat Pump to be non-competitive.

Central forced air system saturation of existing housing rose to 65% in 1980. Heating applications accounted for 36%, and combined heating and cooling applications 29%. Over the forecast period, saturation* of existing housing by central forced air systems is projected to increase to 74%, with heating applications representing 36%, and heating and cooling applications representing 38%. This increase in heating and cooling applications is expected to result from increased saturation of new construction, and the growing add-on and retrofit cooling markets.

Projections of total central forced air systems by residential market segment were also broken down according to census regions (See Table 4.3-2) based on historical trends and analysis of primary and secondary research data.

* Projections of total central forced air heating and cooling system saturation of new and existing housing are based on proprietary econometric and simulation forecast models developed by the Westinghouse Heating and Cooling Business Unit.

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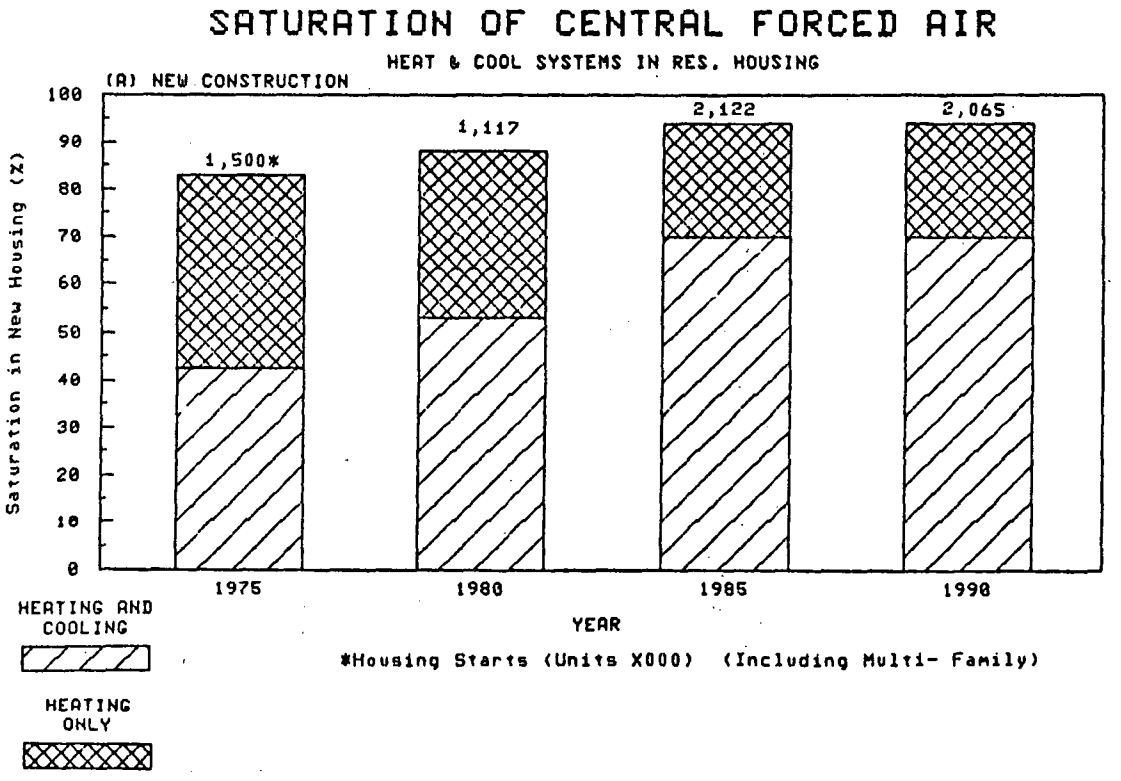

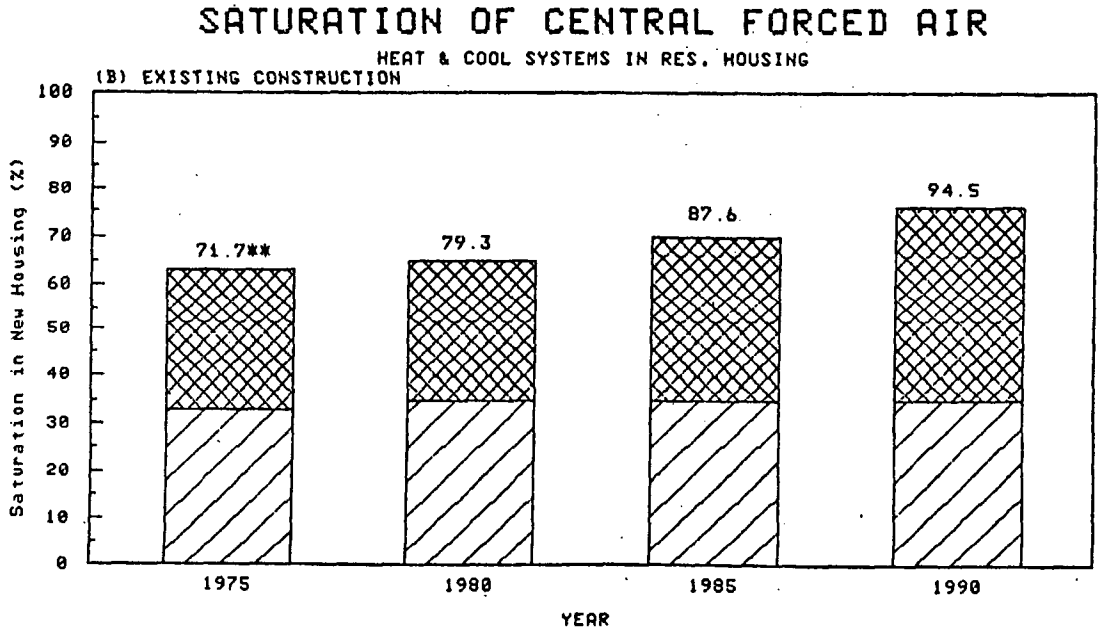

** Stock of Housing Units (Million) (Including Multi Family)

SOURCE: Housing Industry Dynamics Annual Survey of Home Builders - 1979 Annual Housing Survey - 1977
U.S. Dept. of Commerce, Bureau of Census - C25-78 Const.Rept.,H-150-77

Fig. 4.3-3-Saturation of central forced air heating and cooling systems in housing.

TABLE 4.3-2

FORECAST OF RESIDIENTIAL CENTRAL FORCED AIR HEATING AND COOLING SYSTEM SHIPMENTS BY CENSUS REGION - 1980-1990

(UNITS X000)

		N.E.	M.A.	ENC	WNC	S.A.	ESC	WSC	MTN	PAC	TOTAL
New Residential Construction											
	1980	22	63	153	114	244	85	155	103	178	1,117
	1985	29	104	481	250	171	147	315	192	295	1,984
	1990	30	107	499	262	176	156	322	203	310	2,065
Replacement/Retrofit/Add-on											
	1980	18	84	164	222	112	53	129	67	141	990
	1985	54	213	521	416	214	147	389	122	258	2,334
	1990	81	207	647	484	287	165	445	157	464	2,937
Total Central F. A. Sys.											
	1980	40	147	317	336	356	138	284	454	319	2,117
	1985	83	317	1,002	666	385	294	704	314	553	4,317
	1990	111	314	1,146	746	463	321	767	360	774	4,997

Note: A/C only excluded since preliminary estimates confirmed Advanced Heat Pump to be non-competitive in this application.

B. INSTALLED SYSTEM COST

Estimates of installed central forced air heating/cooling systems costs were developed (shown in Table 4.3-3) for various types of systems as well as different applications of the same system. The prices are shown in 1980 current dollars based on estimates of dealer/contractor installed costs excluding ductwork or ductwork modifications and chimney work.* Actual installation prices for the replacement, retrofit, and add-on markets are higher than those of new construction because of cost competitiveness in that market. Since prices in the retrofit segment vary by city and region, as well as the nature of the installation, estimated median prices representative of all variables were used. Prices for all central air conditioning systems and heat pumps are based on split system costs (since more than 70% of all air conditioning and heat pump product shipments are of this type).

System (1), (Table 4.3-3), is a nominal three ton central air conditioning unit whose prices include the indoor unit (blower, motor, and coil), the outdoor unit (compressor, condensing coil, fan and controls) and 25 feet of refrigerant line. Systems (2) and (3) include a standard and high efficiency gas furnace for heating as well as combinations with standard and high efficiency air conditioning (System 1) for heating and cooling applications. (The high efficiency furnace chosen for analysis was based on the most cost-effective furnace available at that time.) Oil furnaces are not expected to improve on the 82% AFUE rating during the forecast period. System (5) prices include the standard electric resistance furnace for heating in combination with standard and high efficiency air conditioning (System 1) for cooling applications.

* Since all systems under study are central forced air systems, ductwork was assumed to be the same for all system applications considered and therefore was not considered as part of the installed system price.

Systems (6), (7), and (8) are nominal three ton (cooling) units whose prices include the outdoor unit (compressor, fan, coil, controls, and outdoor thermostat), the indoor unit (blower, motor, coil, resistance heating element), and 25 feet of refrigerant line. In addition, the cost of Systems (1) through (7) includes standard indoor wall mounted thermostats, and System (8) a microprocessor-controlled indoor wall mounted thermostat.

TABLE 4.3-3

1980 CENTRAL FORCED AIR HEATING/COOLING INSTALLED SYSTEM COST[1]

SYSTEM	HEATING	COOLING	HEATING AND COOLING
1) Central A/C (avg. 3 tons)			
Std. (8.0 EER)		$1,300	
H Eff. (10.0 EER)		1,430	
2) Std. Gas Warm Air Furnace Avg. 82,000 BTU (70% AFUE)	$742		$2,042-S[2] 2,172-H[3]
3) Hi Eff. Gas Warm Air Furnace Avg. 82,000 BTU (80% AFUE)	850		2,150-S 2,280-H
4) Std. Oil Warm Air Furnace Avg. 98,000 BTU (82% AFUE)	1,530		2,830-S 2,960-H
5) Electric Warm Air Furnace Avg. 15 KW (100% Eff.)	675		1.975-S 2,105-H
6) Standard Heat Pump (6.5 EER) (3-ton nominal capacity	2,166	2,166	2,166
7) Two-Speed Heat Pump Advanced (3-ton nominal capacity) (9 EER)	2,867	2,867	2,867
8) Advanced Hi-Efficiency Heat Pump (3-ton nominal capacity) (11.0 EER)	2,782	2,782	2,782

Notes: (1) - Prices are dealer installed costs excluding ductwork or ductwork modifications, and chimney work.
(2) - S = With Standard Air Conditioning
(3) - H = With Hi Efficiency Air Conditioning
(4) - AFUE - Annual Fuel Utilization Efficiency

Data Sources: Estimates by Westinghouse Heating and Cooling Division, Marketing, Field Sales, and Dealers.

C. FUEL PRICE ANALYSIS

The annual operating cost of the central forced air systems studied can be estimated using the projections of national averages of residential fuel prices for heating and cooling shown in Table 4.3-4 (A, B, & C).

Table (A) is a projection of fuel prices for 1980 through 1990 in current dollars using the accepted standard of measure for each fuel.

Table (B) projects fuel prices in 1980 constant dollars (per million BTU's), for ease of comparison. These projections were based on Data Resources, Inc. (DRI) 1981 Control Forecast which showed gas prices escalating over 4 times faster than electricity prices, in real terms through 1990. This gas price escalation is due primarily to the expected deregulation of natural gas. However, even with the 8% compounded real escalation between 1980 and 1990, natural gas is still projected to be less than half the cost of electricity (per million BTU) in 1990.

Table (C) provides a comparison of fuel prices according to fuel conversion efficiency in 1980 constant dollars (corrected for central forced air furnace and heat pump efficiences). The corrected prices are based on the current and projected conversion efficiencies (1980, 1985, and 1990) for gas, oil, and electric furnaces, as well as the electric heat pump. Figure 4.3-4 depicts the effects of efficiency differences on fuel costs for central warm air furnaces and heat pumps. If an Advanced Electric Heat Pump (HSPF:9.24 Btu/watt hr) were introduced by 1985, the fuel cost to operate the heat pump during the winter season would be lower than that of any other system, including the gas furnace. Since fuel prices vary by state and region, a projection of fuel prices by state or by region is needed to better assess the impact of the introduction of an Advanced Electric Heat Pump. Therefore, state and regional energy prices from DRI's Energy Model (12/80 Forecast) were incorporated into the forecast.

TABLE 4.3-4

RESIDENTIAL HEATING FUEL PRICES[1]

National Averages

A.

		Current Dollars		
		1980	1985	1990
Gas	¢/Therm	38.20	76.60	181.00
Fuel Oil	$/Barrel	25.21	57.44	98.78
Electricity	¢/KWHR	4.90	8.20	13.00

B.

	1980 Dollars per Million BTU			Annual % Chng.
	1980	1985	1990	'80 to '90
Gas	3.82	5.10	8.27	8.0
Fuel Oil	5.86	8.04	9.66	6.0
Electricity	14.45	15.88	17.41	1.9

C.

	1980 Dollars per Million BTU (Corrected for Forced Air System)		
	1980	1985	1990
Gas Furnace AFUE	70%	80%	80%
Cost $/MBTU	5.45	6.38	10.34
Oil Furnace AFUE	82%	82%	82%
Cost $/MBTU	7.15	9.80	11.78
Electric Furnace Eff.	100%	100%	100%
Cost $/MBTU	14.45	15.88	17.41
Electric Heat Pump HSPF (Btu/watt hr.)	6.2	9.24	9.2
Cost $/MBTU	5.90	5.40	5.92

[1]Projections based on Data Resource, Inc.
1981 Control Forecast (12/80)

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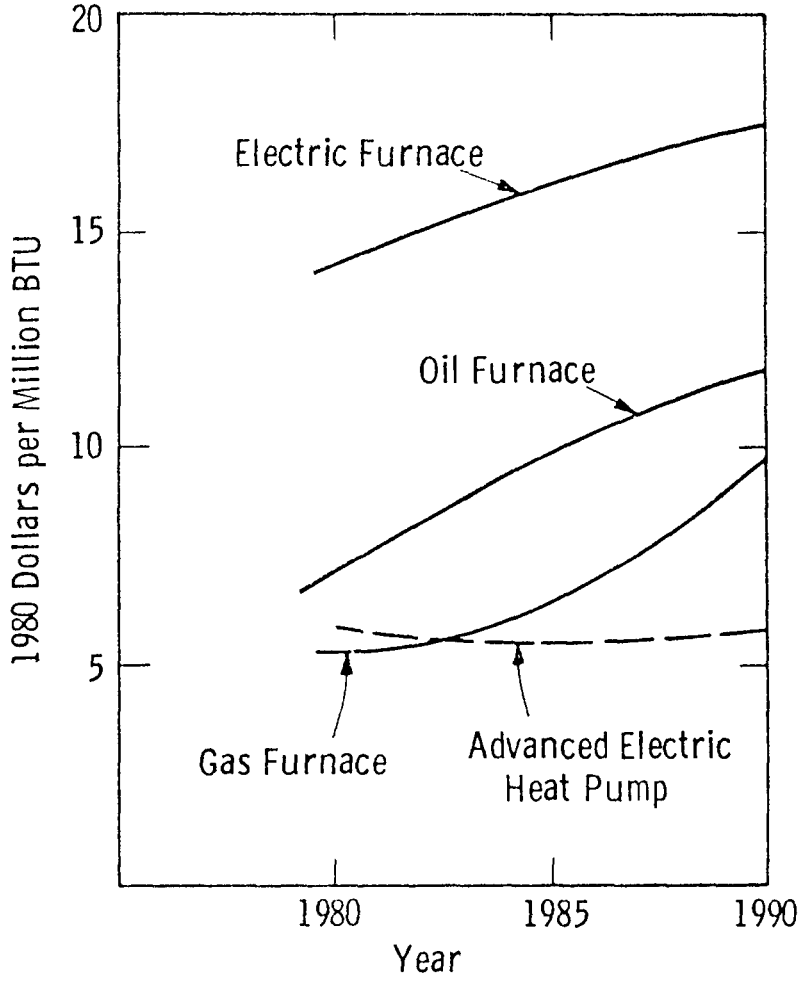

Based on Data from Table 4.3-4 (c)

Fig. 4.3-4—Residential fuel cost comparison (1980 - 1990)

D. HEATING AND COOLING LOAD REQUIREMENTS

Table 4.3-5 provides input for heat pump sizing versus heating and cooling load requirements in an average 1600 square foot residence. Locations representative of climatic conditions in DOE regions II, III, IV and V were chosen. These regions were also selected because preliminary analysis determined them to be the regions most suitable for heat pump applications. Since a majority of homes will have been built or upgraded to Level 2 Status by 1990, average load requirements of a 1600 square foot Level 2 home were used as a base. Also, since the average heat pump capacity required for the four representative areas was approximately three tons, an average three ton-rated central air conditioning or heat pump unit was assumed for subsequent heating/cooling system comparisons.

Using Table 4.3-5 along with available BIN data developed by Westinghouse, and data from the 1979 Gas House Heating Survey, heating and cooling load requirements were broken down further by state and census regions (Table 4.3-6) as input for the Advanced Electric Heat Pump forecast.

The heating and cooling load projections for 1985 are assumed to be 70% of the 1980 load, and the 1990 projections are assumed to be 70% of the 1985 load due to the following: 1) upgrading of residential insulation 2) increased use of passive conservation techniques and 3) the smaller size of new homes.

TABLE 4.3-5

HEAT PUMP PERFORMANCE IN 1600 FT SQ DWELLING

(Optimum Heat Pump Size @ 4.97¢/KWH)

Heat Pump Model	DOE Region	II			III			IV			V		
	City	Phoenix			Nashville			Pittsburgh			Minneapolis		
	Insulation Level	1	2	3	1	2	3	1	2	3	1	2	3
	Htg Load MBTU	47.08	31.56	20.18	102.39	68.77	43.97	163.77	109.78	70.19	191.84	128.60	82.22
	Cool Load MBTU	125.20	83.92	53.66	59.48	39.87	25.49	24.78	16.61	10.62	31.14	20.87	13.34
Standard Low Cost	Nom.Cap.(Tons)	5	3.5	2.5	4	3	2	4	2.5	1.5	5	3.5	2.0
	Installed Cost	2879	2331	1990	2600	2166	1796	2669	2057	1580	3158	2465	1863
	HSPF	7.58	7.33	6.92	6.86	6.79	6.62	6.32	6.18	6.00	5.82	5.79	5.62
	SEER	6.58	6.48	6.30	6.81	6.62	6.37	6.77	6.59	6.29	6.75	6.57	6.33
Competitor 2-Speed & Other Hi. Eff.	Nom.Cap.(Tons)	5	4	2.5	4	3	2	4.5	3	2	5	3.5	2
	Installed Cost($)	3849	3371	2622	3439	2867	2354	3714	2934	2354	4058	3229	2354
	HSPF	8.84	8.44	7.98	7.36	7.38	7.23	6.78	6.70	6.64	6.09	6.11	5.89
	SEER	8.31	8.13	7.95	9.04	8.75	8.36	9.05	8.70	8.13	9.02	8.71	8.34
(W)/DOE	Nom.Cap.(Tons)	5	4	2.5	4	3	2	5	3.5	2	5	3.5	2.5
	Installed Cost($)	3731	3269	2545	3337	2782	2286	3800	3002	2286	3940	3069	2545
	HSPF	11.12	10.57	9.88	9.35	9.52	9.31	9.18	9.24	8.62	7.90	8.00	8.19
	SEER	10.54	10.57	10.23	11.74	11.33	10.71	11.54	10.93	10.15	11.73	11.23	10.42

Notes: A five ton unit was the largest considered.

TABLE 4.3-6

RESIDENTIAL HEATING AND COOLING LOAD REQUIREMENTS

(MILLION BTU'S PER YEAR)

CENSUS REGION	STATE	1985 HEATING	1985 COOLING	1990 HEATING	1990 COOLING
New England	CONN	105.0	27.0	73.5	18.9
	MAINE	135.0	13.0	94.5	9.1
	MASS	102.0	27.0	71.6	18.9
	N.H.	133.0	13.0	93.1	9.1
	R.I.	102.0	27.0	71.4	18.9
	VERMONT	138.0	13.0	96.6	9.1
Mid Atlantic	N.J.	91.0	40.0	63.7	28.0
	N.Y.	120.0	30.0	84.0	21.0
	PA	91.0	33.0	63.7	23.1
South Atlantic	DEL.	80.5	50.0	56.3	35.0
	FLA.	8.8	133.0	6.2	93.1
	GA.	45.5	83.0	31.8	58.1
	MD.	77.0	50.0	53.9	35.0
	N.C.	53.0	67.0	37.1	46.9
	S.C.	40.0	83.0	28.0	58.1
	VA.	70.0	50.0	49.0	35.0
	WVA.	84.0	33.0	58.8	23.1
E. South Central	ALA.	38.5	83.0	27.0	58.1
	KY.	77.0	50.0	53.9	35.0
	MISS	28.0	100.0	19.6	70.0
	TENN	61.0	57.0	42.7	39.9
W. South Central	ARK.	52.5	83.0	36.7	58.1
	LA.	21.0	100.0	14.7	70.0
	OKLA.	61.0	67.0	42.7	46.1
	TX.	38.0	100.0	26.6	70.0

TABLE 4.3-6 Continued

RESIDENTIAL HEATING AND COOLING LOAD REQUIREMENTS (cont'd)

(MILLION BTU'S PER YEAR)

CENSUS REGION	STATE	1985 HEATING	1985 COOLING	1990 HEATING	1990 COOLING
E. North Central	ILL.	110.0	50.0	77.0	35.0
	IND.	98.0	50.0	68.6	35.0
	MICH.	112.0	33.0	78.4	23.1
	OHIO	105.0	40.0	73.5	28.0
	WISC.	131.0	30.0	91.7	21.0
W. North Central	IOWA	112.0	50.0	78.4	35.0
	KS.	87.5	53.0	61.2	37.1
	MN.	137.0	30.0	95.9	21.0
	MO	86.0	67.0	60.2	46.9
	NB.	107.0	50.0	74.9	35.0
	N.D.	158.0	23.0	110.6	16.1
	S.D.	135.0	30.0	94.5	21.0
Moutain	ARIZ.	35.0	93.0	24.5	65.1
	COL.	105.0	17.0	73.5	11.9
	IDAHO	114.0	17.0	79.8	11.9
	MONT.	172.0	17.0	120.4	11.9
	NEV.	53.0	50.0	37.1	35.0
	N.M.	79.0	50.0	55.3	35.0
	UTAH	102.0	17.0	71.4	11.9
	WY.	140.0	17.0	98.0	11.9
Pacific	CAL.	43.8	17.0	30.7	11.9
	OREG.	80.0	13.0	56.0	9.1
	WASH.	93.0	13.0	65.1	9.1

Source: 1) 1979 Gas House Heating Survey

2) Westinghouse estimates based on heat pump performance analysis (Table 4.3-5) and BIN data developed during EPRI Study

E. NATURAL GAS AVAILABILITY

Gas curtailments, which spurred the rapid rise in heat pump shipments between 1976 and 1979, are practically non-existent today. However, there are still areas where natural gas is not available and will probably not be available. In these areas natural gas companies choose not to install gas pipelines due to the high cost of the pipeline installation and low customer demand.

Therefore, the limited availability of natural gas is an important factor in forecasting Advanced Heat Pump sales. (Since natural gas cannot compete against alternative fuels in areas where it is not available.)

For the purposes of this study we assume that there will be no gas curtailments over the forecast period. All recent studies point out that there is a natural gas supply either in reserves or under production and exploration to service the customer base for the next 15-20 years.

Estimates of natural gas availability by census regions appear in Table 4.3-7.

F. BUILDER AND CONSUMER PRODUCT ACCEPTABILITY

The marketability analysis (section 4.2), determined that the builder is the primary decision maker for current central heating/cooling system installations in new residential construction. With increases in consumer utility bills, builders are being pressured by consumers to change their first cost emphasis and consider higher efficiency equipment (which may cost more initially, but will yield lower annual operating costs, and therefore lower out-of-pocket monthly costs). Conversations with builders during personal interviews produced estimates (Figure 4.3-5) of their heating and cooling system acceptability. The resulting curve shows that during the forecast period, builders will accept on the average a two year payback period for higher efficiency equipment 40% of the time. The builder's acceptability curve was the

prime factor in the new residential construction market forecasts since he is the major decision maker in that market. It is assumed that he will remain the primary decision maker in this segment over the forecast period.

It was also determined from the marketability analysis that the consumer is the major decision maker for ninety percent of the heating and cooling products in the current replacement and retrofit/add-on markets. The previously developed consumer acceptability curve was used in developing market forecasts for these segments (TABLE 4.2-2). For the forecast period, consumers will accept on the average a four year payback for higher efficiency equipment 58% of the time.

TABLE 4.3-7

NATURAL GAS AVAILABILITY*

(1980 thru 1990)

CENSUS REGION	STATE	% AVAILABILITY	CENSUS REGION	STATE	% AVAILABILITY
New England	CONN.	95	E. North Central	ILL.	93
	MAINE	97		IND.	88
	MASS.	95		MICH.	94
	N.H.	93		OHIO	95
	R.I.	96		WISC.	92
	VERMONT	89			
			W. North Central	IOWA	85
Mid Atlantic	N.J.	96		KS.	85
	N.Y.	97		MN.	91
	PA.	95		MO.	80
				NB.	83
South Atlantic	DEL.	95		N.D.	86
	FLA.	85		S.D.	80
	GA.	75			
	MD.	94	Mountain	ARIZ.	89
	N.C.	88		COL.	91
	S.C.	83		IDAHO	95
	VA.	93		MONT.	87
	WVA.	93		NEV.	70
				N.M.	87
E. South Central	ALA.	74		UTAH	93
	KY.	85		WY.	84
	MISS.	75			
	TENN.	85	Pacific	CAL.	95
				OREG.	90
W. South Central	ARK.	77		WASH.	96
	LA.	90			
	OKLA.	83			
	TX.	87			

* Natural Gas Availability is defined as that percentage of a region or state which will have natural gas available for home heating.

Source: Based on estimates from 1979 Gas House Heating Survey by American Gas Association.

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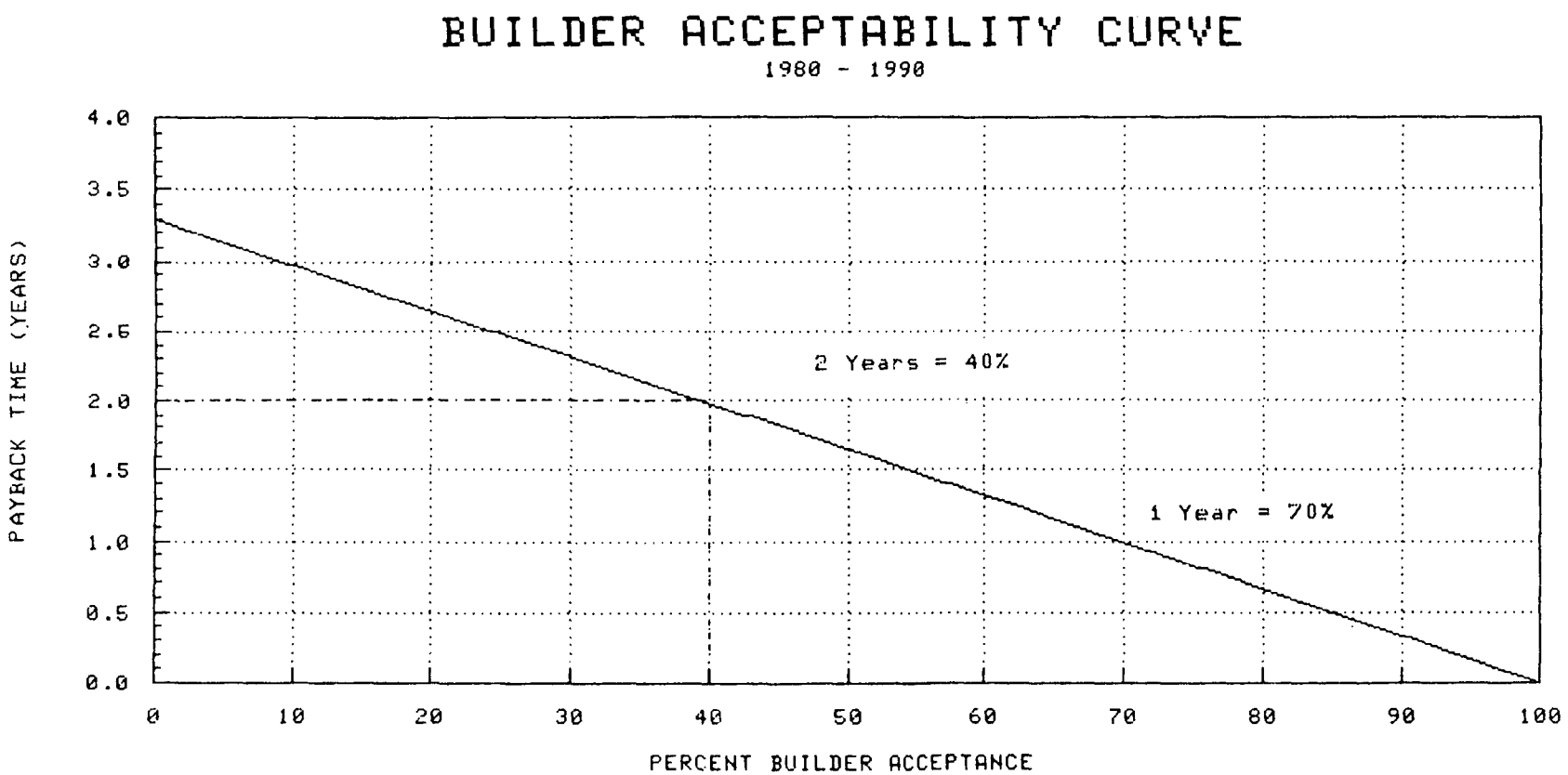
FIGURE 4.3-5



Estimated from personal interviews

RESIDENTIAL MARKET FORECASTS

Applying data from both the consumer and builder acceptability curves, along with inputs on the above variables, the revised Westinghouse proprietary computer-based forecast model was used to generate a Base Case and six alternative cases (See Figure 4.3-1). The Base Case, which assumes that natural gas prices will escalate faster than electricity prices because of natural gas deregulation, projects an Advanced Electric Heat Pump potential market rising from three hundred sixty-one thousand units in 1985 to just under two million units in 1990. The computer output for the Base Case, shown in Table 4.3-8, provides a breakdown of volume forecasts by central forced air systems for both heating and heating and cooling applications, according to census regions. The Case 5 forecast, which assumes more competitive pricing between gas and electricity and a 10% higher installed cost for the Advanced Electric Heat Pump over the Base Case price, shows a potential market of one hundred fifty-four thousand units in 1985, and six hundred eighty thousand units in 1990.

Case 6, which assumes that the home builder will accept only zero payback period in his choice of a heating/cooling system provides the most conservative forecast of Advanced Electric Heat Pump sales. This forecast shows a potential market of one hundred thirty-eight thousand units in 1985 and three hundred four thousand units in 1990. Since the Advanced Electric Heat Pump considered has a higher initial cost than its alternatives, it could only compete in the replacement, retrofit and add-on markets (where the homeowner makes the buying decision) for Case 6.

Case 5 was chosen as the most likely scenario because it is believed that gas companies will price competitively to protect their market position, as a majority of their sales continue to shift to the residential sector. Also, it is believed that the installed cost of the Advanced Electric Heat Pump System will be higher than originally estimated at introduction due to the effect of the learning curve.

Figure 4.3-2 depicts the impact of the Advanced Electric Heat Pump on the residential Central Heating and Cooling market for the period 1980 to 1990.

A regional breakdown of the Advanced Electric Heat Pump market forecast for the most likely case (Case 5) shows that the South Atlantic and East North Central regions represent 46% of forecasted shipments and therefore are the best sites for product introduction (See TABLE 4.3-9).

CONCLUSIONS

While the initial capital cost of the Advanced Electric Heat Pump relative to alternative systems is an integral variable in this study, the key driving variables that will determine the size of the potential market are: 1) Fuel prices, which are primarily influenced by government legislation/regulation and the overall state of the national economy, particularly the inflation rate and 2) consumer/builder product acceptability. While advertising and promotion can be used to increase consumer/builder product awareness and acceptance, fuel prices are much less amenable to private sector influence.

TABLE 4.3-8

ADVANCED ELECTRIC HEAT PUMP MARKET FORECAST

(BASE CASE)

1985 * NEW RESIDENTIAL

CONSTRUCTION BUILDER ACCEPTABILITY

CURVE

UNITS INSTALLED (THOUSANDS)	GAS		OIL & OTHER		LOW COST HP		2 SPEED HP		W/DOE HP		TOTAL		TOTAL
	H	H&C	H	H&C	H	H&C	H	H&C	H	H&C	H	H&C	
NEW ENGLAND	20	3	1	0	0	3	0	0	0	1	22	6	28
MID ATLANTIC	50	40	2	0	0	7	0	0	0	5	53	51	104
SOUTH ATLANTIC	39	360	5	15	0	54	0	0	0	7	44	436	480
EAST NORTH CENTRAL	85	108	6	0	1	44	0	0	0	6	92	157	250
WEST NORTH CENTRAL	29	98	3	0	1	28	0	0	0	12	33	137	170
EAST SOUTH CENTRAL	21	94	5	1	0	22	0	0	0	4	27	121	148
WEST SOUTH CENTRAL	7	263	1	12	0	26	0	0	0	6	9	307	315
MOUNTAIN	61	92	6	2	3	23	0	0	0	5	70	124	194
PACIFIC	135	144	7	0	3	31	0	0	0	5	145	150	295
US TOTAL	447	1171	37	30	8	238	0	1	1	51	493	1491	1984

TABLE 4.3-8 (Cont.)

ADVANCED ELECTRIC HEAT PUMP MARKET FORECAST

(BASE CASE)

1985 * RETROFIT

BASE CASE

UNITS INSTALLED (THOUSANDS)	GAS		OIL & OTHER		LOW COST HP		2 SPEED HP		W/DOE HP		TOTAL		TOTAL
	H	H&C	H	H&C	H	H&C	H	H&C	H	H&C	H	H&C	
NEW ENGLAND	32	9	1	0	1	4	0	0	8	14	42	28	70
MID ATLANTIC	106	78	2	1	0	4	0	1	2	25	110	108	218
SOUTH ATLANTIC	89	287	14	28	1	14	0	5	0	69	103	403	506
EAST NORTH CENTRAL	208	140	5	1	4	11	0	2	11	55	228	209	437
WEST NORTH CENTRAL	85	83	5	2	4	6	0	2	7	37	102	130	231
EAST SOUTH CENTRAL	25	77	5	7	1	7	0	1	0	18	31	110	141
WEST SOUTH CENTRAL	59	248	9	19	0	5	0	1	0	24	69	297	366
MOUNTAIN	48	40	4	2	3	7	0	1	2	12	58	61	119
PACIFIC	113	59	5	2	19	22	0	0	9	16	147	99	246
US T TAL	765	1021	51	63	34	78	0	12	41	268	890	1443	2333

TABLE 4.3-8 (Cont.)
ADVANCED ELECTRIC HEAT PUMP MARKET FORECAST
(BASE CASE)

1990 * NEW RESIDENTIAL

CONSTRUCTION BUILDER ACCEPTABILITY

CURVE

UNITS INSTALLED (THOUSANDS)	GAS		OIL & OTHER		LOW COST HP		2 SPEED HP		W/DOE HP		TOTAL		TOTAL
	H	H&C	H	H&C	H	H&C	H	H&C	H	H&C	H	H&C	
NEW ENGLAND	18	0	0	0	3	4	0	0	1	3	23	6	29
MID ATLANTIC	52	0	1	0	1	28	0	0	0	25	55	53	108
SOUTH ATLANTIC	40	183	5	0	0	159	0	1	0	111	45	454	500
EAST NORTH CENTRAL	83	0	1	0	12	93	0	0	1	72	97	165	262
WEST NORTH CENTRAL	29	0	1	0	3	80	0	1	1	61	34	143	177
EAST SOUTH CENTRAL	23	21	6	0	0	66	0	0	0	40	29	128	156
WEST SOUTH CENTRAL	7	184	1	0	0	57	0	2	0	71	9	313	322
MOUTAIN	59	33	3	0	9	57	0	0	1	41	73	130	203
PACIFIC	129	68	6	0	16	76	0	0	2	13	153	157	310
US TOTAL	441	490	25	0	45	621	0	4	5	435	517	1550	2067

TABLE 4.3-8 (Cont.)

ADVANCED ELECTRIC HEAT PUMP MARKET FORECAST

(BASE CASE)

1990 * RETROFIT

BASE CASE

UNITS INSTALLED (THOUSANDS)	GAS		OIL & OTHER		LOW COST HP		2 SPEED HP		W/DOE HP		TOTAL		TOTAL
	H	H&C	H	H&C	H	H&C	H	H&C	H	H&C	H	H&C	
NEW ENGLAND	10	1	0	0	10	10	1	2	25	21	46	35	81
MID ATLANTIC	52	7	1	0	7	22	0	18	61	95	121	142	263
SOUTH ATLANTIC	86	140	10	17	3	23	0	38	14	344	113	562	675
EAST NORTH CENTRAL	75	12	1	0	43	59	0	29	130	173	250	274	523
WEST NORTH CENTRAL	32	8	1	1	26	40	2	18	50	100	111	167	278
EAST SOUTH CENTRAL	23	24	3	5	2	9	0	13	5	106	34	157	191
WEST SOUTH CENTRAL	64	118	8	14	0	5	0	9	3	241	75	387	463
MOUNTAIN	37	12	2	1	7	16	0	6	17	59	63	94	157
PACIFIC	110	68	5	2	22	31	0	3	24	41	161	145	306
US TOTAL	490	389	31	40	121	216	4	137	329	1181	975	1962	2937

Source: (W) Proprietary Computer Model

TABLE 4.3-9

HEAT PUMP RESIDENTIAL MARKET FORECAST
BY CENSUS REGION, 1990

(IN THOUSANDS OF UNITS)

	N.E.	M.A.	E.N.C.	W.N.C.	S.A.	E.S.C.	W.S.C.	MTN	PAC.	TOTAL
Variable Speed H.P.	3	18	31	20	40	13	11	6	3	145
Conventional H.P.	8	17	61	44	53	23	18	26	42	292
Advanced H.P.	17	63	131	74	163	53	110	41	28	680
TOTAL	28	98	223	138	256	89	139	73	73	1117
Region % of Total	3%	8%	20%	12%	23%	8%	12%	7%	7%	100%

4.3.4 COMMERCIAL MARKET FORECAST (1-15 TON CAPACITY)

Responses from dealers, distributors and field sales personnel during personal interviews were so varied that estimates of the commercial market for the Advanced Electric Heat Pump could not be used. Projections for the commercial market appearing in Table 4.3-10 were based on secondary research through available printed sources. The commercial market for the Advanced Electric Heat Pump was estimated to be 17% of the total market by 1990.

4.3.5 TOTAL U.S. MARKET FORECAST (1-15 TON CAPACITY)

The market forecast for the total U.S. Heat Pump Market in 1990, assuming the introduction of the Advanced Electric Heat Pump, is shown in Table 4.3-10. The conventional Heat Pump represents 26% of the total heating/cooling system market and the Advanced Heat Pump, based on the most likely forecast (Case 5), represents 61% of all forecasted shipments.

TABLE 4.3-10

TOTAL U.S. HEAT PUMP MARKET FORECAST*

	1980		1985		1990	
	UNITS	PERCENT	UNITS	PERCENT	UNITS	PERCENT
Residential						
New Construction	247	59%	257	52%	566	40%
Replacement	34	8	75	15	300	21
Add-on, Retrofit	68	16	60	12	251	18
TOTAL Residential	349	83	392	83	1117	83
Commercial	71	17	80	17	229	17
Heat Pump TOTAL	420	100%	472	100%	1346	100%

* Based on Case 5 Assumptions.

5.0 APPENDIX A

Sample Questionnaire Forms for Advanced Electric Heat Pump Mail and Personal Interview Surveys.

ADVANCED HEAT PUMP STUDY (DOE)
CONSUMER PRE-SCREENING PHONE CALLS (NON-USERS)

INTRODUCTION:

Good Morning/Afternoon. This is _____.
We are doing a study of major consumer purchases for the home.
May I ask you a few questions?

A. Are you a homeowner?

☐ YES ☐ NO

(If no, terminate)

B. Single Family Home?

☐ YES ☐ NO

(If no, terminate)

C. Are you the major decision maker or is there someone else who makes such decisions?

Consumer's Name: _____

Consumer's Phone Number: _____

D. Have you purchased any of the following goods within the past five years?

1. Automobile ☐ YES ☐ NO
   If yes,
   a) What type or make? _____
   b) How long ago? _____

2. Refrigerator ☐ YES ☐ NO
   If yes,
   a) What make? _____
   b) How long ago? _____

ADVANCED HEAT PUMP STUDY (DOE)
CONSUMER PRE-SCREENING PHONE CALLS (NON-USERS), (CONTINUED)

3. Heating and/or Cooling system? ☐ YES ☐ NO
If yes,

a) What type?_____
b) How long ago?_____

4. Television ☐ YES ☐ NO
If yes,

a) What type?_____
b) How long ago?_____

ADVANCED HEAT PUMP STUDY (DOE)
CONSUMER PRE-SCREENING PHONE CALLS (USERS)

INTRODUCTION:

Hello. This is _____. We are doing a study on heat pumps. We are not trying to sell you anything. May I ask you a few questions?

1. Are you the major decision maker or is there someone else who makes such decisions?

   ☐ YES, they are major decision maker (continue)

   ☐ NO, someone else (ask to speak to that person)

2. Do you use a heat pump to heat or cool your home?

   ☐ YES (continue)

   ☐ NO (thank & terminate)

3. Are you a single family unit?

   ☐ YES (continue)

   ☐ NO (thank & terminate)

We are interested in seeking information from heat pump users that would be helpful in making them more efficient. We are not interested in selling anything whatsoever and for your time you will be paid _____. We are inviting a select few heat pump users to visit with other users at our facility at _____. We are also providing refreshments.

Can we plan on you attending?

☐ YES

☐ NO (thank & terminate)

ADVANCED HEAT PUMP STUDY (DOE)
CONSUMER PRE-SCREENING PHONE CALLS (USERS), (CONTINUED)

If "Yes" NAME _____

ADDRESS _____

_____

PHONE _____

☐ MALE ☐ FEMALE

We will be sending you a letter of confirmation along with a map to show you how to get to our facility. Thank you for your participation.

NFO MULTICARD SURVEY

THIS CARD IS TO BE COMPLETED BY THE PERSON IN YOUR FAMILY WHO WOULD MAKE DECISIONS CONCERNING A HEATING AND/OR COOLING SYSTEM!

1. Do you live in a single-family home?

   ☐ YES ☐ NO - (STOP! RETURN CARD)

2. Do you own your own home?

   ☐ YES ☐ NO - (STOP! RETURN CARD)

3. Check all applicable heating and/or cooling systems which you have in your home. (CHECK ALL THAT APPLY)

   ☐ Central Air Conditioning
   ☐ Electric Baseboard Heat
   ☐ Electric Furnace
   ☐ Gas Furnace
   ☐ Heat Pump
   ☐ Oil Furnace
   ☐ Radiator (Hydronic) --
   Is that: ☐ Gas ☐ Oil
   ☐ Room (Window) Air Conditioning
   ☐ Other (specify): _____

4. On what criteria was/were system(s) indicated in Question 3 chosen?

   _____

   _____

5. Who made the purchase decision to put the system in your home? (ANSWER "A" AND/OR "B", WHICHEVER APPLY)

	A HEATING SYSTEM	B COOLING SYSTEM
Builder	☐	☐
Dealer/Contractor	☐	☐

(CONTINUED)

	A HEATING SYSTEM	B COOLING SYSTEM
Utility (available fuel)	☐	☐
You (owner).	☐	☐
DON'T KNOW (system in place at time of purchase)	☐	☐
Other (specify)_____	☐	☐

6. How was this system installed?
(ANSWER "A" AND/OR "B", WHICHEVER APPLY)

	A HEATING SYSTEM	B COOLING SYSTEM
New (at the time home was built). . . .	☐	☐
In place (when home was purchased). . .	☐	☐
Replacement (same as original system) .	☐	☐
Retrofit (other than original system) .	☐	☐
Add-on (to existing system)	☐	☐

7. Rank below the three most important product features in order of importance to you with "1" being most important, "2" being second most important, and "3" being third most important.
(RANK 3 ONLY)

_____ Electronic Air Cleaner
_____ Humidifier
_____ Low noise level
_____ Size
_____ Styling
_____ Other (specify):_____

8. Approximately how many square feet of your home do you heat (exclude garage, basement, or any other area not being heated)?

#_____sq. ft.

NFO MAIL SURVEY

THIS QUESTIONNAIRE IS TO BE ANSWERED BY THE PERSON IN YOUR FAMILY WHO MAKES THE MOST DECISIONS CONCERNING THE HEATING AND/OR COOLING SYSTEM!

1. What do you like about your present heating/cooling system?

_____

_____

_____

2. What do you dislike about your present heating/cooling system?

_____

_____

_____

3. What product features on a heating/cooling system are important to you?

_____

_____

_____

4. If you were going to install a new heating/cooling system, where or to whom would you go for information?

_____

_____

_____

5. What method and/or criteria would you use to determine which heating/cooling system to choose?

_____

_____

NFO MAIL SURVEY (CONTINUED)

Assume for the basis of Questions 6 through 8 that you have a new heating/cooling system installed excluding duct work. Assume that the price you would have to pay for the installed system is $2300 and the corresponding annual utility bill will be $800, even if this is different from your own experience.

6. If you could save $160 in fuel cost, reducing the annual utility bill from $800 to $640, how much more over $2300 would you be willing to pay for the system?

$_____ Additional over $2300 (for $160 a year savings)

7. If you could save $80 in fuel cost, reducing the annual utility bill from $800 to $720, how much more over $2300 would you be willing to pay for the system?

$_____ Additional over $2300 (for $80 a year savings)

8. If you could save $240 in fuel cost, reducing the annual utility bill from $800 to $560, how much more over $2300 would you be willing to pay for the system?

$_____ Additional over $2300 (for $240 a year savings)

9. How did you determine your answers for Questions 6 through 8 (what method and/or criteria did you use)?

_____

_____

_____

10. Do you know what a heat pump is?

YES - (CONTINUE WITH QUESTION 11)
NO - (GO TO QUESTION 15)

11. Where did you get your information about heat pumps?

_____

_____

_____

NFO MAIL SURVEY (CONTINUED)

12. Would you consider buying a heat pump (or another if you currently own one)?

☐ YES -(ANSWER QU. 13) ☐ NO - (ANSWER QU. 14)

13. Why would you buy a heat pump?

_____

_____

_____ (SKIP TO QU. 15)

14. Why wouldn't you buy a heat pump?

_____

_____

_____

15. Please indicate your AGE and SEX. AGE:_____

SEX: ☐ Male ☐ Female

ADVANCED ELECTRIC HEAT PUMP
BUILDER QUESTIONNAIRE
PERSONAL INTERVIEW - DX 5246

COMPANY_____ RESPONDENT_____

PHONE_____ POSITION_____

ADDRESS_____ DATE/TIME_____

_____

1. What is the composition of your business, that is, how many_____ units do you build annually?

UNIT VOLUME

Residential_____ (Single-family)

Multi-Family_____ (Condominiums, apartments)

Commercial_____

2. What do you expect your volume of residential units to be five years from now?

1985 Residential Unit Volume_____

3. Do you install heat pumps?

☐ YES How many heat pumps do you install annually in your:

1980 HEAT PUMP VOLUME

Residential Units_____

Multi-family Units_____

Commercial Units_____

☐ NO

4a. What is the average size of heat pump that you install? (If no heat pumps, cooling system)

TYPE OF SYSTEM		TYPE OF SYSTEM	
☐ 1 ton	_____	☐ 4 tons	_____
☐ 1½ "	_____	☐ 5 "	_____
☐ 2 "	_____	☐ 6-8 "	_____
☐ 2½ "	_____	☐ 9-11 "	_____
☐ 3 "	_____	☐ 12-15 "	_____
☐ 3½ "	_____	☐ 15 "	_____

4b. How has this average size changed over the past five years? How will it change over the next five years?

	1975		1980		1985
Average Unit Size	_____	vs.	_____	vs.	_____

(Q. 4a)

5. Who usually makes the decision concerning heating/cooling system purchase and installation?

_____ Builder

_____ Consumer

_____ Utility

_____ Dealer/Contractor

_____ Other_____

6. Why do you choose heat pumps or why do you think they are chosen as opposed to other heating and cooling methods?

_____ Energy Efficiency

_____ Economics

_____ Reliability

_____ Code Requirements

_____ Other_____

7. (If Code Requirements) Which code requirements? How do they affect your business?

_____

_____

_____

_____

8. How do you aid the consumer in making a purchase decision regarding heating/cooling systems (or regarding heat pumps)?

_____

_____

_____

_____

9. Are there any constraints to consumer acceptance of heat pumps? If so, what are they?

_____ Higher initial cost

_____ Reluctance to try new system

_____ Other _____

_____

_____

_____

10. How do you merchandise heat pumps?

_____

_____

_____

_____

11. Have you had any problems with heat pumps?

☐ YES ➡ What were they? _____

_____

_____

☐ NO

12. Several manufacturers have introduced high efficiency heat pumps--two-speed, variable speed. Are you using any of these units?

☐ YES ➡ How many?_____

Why did you decide to use these high-efficiency heat pumps?

_____

_____

_____

☐ NO ➡ Why not?_____

_____

_____

13. a) What is the average cost to you of a high efficiency heat pump before installation?

$_____

b) If consumers could be assured of a 20% energy savings, over the current high efficiency units currently available and there were no difference in cost to you how many do you think you would use?

_____ Units

c) If that unit cost you 10% more or $_____how many units would you use?

_____ Units

d) If that unit cost you 20% more or $_____how many units would you use?

_____ Units

14. How do you merchandise this high-efficiency heat pump?

_____

_____

_____

15. Which features in a heat pump are important to the consumer?

_____ Humidifier

_____ Low Noise Level

_____ Thermostat

_____ Styling

_____ Other _____

_____

16. What design options in a heat pump would you want?

_____

_____

_____

_____

17. What are the advantages and/or disadvantages as you see them, to putting a compressor inside the home in a basement or utility closet as opposed to outside in the condensing unit?

_____

_____

_____

_____

18. What do you view as the optimum size of outdoor unit in height, width and length?

HEIGHT_____ WIDTH_____ LENGTH_____

19. What would you view as the optimal size and locations of an Indoor Air Handler Unit

_____

_____

_____

ELECTRIC UTILITY

PERSONAL INTERVIEW

DX 5247

COMPANY _____ STREET ADDRESS _____

PHONE _____ CITY, STATE _____

PERSON _____ TITLE _____

DATE _____ INTERVIEW PERIOD _____

RESIDENTIAL CUSTOMERS _____

1. What has been your posture regarding heat pumps and what, if any, programs have you carried out concerning heat pumps?

_____

_____

_____

_____

(Probe - If they say they promoted heat pumps, exactly what did that entail?)

_____

_____

2. What do you expect your posture and programs to be over the next five years?

_____

_____

_____

3a. Approximately how many residential central A/C units did you have in your territory at the end of 1979 and how many of these were heat pumps?

Total Central A/C_____

Heat Pumps_____

b. How many commercial central A/C units and HP units do you have on your system?

Total Central A/C_____

Heat Pumps_____

4a. Approximately how many central A/C units are added per year now and how many of these are heat pumps?

	1980 through 1985 Annual Additions		
	Total	New	Retrofit and Replacements
Central A/C	_____	_____	_____
Heat Pumps	_____	_____	_____

5a. What percent of the heat pumps in your territory now are high efficiency units?

_____% in 1980

b. What do you expect that percent to be by 1985?

_____% in 1985

6. What is the average COP and EER of heat pumps in your territory?

Coefficient of Performance (COP)_____(Heating)

Energy Efficiency Ratio (EER)_____(Cooling)

7a. What are the competing central home heating fuels and what is the percent (%) of each in your territories?

Heating Fuel Type	Residential: 1979 Total in Territory	Residential: Added 1980-1985	Commercial: 1979 Total in Territory	Commercial: Added 1980-1985
• Electric				
• Gas				
• Oil				
• Other				

8. How would that be different for commercial? _____

_____

_____

9. What is the average cost of competing fuels in your areas for residential and commercial installation (based on your estimate of average annual fuel use? (varies)

Electricity	_____ ¢/KWHR	Electricity	_____ ¢/KWHR
Gas	_____ $/MCF	Gas	_____ $/MCF
Oil	_____ ¢/Gal	Oil	_____ ¢/GAL

10a. What is the average size of electric heating and cooling units for residential and commercial segments?

b. What is the average annual heating and cooling KWHRS usage for residential and commercial customers on your system? (varies)

	Heating Load (KWHRS)			Cooling Load (KWHRS)		
	Size	Electric Resistance	Heat Pumps	Size	Central A/C	Heat Pumps
Residential						
Commercial						

11. Who makes the decision on a heating/cooling system for a new home or for an existing home?

New Home _____

Existing Home _____

12. If a customer could be assured of a higher coefficient of performance COP), would he be willing to pay a higher initial price for a heating/cooling system?

☐ YES ➡ GO TO Q. 10

☐ NO

13. How much more do you feel a consumer would be willing to pay for the initial cost of a heat pump if he could be assured of a 20% savings in energy efficiency

$ _____

14. In your opinion does the average utility residential customer think payback when making a purchase for a central heating and cooling system or is some other method employed? Comment.

_____

_____

15. Would you offer any programs or incentives? Comments.

☐ YES _____

_____

_____

☐ NO _____

_____

_____

16. Do you feel there will be any constraints to consumer acceptance of this new heat pump?

☐ YES _____

_____

_____

☐ NO _____

_____

_____

17. What features should be incorporated in to the new advanced heat pump that will be important to the consumer? To the utility?

CONSUMER _____

_____

_____

UTILITY _____

_____

_____

18. How do you view your relations with the following groups? How might they change in the future?

Manufacturers _____

_____

Contractors _____

_____

Consumers _____

_____

19. Would you or your utility group be willing to participate in a demonstration program of the new advanced heat pump under development?

☐ YES _____

☐ NO _____

DISTRIBUTOR
PERSONAL INTERVIEW

COMPANY _____ RESPONDENT _____

PHONE _____ POSITION _____

ADDRESS _____ DATE/TIME _____

1. Do you sell heat pumps?

   ☐ YES

   ☐ NO

2. Approximately how many cooling units are sold in your market area annually?

   _____ UNITS - 1980

3. Of this amount, how many are heat pumps?

   _____ Heat Pumps - 1980

4. Approximately what annual growth do you expect in your market for cooling units?

   _____ Annual % Growth from 1980 thru 1985

5a. How are heat pumps currently regarded in your marketplace and how do you see that changing in the next five years?

_____

_____

_____

_____

b. What do you expect the annual percent growth of heat pumps to be from 1980 thru 1985?

_____%

c. What percent do heat pumps comprise of total cooling units now?

_____% in 1980

d. And what percent would you expect them to comprise by 1985?

_____%

6. What are the constraints to consumer acceptance of the current heat pumps? (Number in order mentioned 1, 2, etc; and write in comments.)

- ☐ Increase initial cost_____
- ☐ Service Reliability_____
- ☐ Consumer awareness_____
- ☐ Reluctance to try new system_____
- ☐ Education & training of sales personnel_____
- ☐ Absence of desired product features_____
- ☐ Other_____

7. Of the total heat pumps now sold in your marketplace what percent are residential versus commercial units?

_____ Residential (5 tons and under)

_____ Commercial (over 5 tons)

8a. What percent of the heat pumps which you sell for residential use are installed in new facilities? Commercial?

Residential	Commercial
_____% New	_____% New

b. Which % is installed as a replacement for a conventional heating/cooling system?

_____% Retrofit	_____% Retrofit

c. Which % is installed as an addition to a present system?

_____% Add-on	_____% Add-on

d. Which % is installed as a replacement for an electric heat pump?

_____% Replace	_____% Replace
TOTAL 100%	TOTAL 100%

9a. Of the heat pumps currently sold in your market area, how many units or what percent are high efficiency type--that is, the variable speed or two-speed type?

Number or % of total HPs which are high efficiency_____%

b. How many of these or what percent are sold for residential use? Commercial?

Residential Portion_____

Commercial Portion_____

c. How many would you expect to be sold in 1985 for residential use? Commercial?

Residential Units_____

Commercial Units_____

10. Which product features would be important to the consumer in the new high efficiency heat pump?

- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

11. Which design options should be included? (Which would be important to the engineers, utilities, builders, dealers, distributors.)

- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

12. Would the constraints to consumer acceptance for the high efficiency heat pump be different from the constraints for the conventional heat pump which we discussed in question 6? If so, how?

- ☐ NO → (Go to Q.13)
- ☐ YES →
- ☐ Increased initial cost _____
- ☐ Service reliability _____
- ☐ Consumer awareness _____
- ☐ Reluctance to try new system _____
- ☐ Education & Training of sales personnel _____
- ☐ Absence of desired product features _____
- ☐ Other _____

RESIDENTIAL

13a. What is the average price { o For Distributor - to Dealer / o For Dealer - Installed to homeowner } in your market area for a currently available high efficiency heat pump?

$_____

b. You mentioned that about_____(Units from Q.9) high efficiency heat pumps are currently sold. If you had available a unit which was 20% more fuel efficient what volume would expect to be used? _____units

c. If this more efficient unit cost 10% more approximately how many units would expect to be sold? _____units

d. If this more efficient unit cost 20% more approximately how many units would expect to be sold? _____ units

COMMERCIAL

13b. What is the average price { o For Distributor - to Dealer / o For Dealer - Installed to homeowner } in your market area for a currently available high efficiency heat pump?

$_____ _____units

c. You mentioned that about_____(Units from Q. 9) high efficiency heat pumps are currently sold. If you had available a unit which was 20% more fuel efficient what volume would expect to be used? _____units

d. If this more efficient unit cost 10% more approximately how many units would expect to be sold? _____units

e. If this more efficient unit cost 20% more approximately how many units would expect to be sold? _____units

ADVANCED ELECTRIC HEAT PUMPS

DEALER/CONTRACTOR QUESTIONNAIRE

PHONE INTERVIEW-DX 5250

COMPANY_____

LOCATION_____ PHONE_____

Call 8 AM and 4 PM

ASK TO SPEAK WITH THE OWNER OR MANAGER

Good morning/afternoon. This is_____of Field and Phone Interviewing Service. We are doing a study on heat pumps. May we ask you a few questions?

RESPONDENT	POSITION	PHONE

1. Do you sell and install heat pumps thru 15 tons?

_____Yes

_____No (Go to Question 7)

2. What percentage of your total sales of heating and cooling equipment do heat pumps comprise?

_____%

3. What percent of your heat pumps are installed in Commercial applications versus Residential?

_____Commercial _____Residential

4. In commercial applications, what is your split between new installations and replacements or retrofits?

New_____ Replacements & Retrofits_____

5. In your residential installations, what is the split between new and replacements?

New_____ Replacements & Retrofits_____

6. Do you see any trends relative to downsizing of units? (i.e., going from 3 ton to 2½ ton units for same application.)

_____Yes What are they?_____

_____

_____

_____No

7. What are the most important criteria in the customer's choice of a heating/cooling system?

(Probe)_____

_____

_____Payback period

_____Energy efficiency

_____Economics

_____Reliability

_____Builder/Dealer Opinion

_____Other_____

8. Are there any constraints to acceptance of heat pumps?

_____

_____

_____

9. Which product features in a heat pump are important to the consumer?

_____Humidifier

_____Styling

_____Low Noise Level

_____Other_____

10. What product features are important to you?

_____

_____

_____

11. What are the advantages and/or disadvantages as you see them, to putting a compressor inside the home in a basement or utility closet (as opposed to outside in the condensing unit?)

_____

_____

_____

_____

12. In your area, are physical size constraints to the outdoor unit for residential applications?

_____

_____

_____

13. What do you view as the optimum size (residential--thru 5 tons) of outdoor unit in height, width & length?

HEIGHT_____ WIDTH_____ LENGTH_____

14. Do you see a demand for a product which is not available to you?

☐ YES _____

_____

☐ NO _____

_____

_____

15. Do you have product needs which are not being met by the manufacturers? (probe)

_____

_____

_____

16. What would be the best method for educating and training your service people in installation and repair of heat pumps?

_____

_____

17. What proportion of your heat pump sales now are high efficiency type?

_____%

18. What do you think that percentage would be five years from now?

_____%

THANK YOU VERY MUCH FOR YOUR TIME!!!

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