BPA

1983 Pacific Northwest Residential Energy Survey : Basic Findings

U.S. Department of Energy
Bonneville Power Administration

April 1986

PNWRES-83

Objectives

1. Long-range load forecasting

2. Conservation assessment and program planning.

PNWRES-83

INTERVIEW TOPICS

- Basic dwelling unit characteristics
- Energy-related attitudes/opinions
- Conservation measure taken
- Space heating fuels and equipment
- Water heating fuels and equipment
- Air conditioning fuels and equipment
- Household appliance characteristics
- Resident demographics
- Physical measurement of dwelling unit and water temperature
- Electricity and natural gas billing histories

PNWRES-83 Summary

In 1983, the Bonneville Power Administration commissioned Louis Harris and Associates to conduct the 1983 Pacific Northwest Residential Energy Survey (PNWRES). The survey was designed to support BPA's conservation assessment, program evaluation, and power forecasting responsibilities. The resulting data base contains information on the socio-economic status, family size, and energy-related attitudes of residential consumers, as well as on the heating systems, electric appliances, weatherization, and other conservation practices followed in their dwellings.

Personal interviews were conducted at a probability sample of 4703 households in 57 utility service areas. In addition to interviewing customers, the Louis Harris staff measured the temperature of hot water at the tap and recorded the outside dimensions of the dwellings. The survey was begun in late May 1983 and was completed in September 1983. About 70 percent of the interviews were done in June and July 1983. Surveyors also obtained waivers allowing access to utility data covering the period between September 1981 and January 1983. After the interviews, utility billing data were requested.

The PNWRES survey data was merged with the billing data, allowing cross-tabular analysis of data with key variables, including region, utility type, customer characteristics, dwelling unit characteristics, conservation measures and practices, and consumption habits. The final report appeared in 1985. Results were summarized in the four major categories which follow: "The Homes and People of the Pacific Northwest"; "Residential Energy Consumption Patterns"; "Home Weatherization and Energy Conservation Practices"; and "Customer Attitudes about Energy Consumption and Conservation."

The Homes and People of the Pacific Northwest

Most of the residential consumers of electricity in the Pacific Northwest live in the relatively more urbanized area west of the Cascades, that is, in western Washington and Oregon. About a third of the residential customers live east of the Cascades, with the lowest density of population occurring in Montana and eastern Oregon. The percentage of the total population in each area is: western Washington (40%), western Oregon (28%), eastern Washington (12%), Idaho (12%), eastern Oregon (4%), and Montana (3%).

The single family house is the predominant dwelling unit in the region, comprising about three-fourths of the units. About a sixth of the dwelling units are multi-family and a tenth are mobile homes. In more sparsely populated areas, mobile homes are more common and multi-family units are far less common. Nearly two-thirds of the housing was built before 1970; 10 percent was built since 1979, with a disproportionate share of this being multi-family units.

Most dwellings in the region have wood frame exteriors. The average size is about 1462 square feet, although there is a great variance from the average among housing subcategories. Owner-occupied single-family units are nearly 21 percent larger, rented single-family units are nearly 13 percent smaller, owner-occupied multi-family units are 24 percent smaller, and multi-family rented units are 45 percent smaller than the average. Mobile homes are a third smaller than the average.

Seventy percent of residential customers own their own homes. The highest proportion of renters is in western Washington, the lowest in eastern Oregon. Single family homes and mobile homes are mostly owner occupied.

Residential consumers in the Pacific Northwest are highly mobile. Nearly half moved into their current homes in the 4½ years before the survey. Renters were far more mobile than home owners. Comparisons between the 1979 PNWRES and the 1983 PNWRES show relatively stable dwelling and consumer characteristics. Household income was somewhat higher in 1983, the population slightly less mobile, and the head of household slightly better educated. Dwelling characteristics were very much the same, although among housing built since 1979 there was a higher proportion of multi-family units.

Residential Energy Consumption Patterns

The energy consumption patterns for residential consumers in the Pacific Northwest have changed since 1979. Mostly the change has been in the choice of fuel, with price probably being the main reason for change. There has been a continuation of the trend toward wider use of electric appliances.

Space heating is the largest component in residential electrical consumption in the Pacific Northwest. Nearly 45 percent of the dwellings use electricity most often as their source of heat. This is virtually the same percentage as in 1979. A great increase in the use of electricity as the main heat source in Montana was mostly offset by small decreases in Washington and Idaho. Gas was the fuel most often used in 21 percent of the dwellings, wood in 21 percent, and oil in 10 percent. It is unclear whether there has been an increase since 1979 in the use of wood as the most often used fuel because the relevant question in 1979 was not comparable to the 1983 survey question. What is clear is that wood has a significant share of the heating fuel market in the region. More than half of those who use wood most often as their heating fuel do not buy the wood, a fact that partly explains the wide use of wood as a heating fuel in the region.

Water heating is another heavy user of energy among residential consumers. PNWRES 1983 notes an increase in the percentage of dwellings using electricity to heat water, compared with 1979, from 81 percent to 85 percent. This is the result of a massive conversion from gas water heating to electric water heating in Montana rather than of a regionwide shift. In 1979, 38 percent of Montana's dwellings heated water with electricity. In 1983, 66 percent used electricity, with a corresponding decrease in the use of gas for heating water.

Air conditioning is now installed in 23 percent of Pacific Northwest dwellings, compared to 19 percent in 1979. This is the result of increases in Oregon and Washington, offsetting decreases in Idaho and Montana.

Every type of major electric appliance exists in a greater percentage of residences in 1983 than in 1979. For the common major appliances, this is the apparent continuation of a long-established trend, with increases in the range of 3-10 percent. Microwave ovens, however, showed a dramatic increase in acceptance by consumers in the period 1979-1983. Consumers possess many other appliances which can increase electrical consumption significantly. Among these are wood and metalworking equipment, water bed heaters, pumps, and office equipment. Unfortunately, comparisons with 1979 are not possible for these sorts of appliances.

The consumption of electricity varies among households according to the household's dwelling size, heating fuel, number of major electric appliances, and income. The larger the unit size, the more electricity the household consumes, other factors being the same. Those whose most often used heating fuel is electricity obviously use more electricity than others. The same is true for those with more electric appliances. Those with higher income tend to use more electricity. However, none of the factors display a linear relationship to electrical consumption. The fuel used most often for space heating is probably the most significant factor affecting consumption.

Home Weatherization and Energy Conservation Practices

For several years energy conservation programs have encouraged residential consumers to save energy. Utilities and government at all levels have provided information, advice, audits, and financial incentives to consumers. According to PNWRES 1983, consumers seem aware of the level of energy efficiency of their homes, but few have taken advantage of the audits or financial incentives. Although there appears to be widespread compliance with recommended household temperatures and hot water heater temperatures, less than a third of the households which have not had energy audits have adopted other conservation measures. Those measures that require substantial work or money appear not to have been applied with great frequency. Nevertheless, energy audits seem to be an effective way of increasing the adoption of conservation measures. The rate of application of substantial conservation measures is twice as high among households that have been audited. The PNWRES 1983 survey indicates several areas with substantial conservation potential in Pacific Northwest dwellings: insulation in the ceiling, walls, and basement; and weatherization of windows and doors.

Higher rates of adoption of conservation measures is related to higher levels of education, to home ownership and to higher household income. The educational and incentive programs have been less successful in reaching poorer, less educated residents.

Customer Attitudes about Energy Consumption and Conservation

The attitudes of Pacific Northwest residents concerning energy-related issues were explored in a series of questions in the PNWRES 1983 survey. The first group of questions asked residents to rate the severity of several problems in their state. With the exception of unemployment, the high price of energy aroused the highest level of "very serious" concern among the public. On the other hand, a majority of those interviewed did not believe that scarcity of energy is a serious problem.

A follow-up question to those who stated that the cost of energy is a moderately or very serious problem revealed that a majority cited the cost of electricity as an example of the problem of energy costs. Those who use electricity as their most often used heating fuel showed concern about energy costs more often than those using fuels for heating. Forty-three percent showed concern, compared to 36 percent for gas and oil users. Wood users showed the same level of concern as those using electricity.

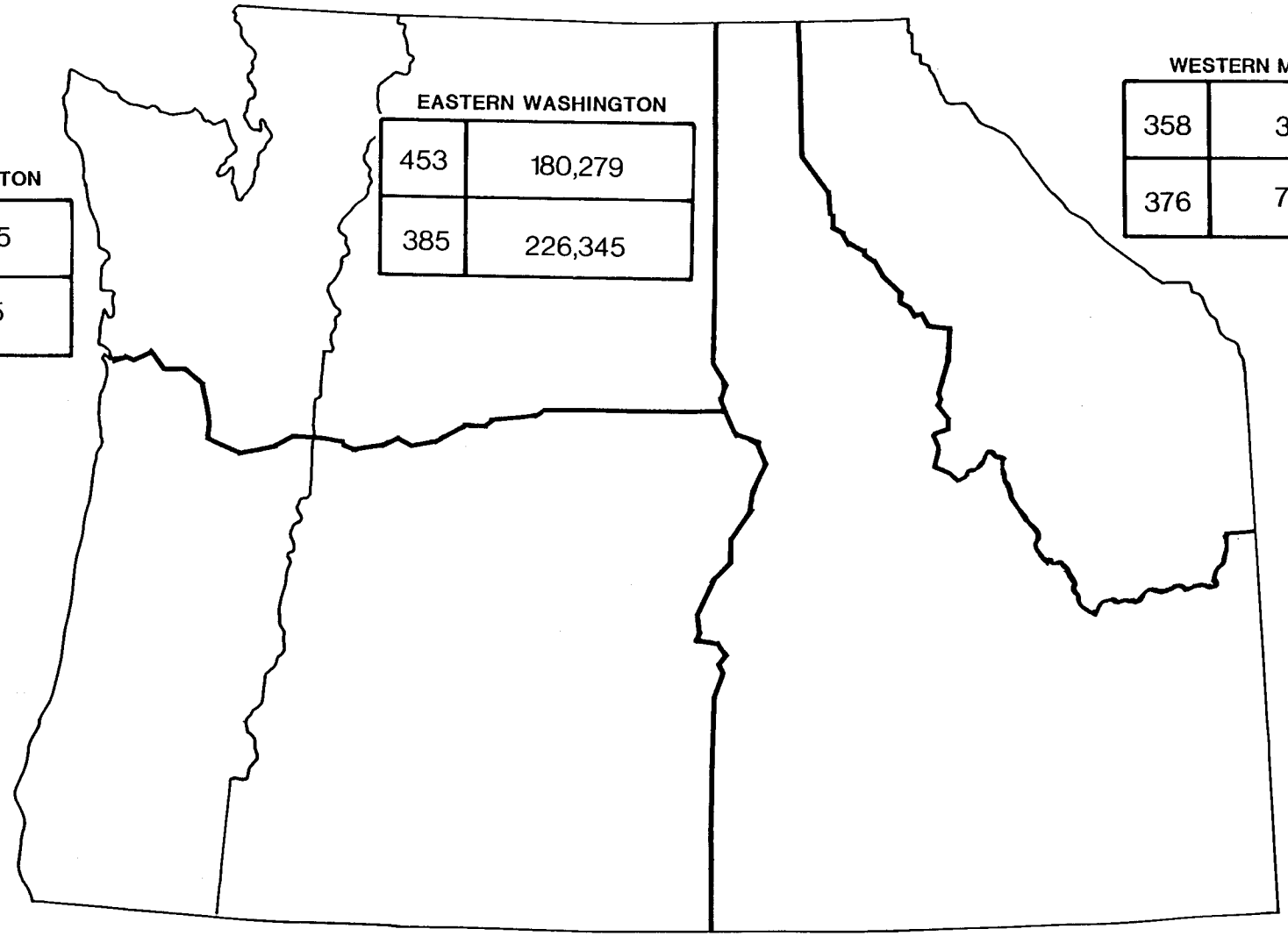
Consumers were also asked to respond to a series of questions about energy consumption and conservation by indicating their degree of agreement or disagreement. On specific conservation measures, a majority agreed that reducing the water heater temperature and turning down the heat when no one is at home is worth doing. Also, a majority disagreed that the purchase price

of an appliance is more important than the energy savings over the appliances' lifetime. In a more general sense, the measures were related to the statement that the main reason to conserve energy is to save money. When asked whether people have the right to use as much energy as they can pay for and want, a majority disagreed.

Responses to three other questions indicated public awareness of some limits to energy conservation measures. A majority agreed that they would not feel comfortable when the temperature in their homes is below 68°F. A small majority agreed that saving enough energy to make a difference in energy bills would require a change in lifestyle. The consumers were almost evenly divided on whether it is hard to get around to making their homes energy efficient. In general, the responses to the statements indicated an acceptance of the desirability of energy conservation by a majority, as well as an awareness of some of the problems of implementing conservation measures.

SAMPLE

PNWRES: Number of Households Sampled, Represented by Public Utilities and IOU's



WESTERN WASHINGTON

684	753,845
189	496,995

EASTERN WASHINGTON

453	180,279
385	226,345

WESTERN MONTANA

358	34,279
376	77,909

WESTERN OREGON

413	189,520
334	709,373

EASTERN OREGON

398	48,411
339	105,805

IDAHO

414	75,767
360	301,236

KEY

	Sample	Population
Publics		
IOU's		

SAMPLE FRAME*

	Public		Private	
Area	Utilities**	Accounts	Utilities	Accounts
Washington-West	27	753,845	1	496,995
Washington-East	22	180,279	2	226,345
Oregon-West	18	189,520	2	709,373
Oregon-East	11	48,411	3	105,805
Idaho	17	75,767	4	301,236
Montana	7	34,279	2	77,909
TOTAL	102	21,059,737	14	25,593,416

* Source: 1981 Electricity Sales Data

** Utilities have been grouped or divided such that no group has fewer than 1,000 customers and no group crosses a geographic area boundary.

SAMPLE

Area	Public		Private	
	Utilities	Accounts	Utilities	Accounts
Washington-West	12	900	1	240
Washington-East	8	600	2	480
Oregon-West	8	600	2	480
Oregon-East	4	480	3	480
Idaho	6	540	4	450
Montana	4	480	2	480
TOTAL	42	3,600	14	2,610

COMPLETION RATES

	Selected	Completed	Percent
Washington-West			
Public	900	684	76.0
Private	240	189	78.8
Washington-East			
Public	600	453	75.5
Private	480	385	80.2
Oregon-West			
Public	600	413	68.8
Private	480	334	69.6
Oregon-East			
Public	480	398	82.9
Private	480	339	70.6
Idaho			
Public	540	414	76.7
Private	450	360	80.0
Montana			
Public	480	358	74.6
Private	480	376	78.3
TOTAL	6,210	4,703	75.7

UTILITY CUSTOMER ACCOUNTS

	1981 Customer Accounts	Estimate
Washington-West		
Public	753,845	711,774
Private	496,995	469,233
Washington-East		
Public	180,279	158,378
Private	226,345	211,353
Oregon-West		
Public	189,520	170,274
Private	709,373	664,452
Oregon-East		
Public	48,411	43,908
Private	105,805	89,916
Idaho		
Public	75,767	71,313
Private	301,236	276,198
Montana		
Public	34,279	30,744
Private	77,909	69,552
TOTAL	3,199,764	2,967,095

NUMBER OF HOUSEHOLDS

	PNWRES-83	Census-80
Washington	1,550,737	1,542,685
Oregon	968,550	992,750
Idaho	347,510	324,889
Western Montana	100,296	137,835
TOTAL	2,967,093	2,998,159

OWNER-OCCUPIED DWELLING UNITS

	PNWRES-83	Census-80
Washington	1,027,776 (66.3)	1,011,319 (65.6)
Oregon	708,012 (73.1)	645,941 (60.3)
Idaho	253,326 (72.9)	233,393 (72.0)
Western Montana	78,038 (77.8)	94,335 (68.4)
TOTAL	2,067,152	1,984,988

PERSONS PER HOUSEHOLD

	PNWRES-83		Census-80	
	Estimate	Percent	Estimate	Percent
1	631,617	(21.3)	699,169	(23.3)
2	1,026,341	(34.6)	1,012,484	(33.7)
3	520,948	(17.6)	491,416	(16.4)
4	477,025	(16.1)	453,479	(15.1)
5	189,433	(6.4)	216,699	(7.2)
6+	121,721	(4.1)	124,812	(4.2)

INCOME

	PNWRES-83		Census-80	
	Population	Percent	Population	Percent
Under $5,000	182,840	7.1	356,793	11.9
$5,000-$9,999	389,961	15.1	474,407	15.8
$10,000-$19,999	791,634	30.6	894,142	29.8
$20,000-$24,999	316,666	12.2	395,143	13.2
$25,000-$34,999	475,108	18.4	493,557	16.5
$35,000-$50,000	262,391	10.1	257,475	8.6
Over $50,000	168,407	6.5	124,806	4.2
TOTAL	2,587,007		2,996,323	

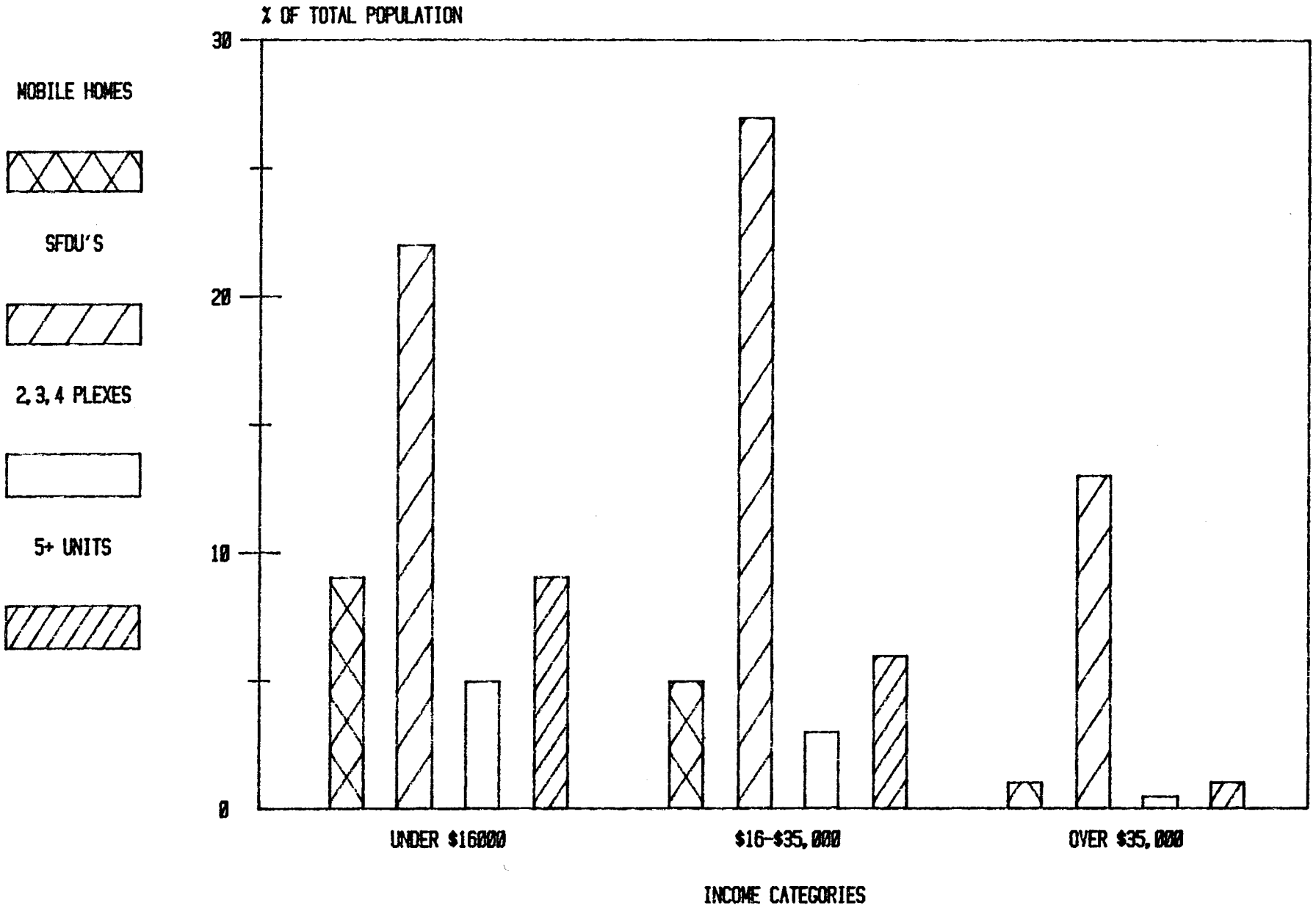
SUMMARY

- APPROXIMATELY 55% OF PNW RESIDENCES HAVE PERMANENT INSTALLED ELECTRIC SPACE HEATING EQUIPMENT

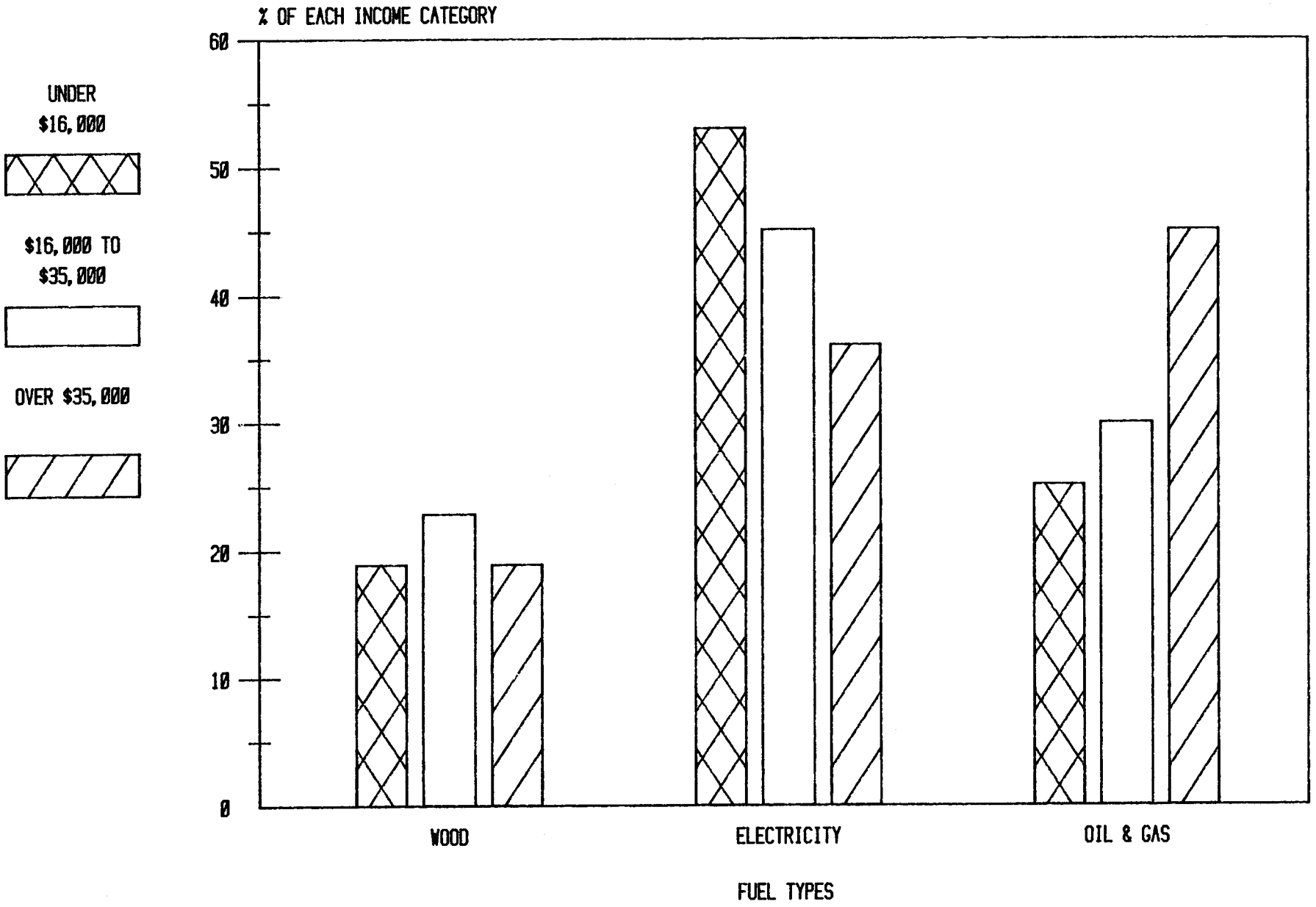
- PEOPLE IN THE LOW INCOME CATEGORY
  - LIVE IN MULTIFAMILY BUILDINGS OR MOBILE HOMES
  - RENT RATHER THAN OWN THEIR HOMES
  - USE ELECTRICITY FOR SPACE HEATING

INCOME CATEGORIES BY DWELLING UNIT TYPE

FOR PESHE HOMES ONLY

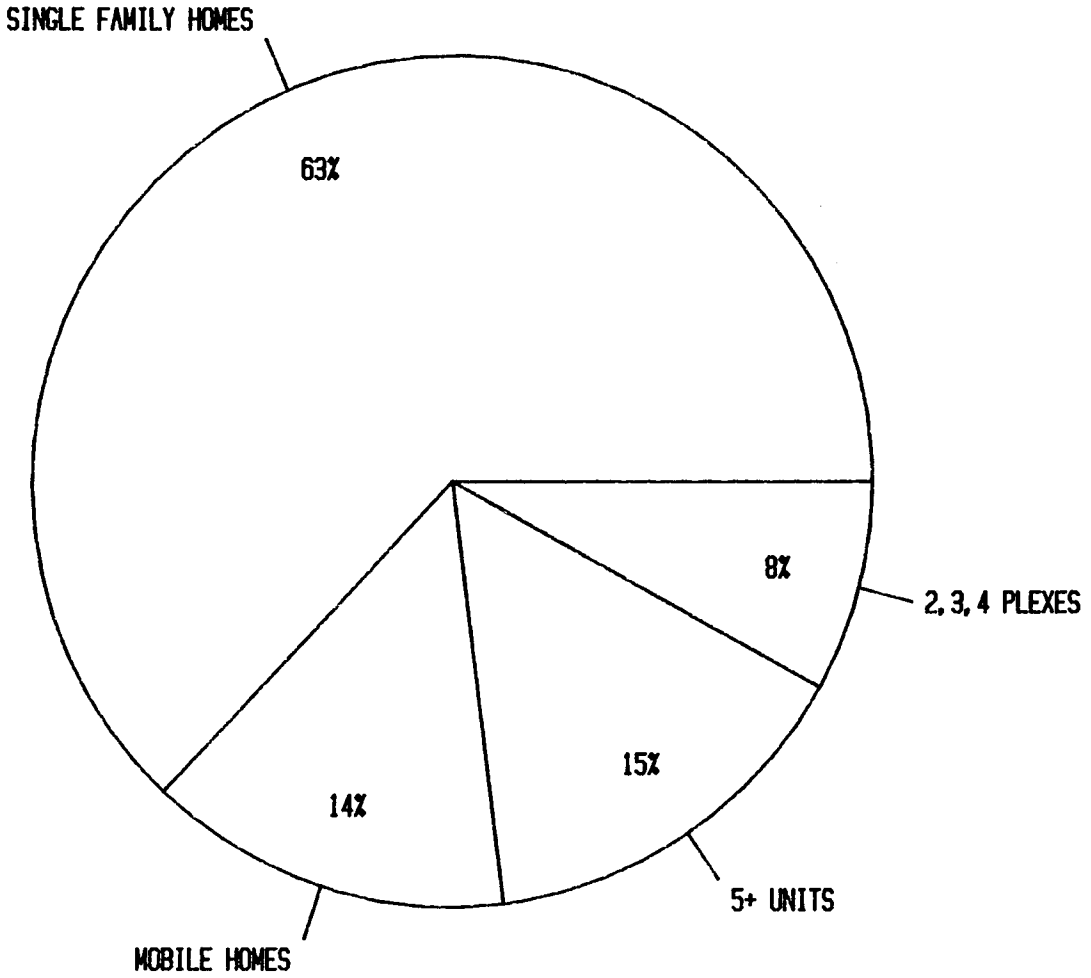


SPACE HEAT USED MOST BY INCOME



PESHE HOMES BY TYPE OF DWELLING UNIT

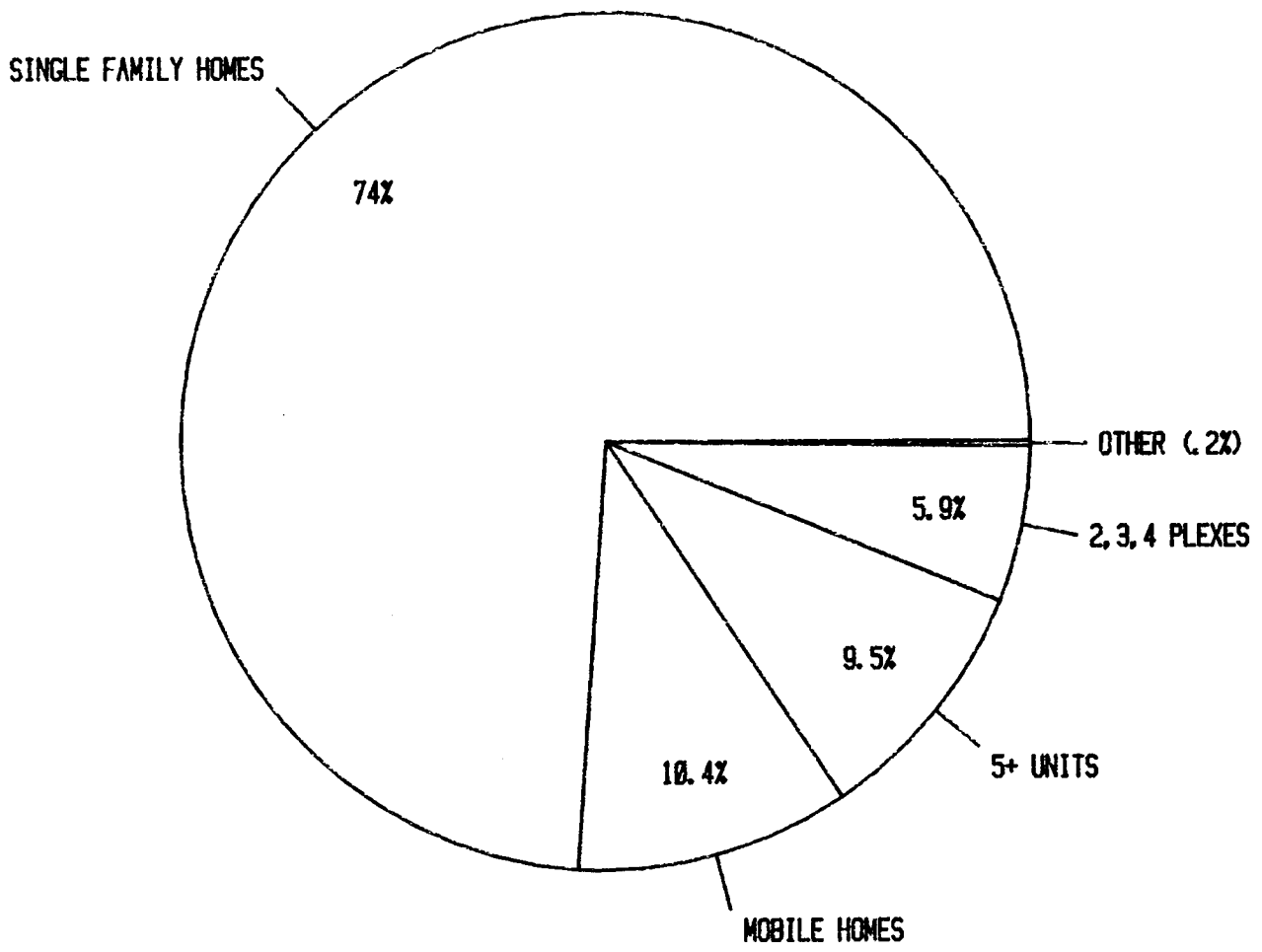
EQUALS 55% OF ALL DU'S IN THE REGION



POPULATION CHARACTERISTICS

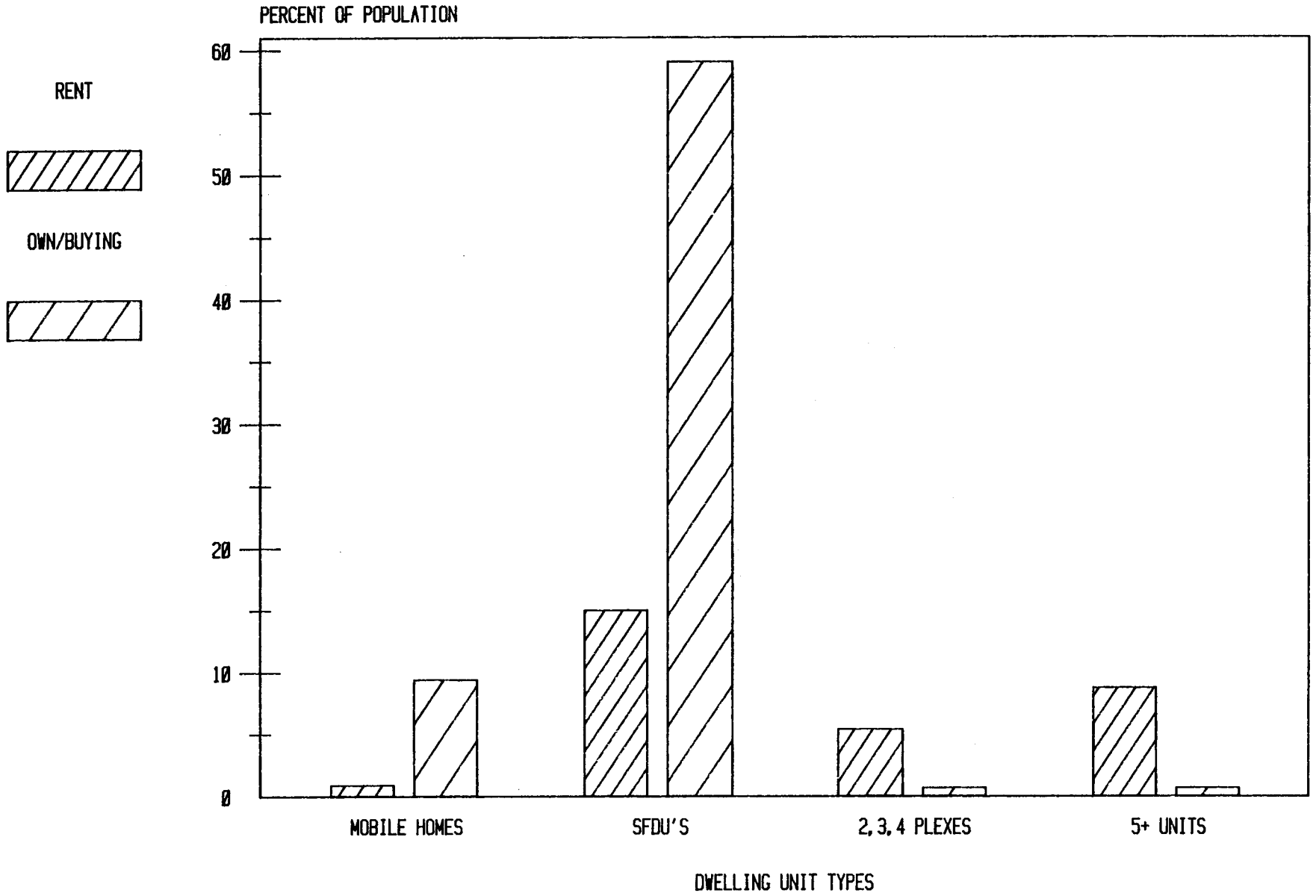
DWELLING UNIT TYPES

2,967,093 TOTAL DWELLING UNITS

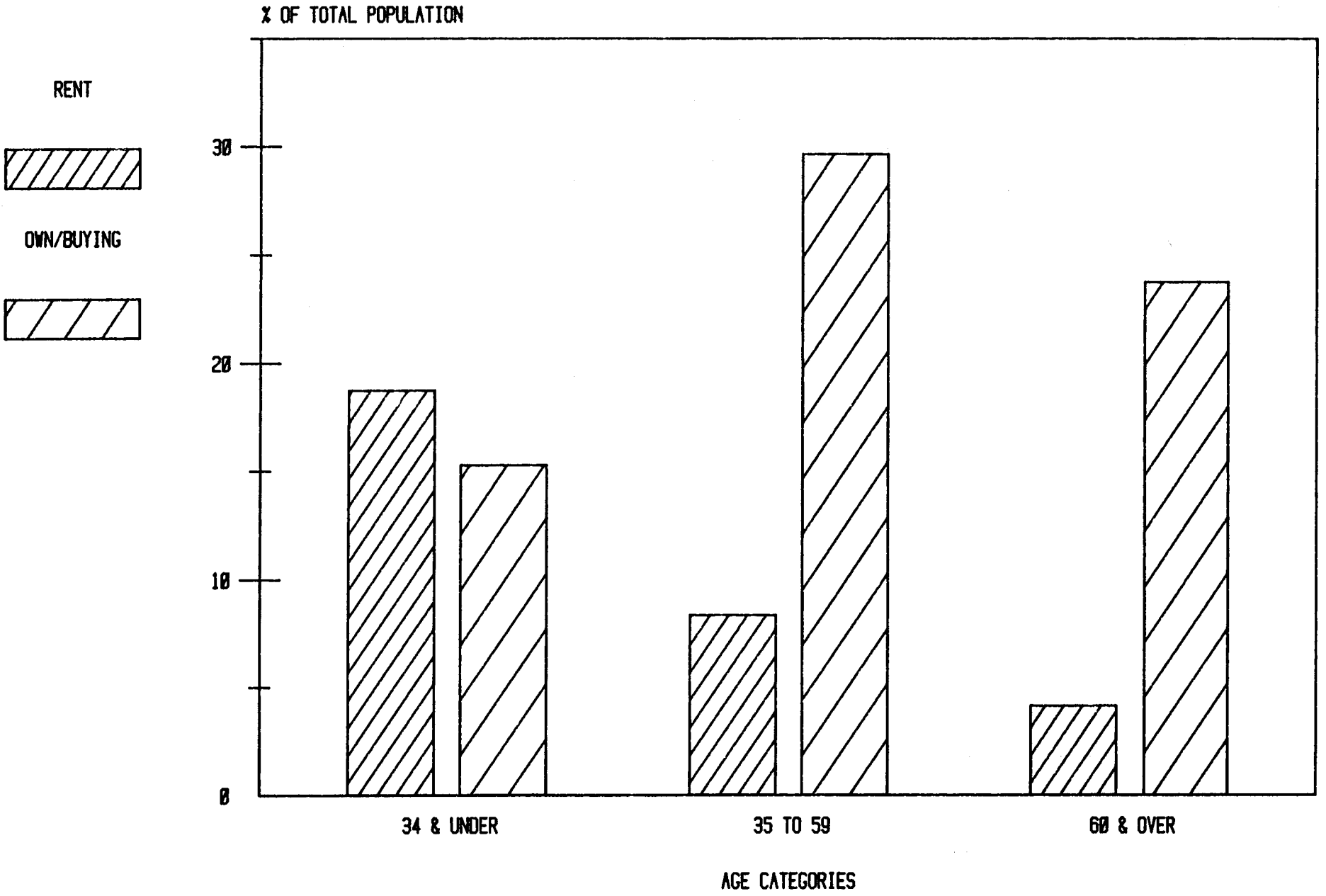


DWELLING UNIT TYPES BY TENURE

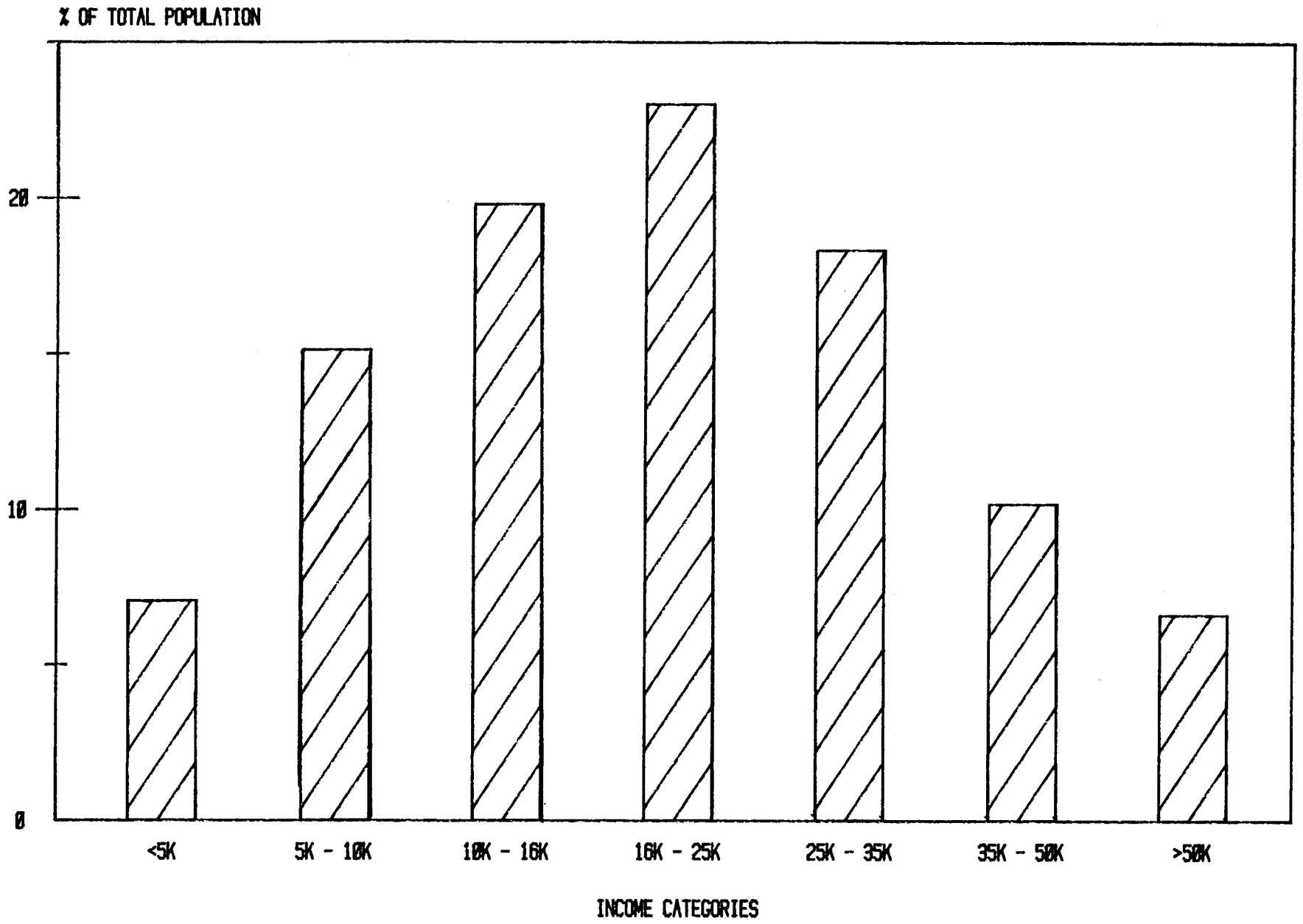
RENTAL UNITS EQUAL 29.5% OF ALL DU'S



HOUSEHOLDER'S AGE BY TENURE

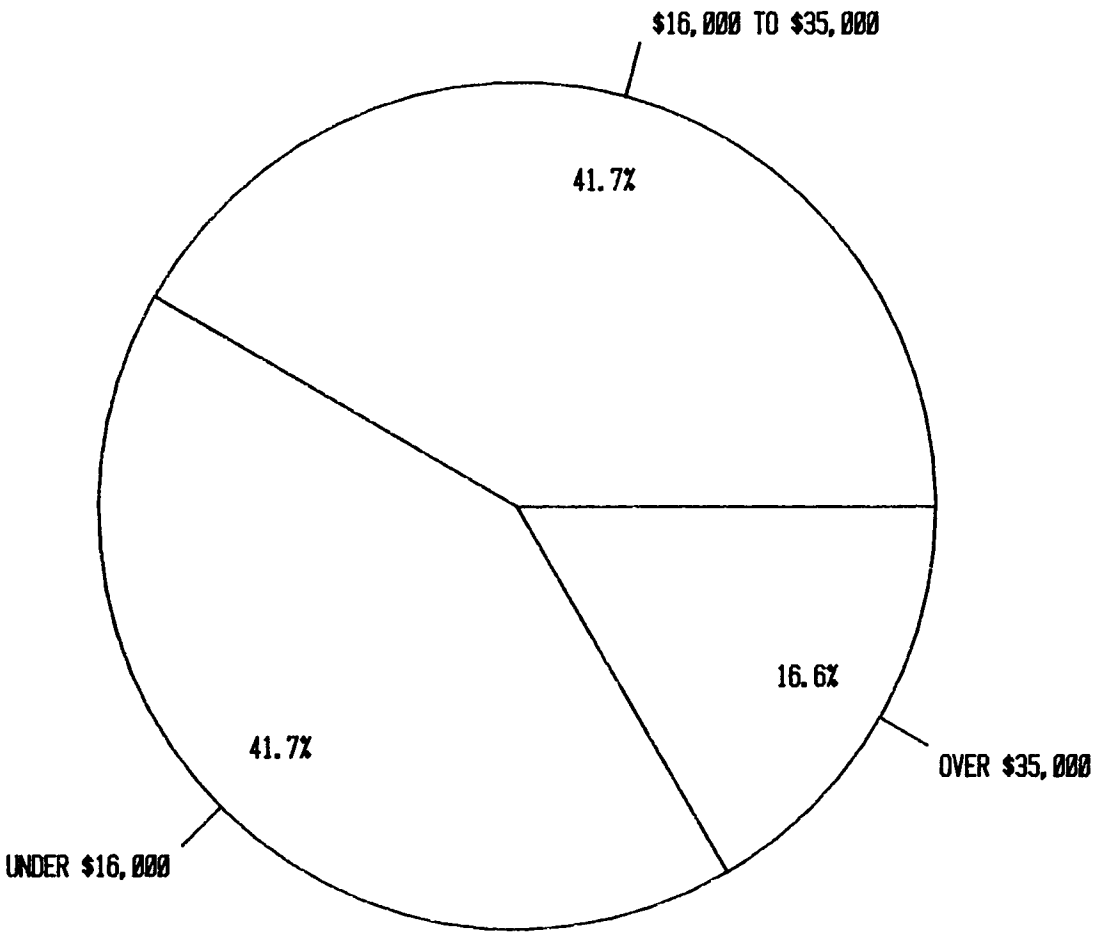


HOUSEHOLD INCOME DISTRIBUTION



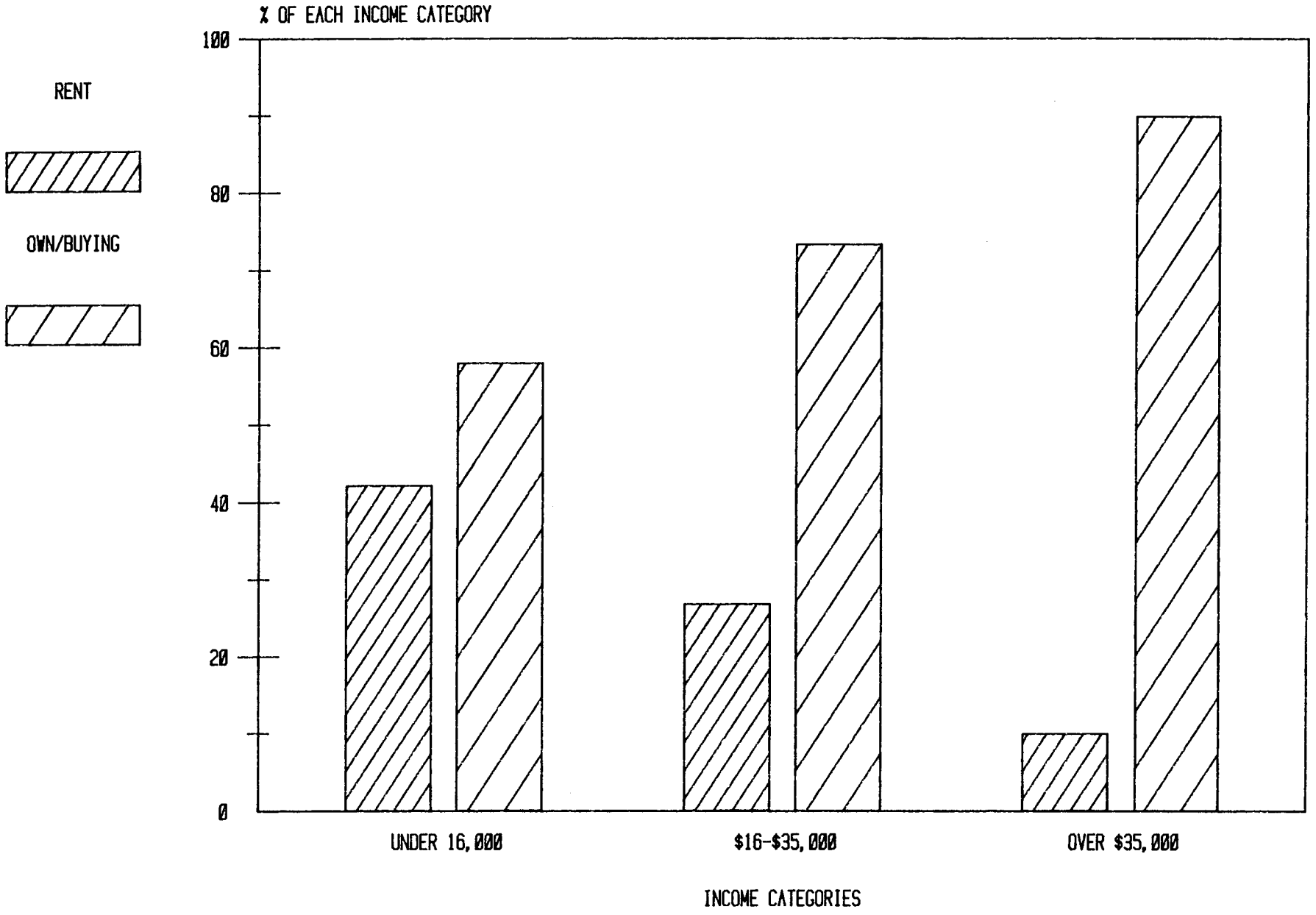
HOUSEHOLD INCOME

INCOME CATEGORIES OF TOTAL POPULATION

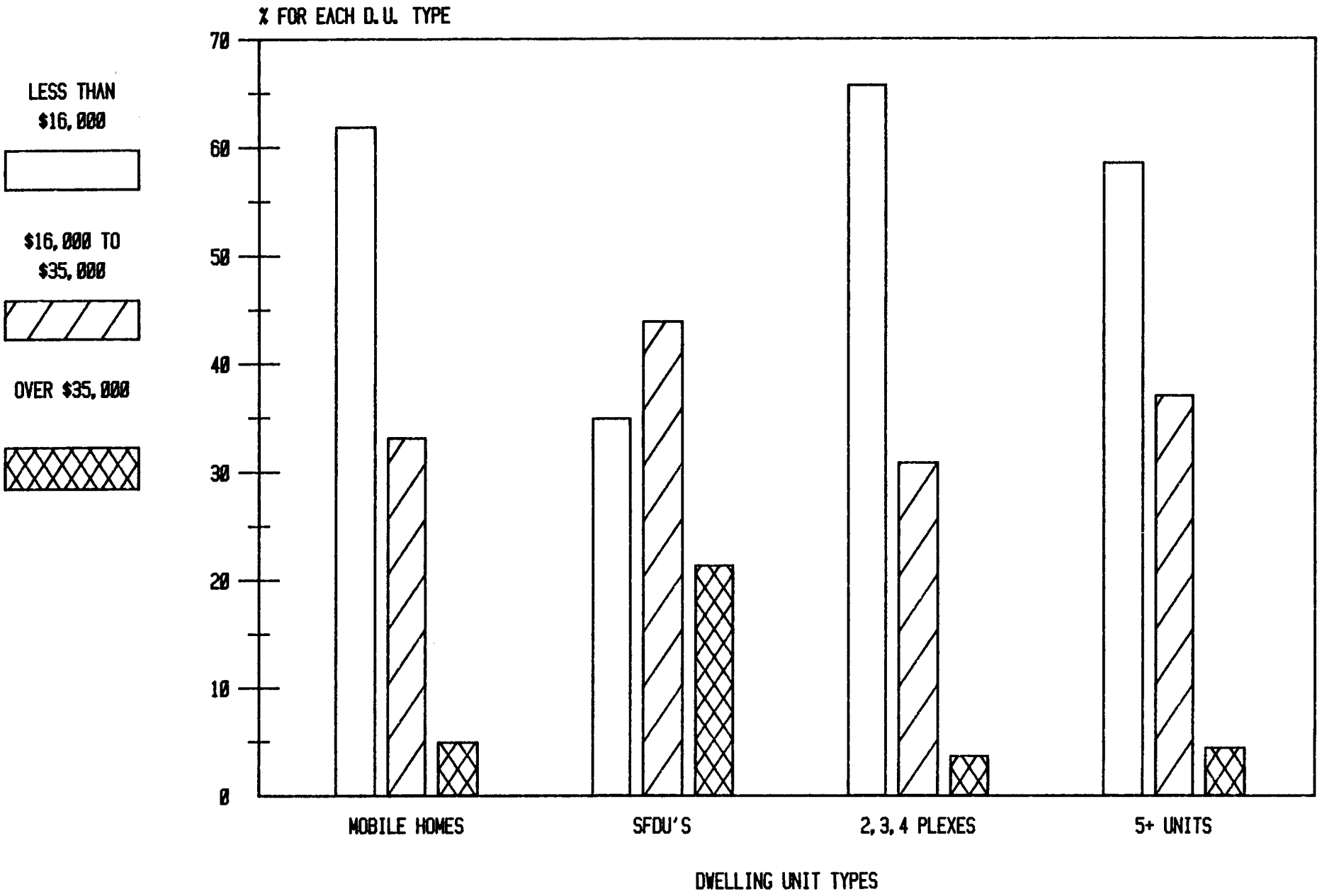


INCOME CATEGORIES BY TENURE

PERCENT OF EACH INCOME CATEGORY

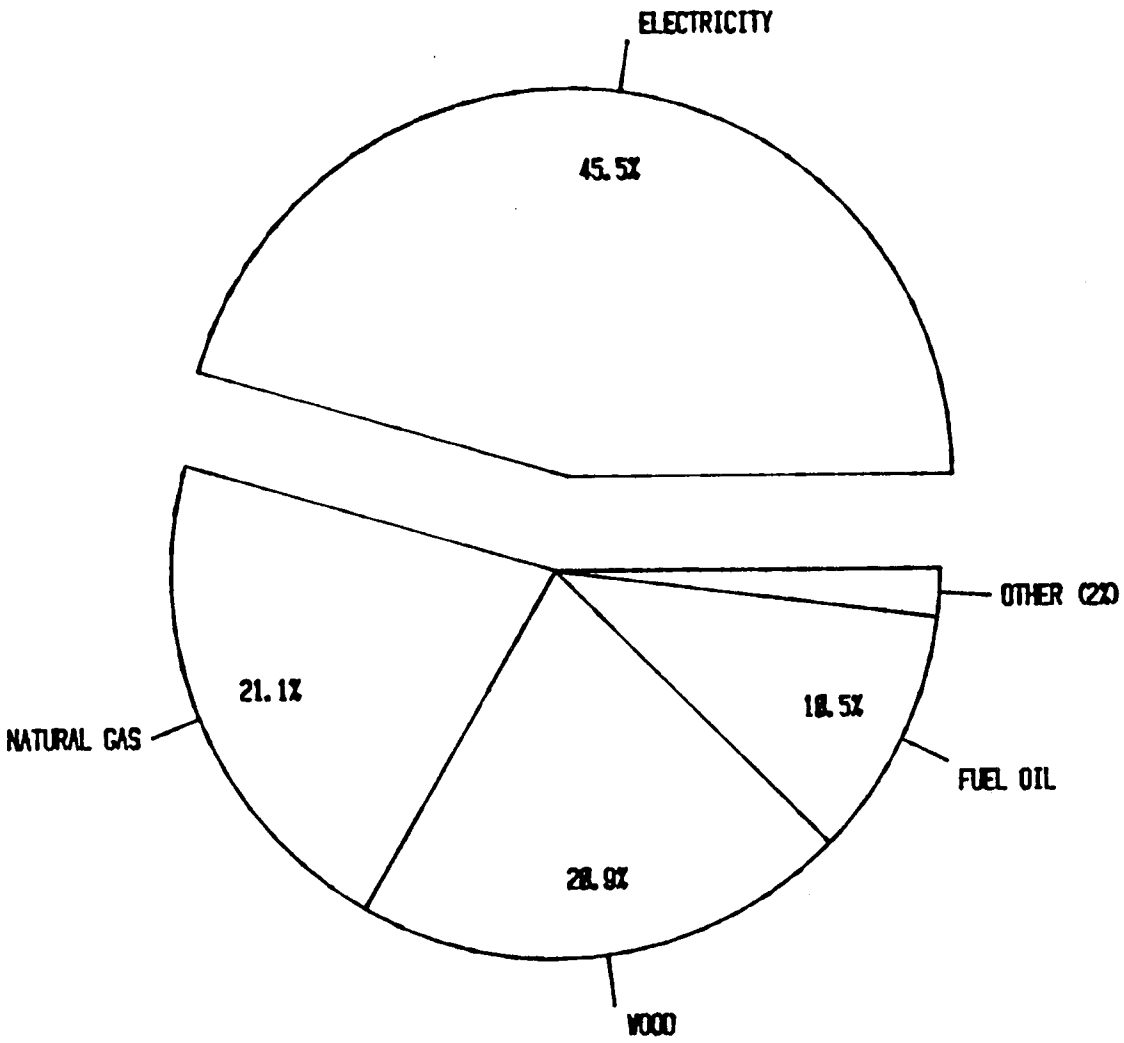


DWELLING UNIT TYPES BY INCOME CATEGORIES



PRIMARY SPACE HEATING FUELS

IN THE PACIFIC NORTHWEST



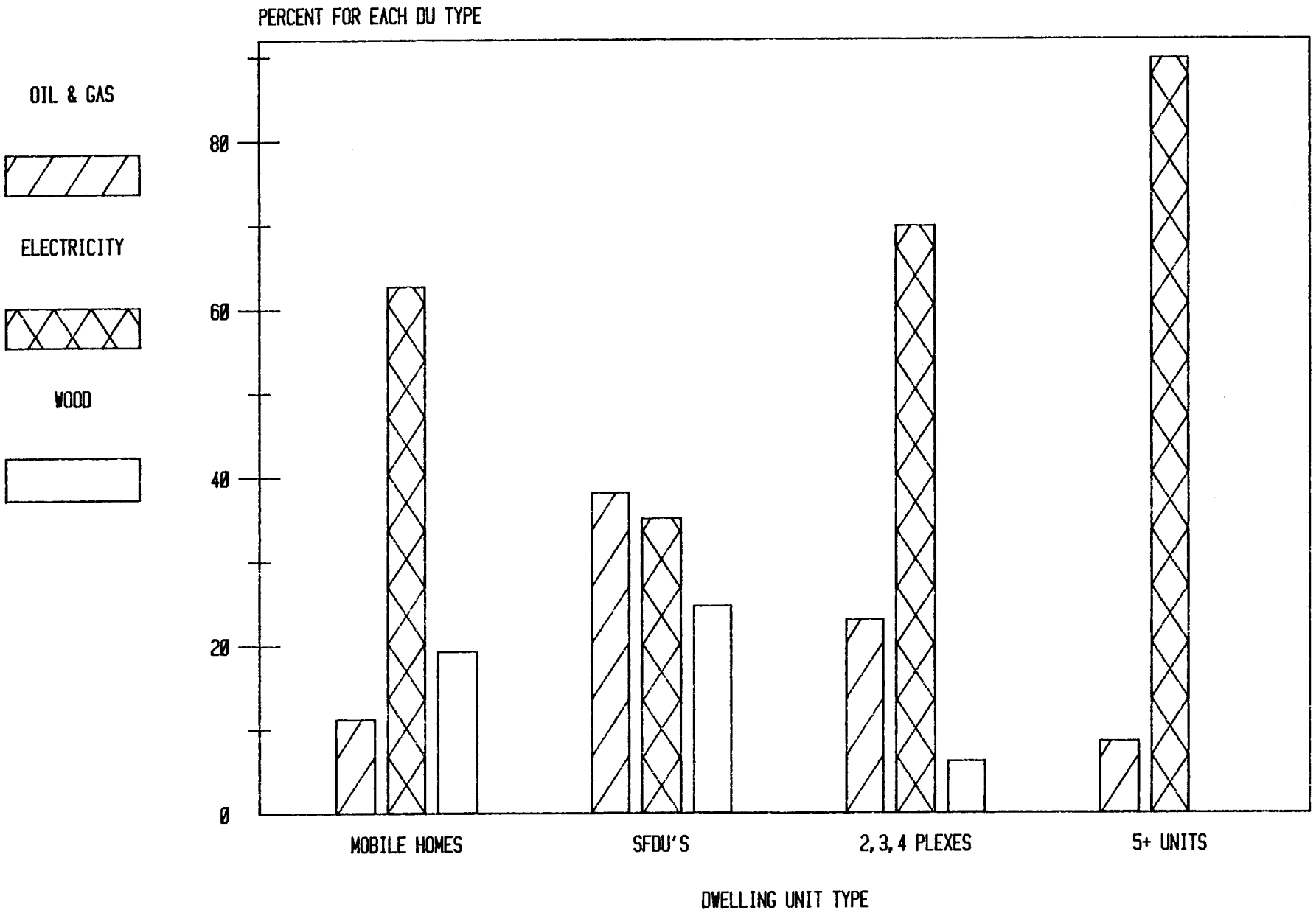
DWELLING WITH ELECTRIC SPACE HEAT
SERVED BY PUBLIC UTILITIES
BY AREA OFFICE

	ENVELOPE INDEX	EFFECTIVE IMPROVEMENT
Seattle	2.0	1.3
Portland	2.1	1.4
Spokane	2.7	1.8
Walla Walla	2.8	1.6
TOTAL	2.4	1.7

NUMBER OF DWELLING UNITS
BY AREA OFFICE AND
UTILITY OWNERSHIP

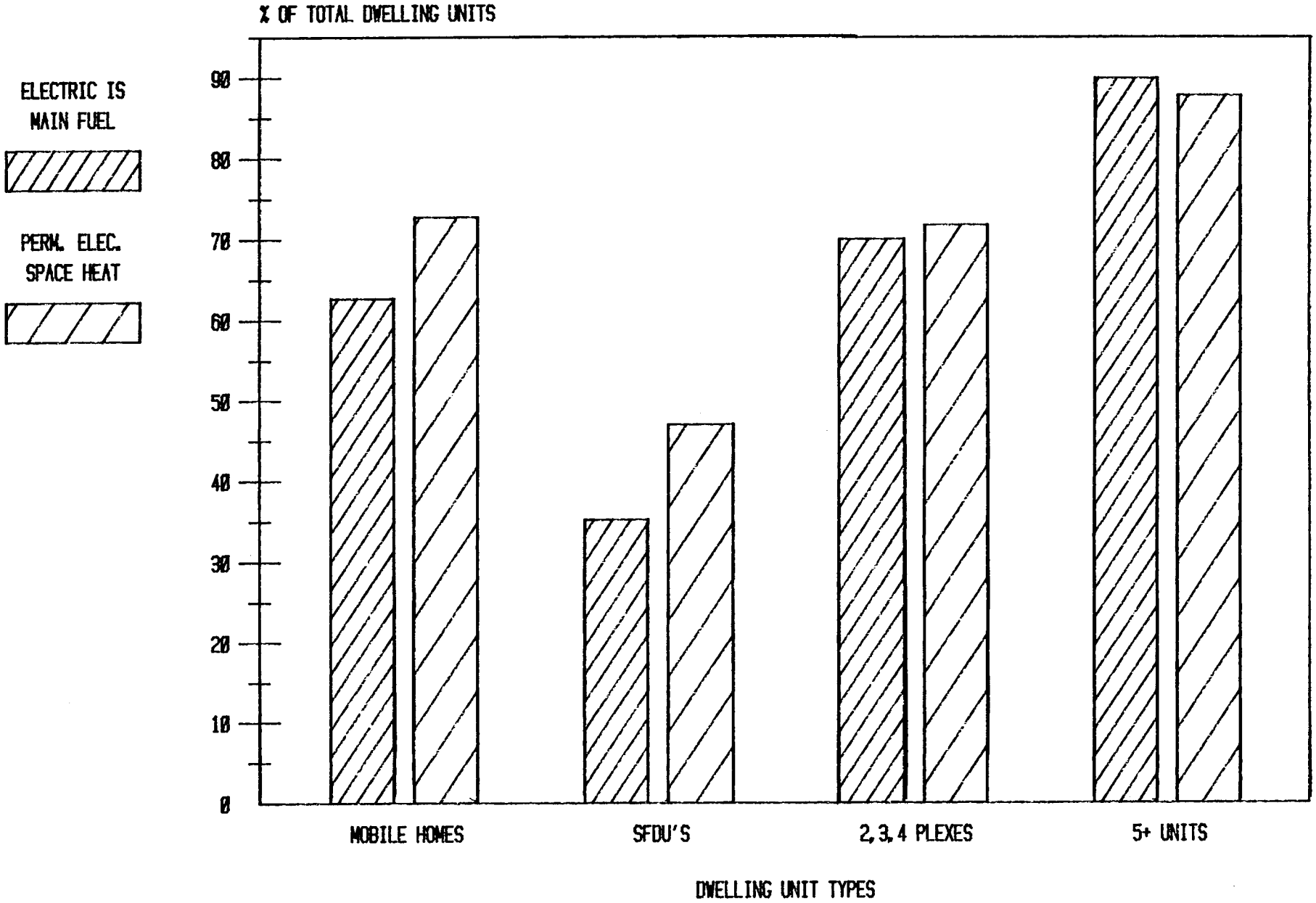
	PUBLIC	(%)	IOU
Seattle	609,979	(56.6)	469,233
Portland	272,069	(29.1)	664,452
Spokane	93,168	(21.7)	336,145
Walla Walla	211,174	(40.5)	310,875
	1,186,390	(40.0)	1,780,703

FUEL TYPES BY DWELLING UNIT TYPES



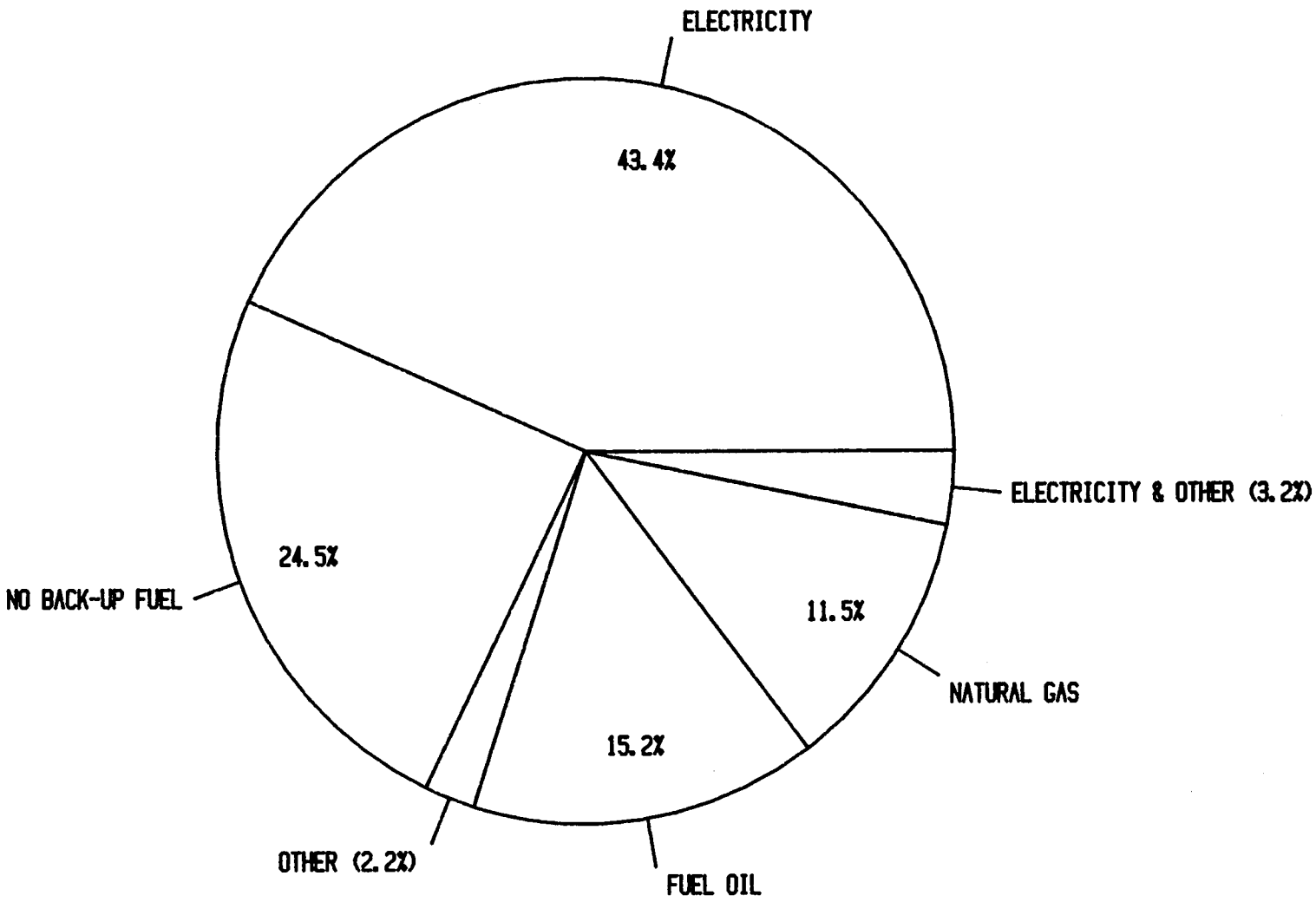
PERMANENT ELECTRIC SPACE HEAT EQUIPMENT

AND ELECTRICITY USE BY DWELLING TYPE



BACK-UP FUELS FOR D.U.'S BURNING WOOD

DU'S BURNING WOOD EQUAL 20% OF TOTAL



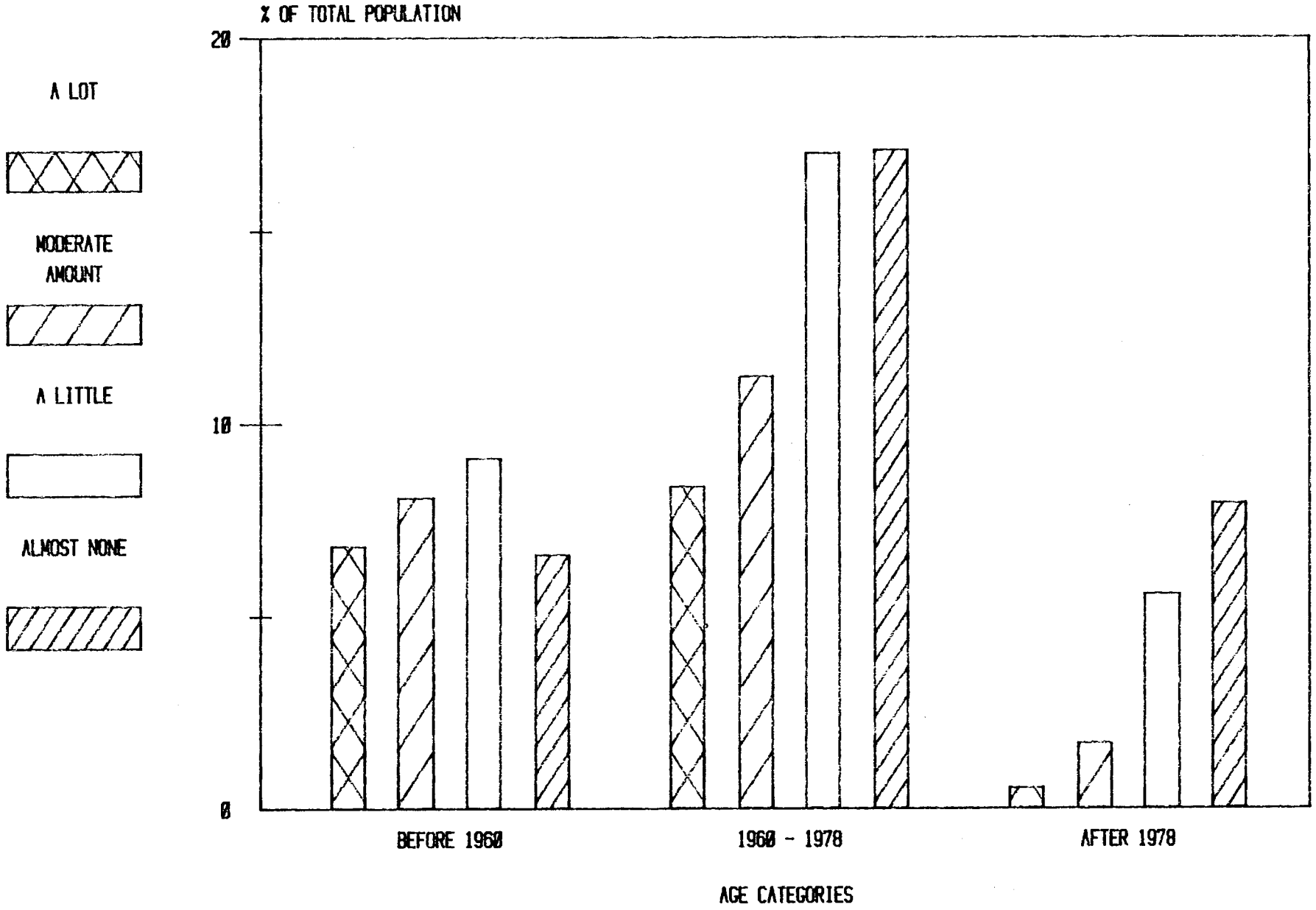
SUMMARY

- PNW RESIDENTS THINK THAT THE COST OF ELECTRICITY IS A SERIOUS ISSUE

- PEOPLE WHO RENT, ESPECIALLY IN MULTIFAMILY BUILDINGS, ARE LESS LIKELY TO THINK THEIR HOMES ARE ENERGY EFFICIENT

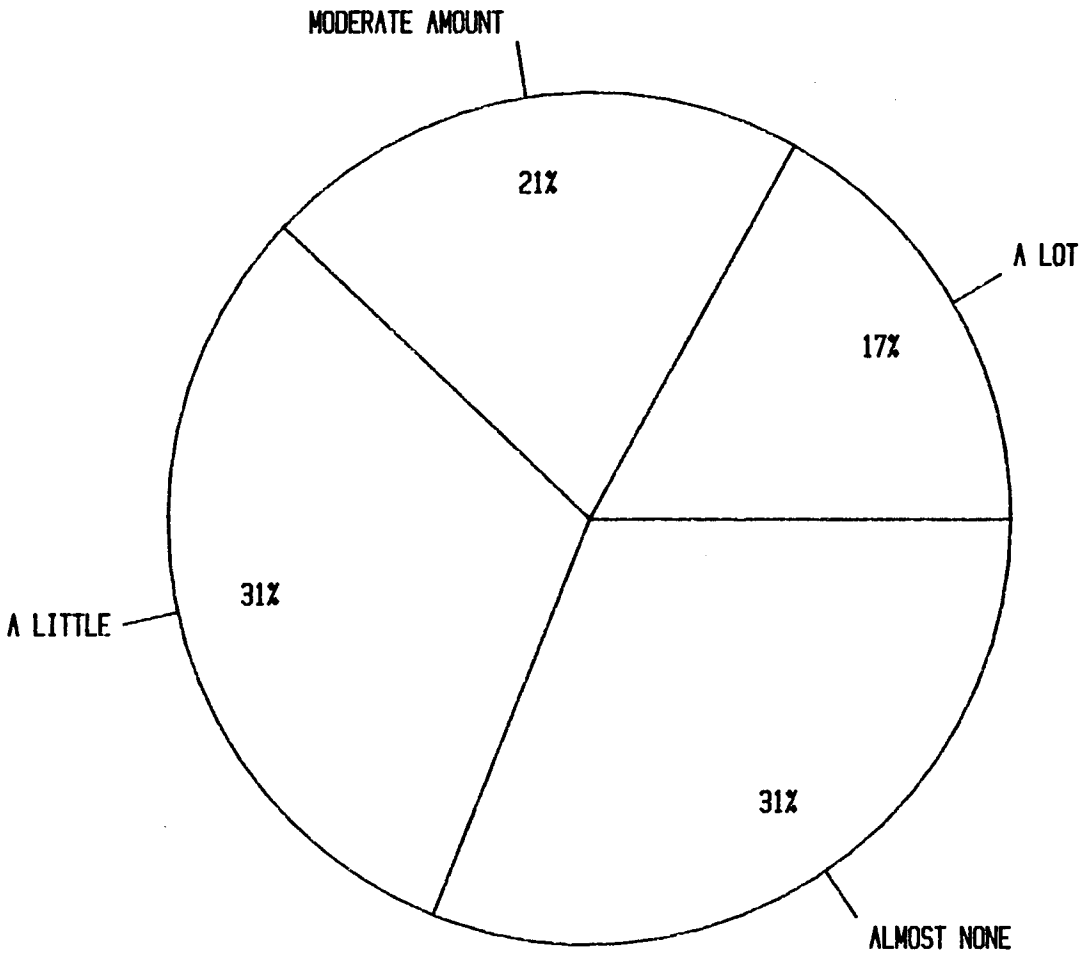
POTENTIAL FOR IMPROVEMENT BY BLDG AGE

FOR PESHE HOMES ONLY



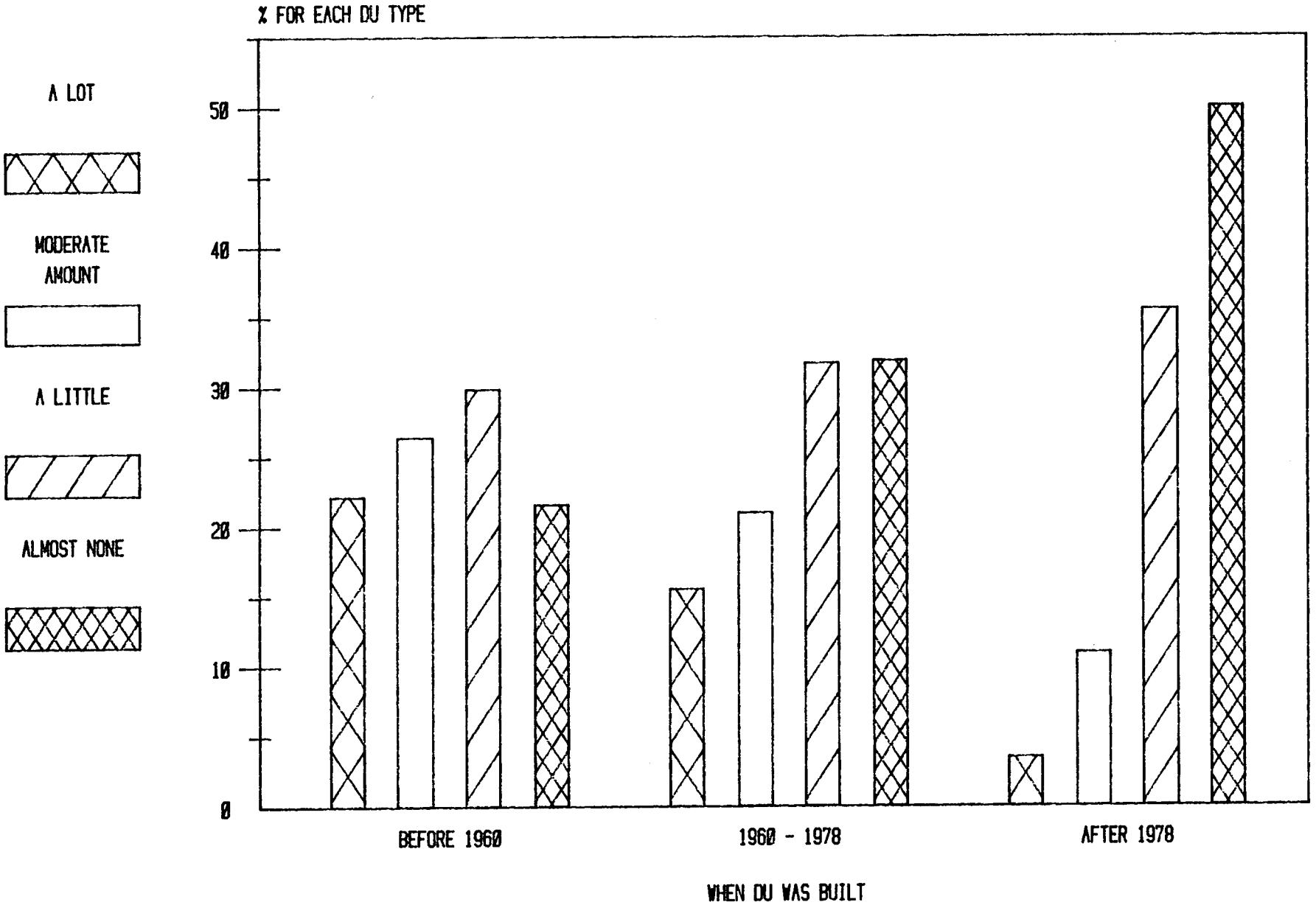
HOW MUCH CAN DU EFFICIENCY BE IMPROVED?

FOR HOMES WITH PESHE



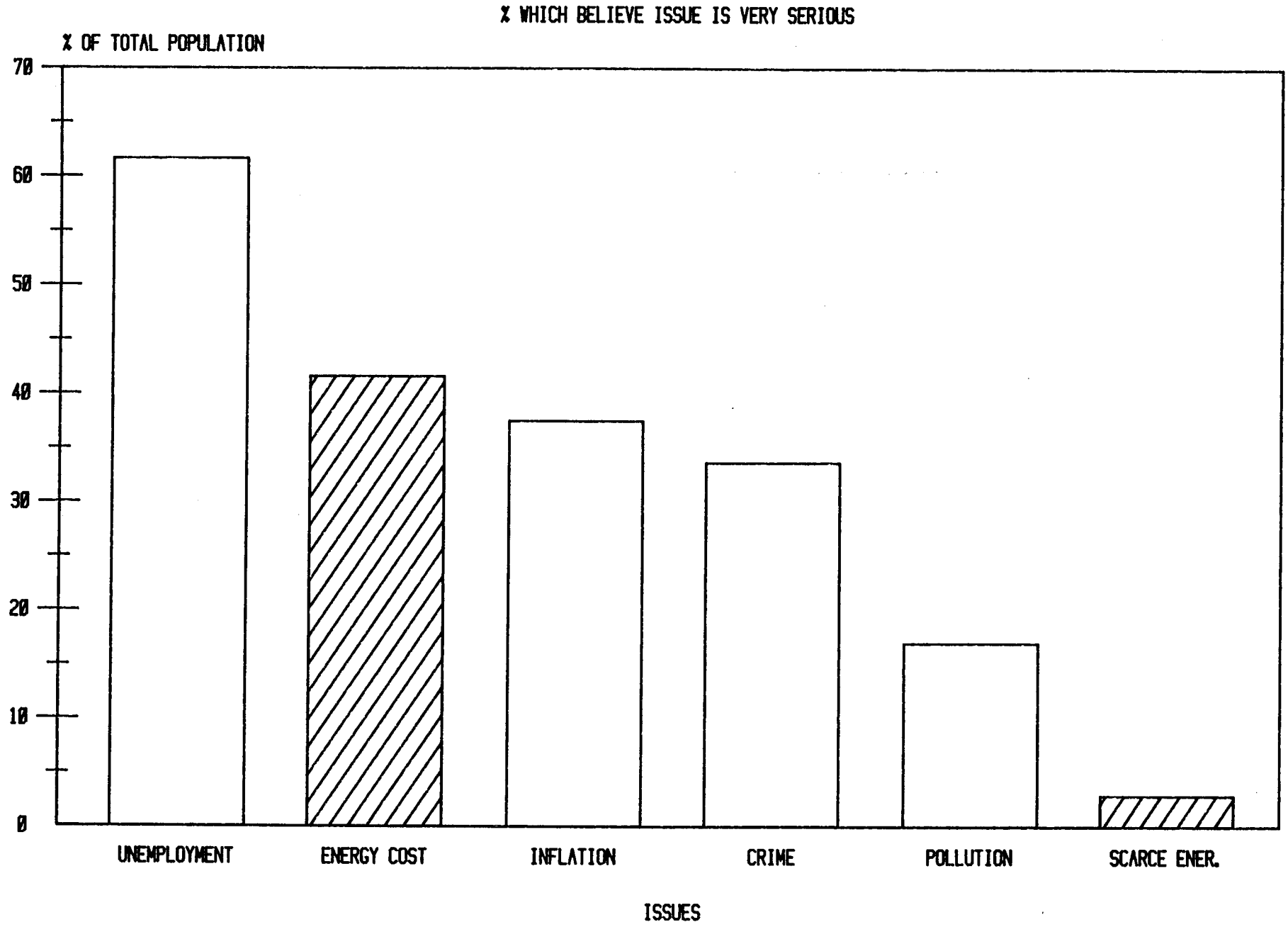
POTENTIAL FOR IMPROVEMENT BY BLDG. AGE

FOR HOMES WITH PESHE

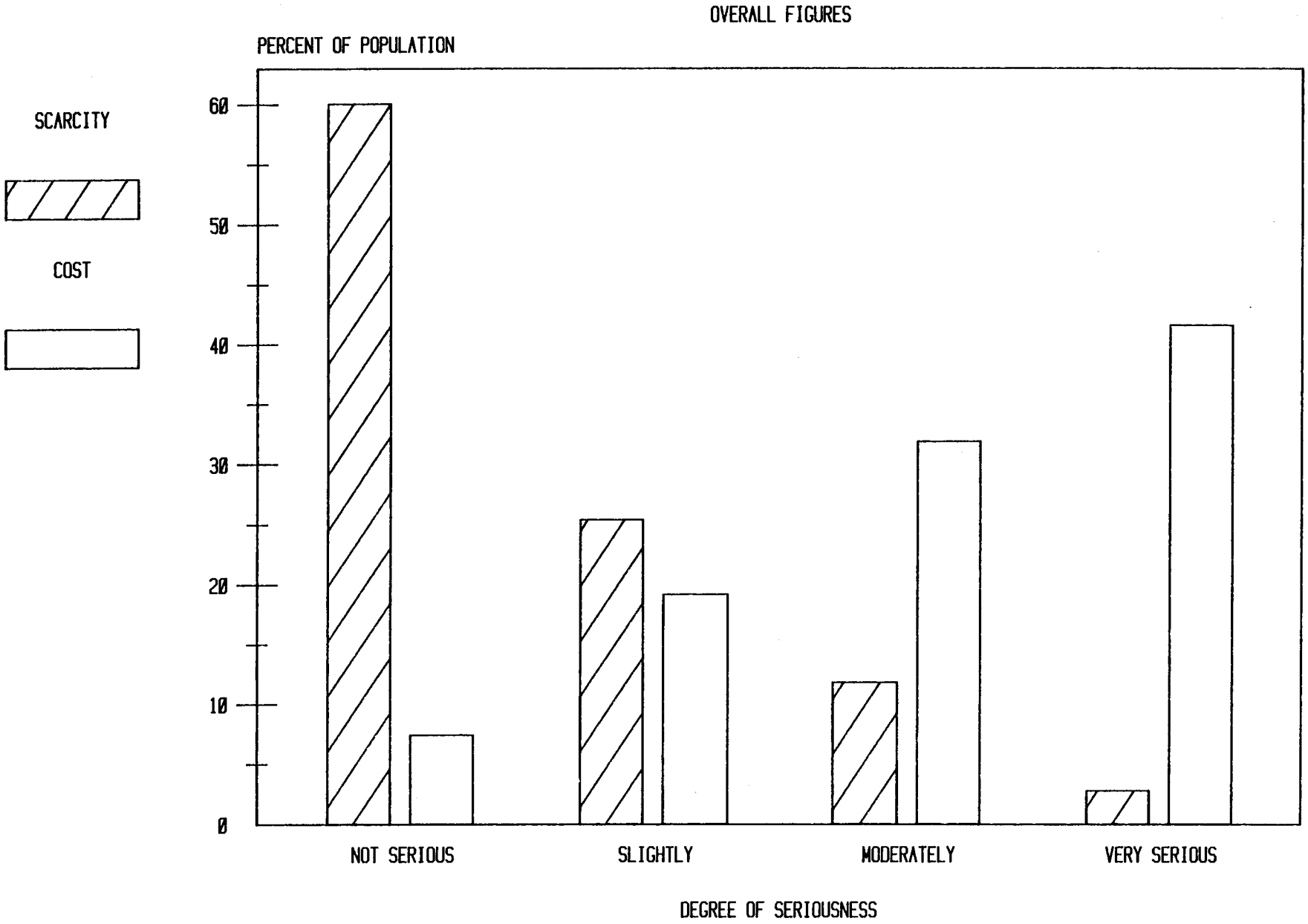


ATTITUDES

SERIOUS ISSUES IN THE PACIFIC NORTHWEST

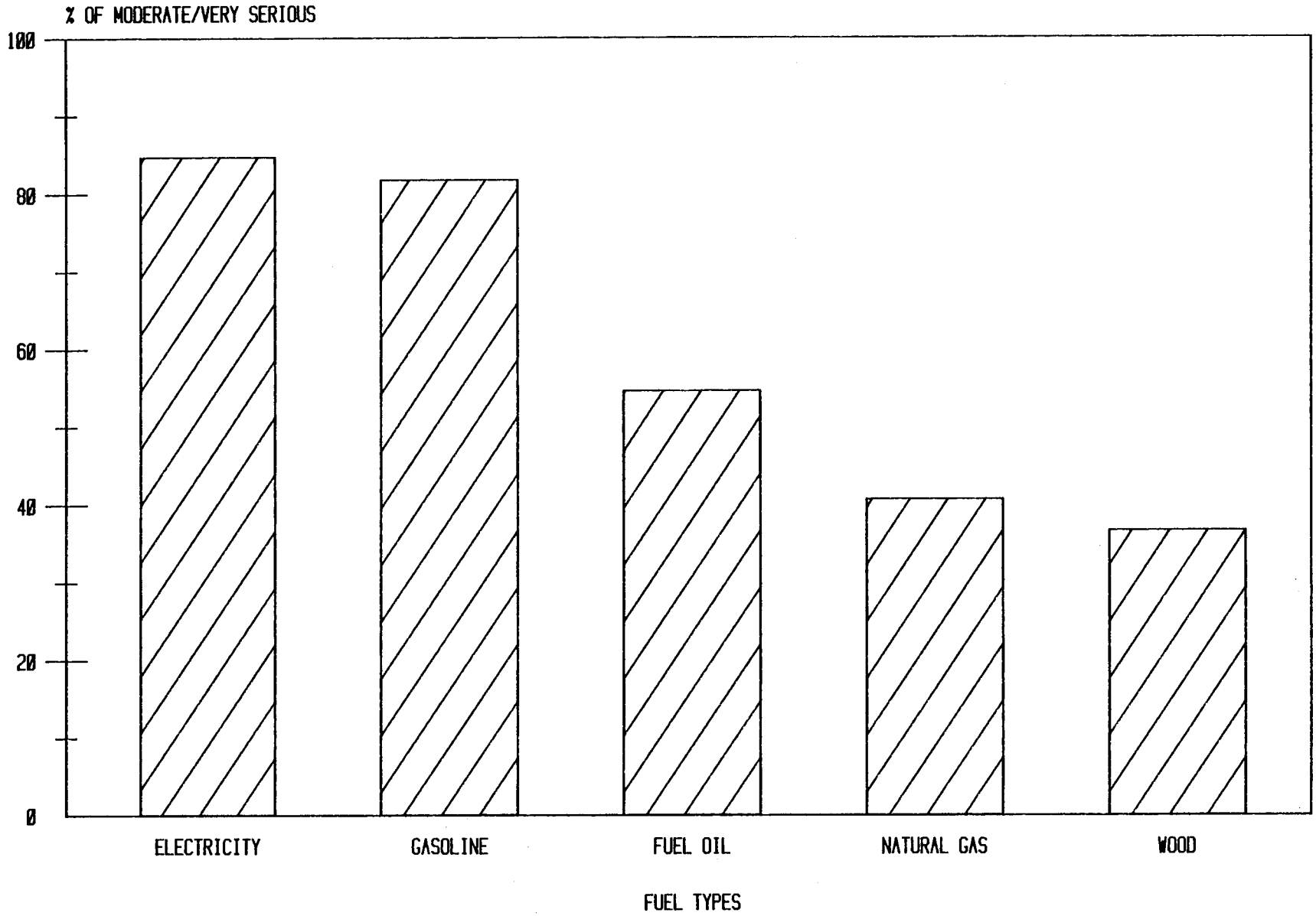


SCARCITY VS. COST AS A SERIOUS ISSUE



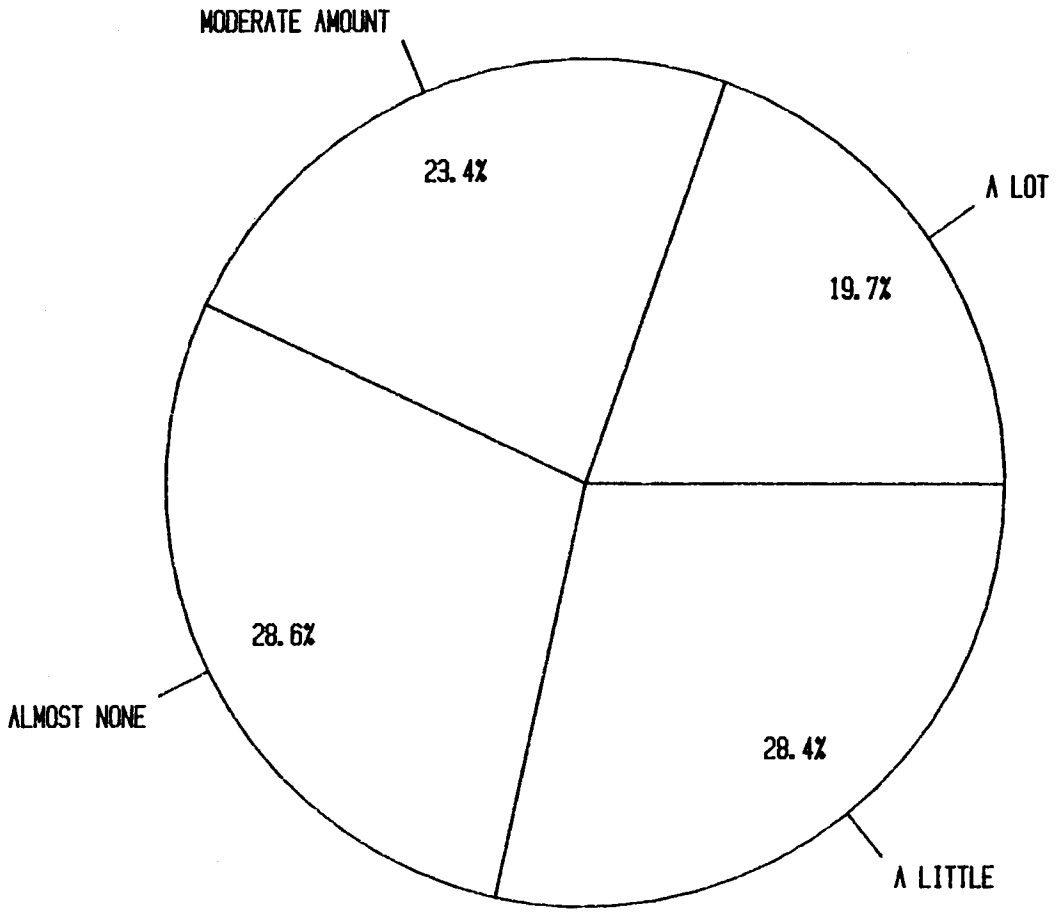
FUEL TYPES

FOR WHICH COST IS A SERIOUS ISSUE



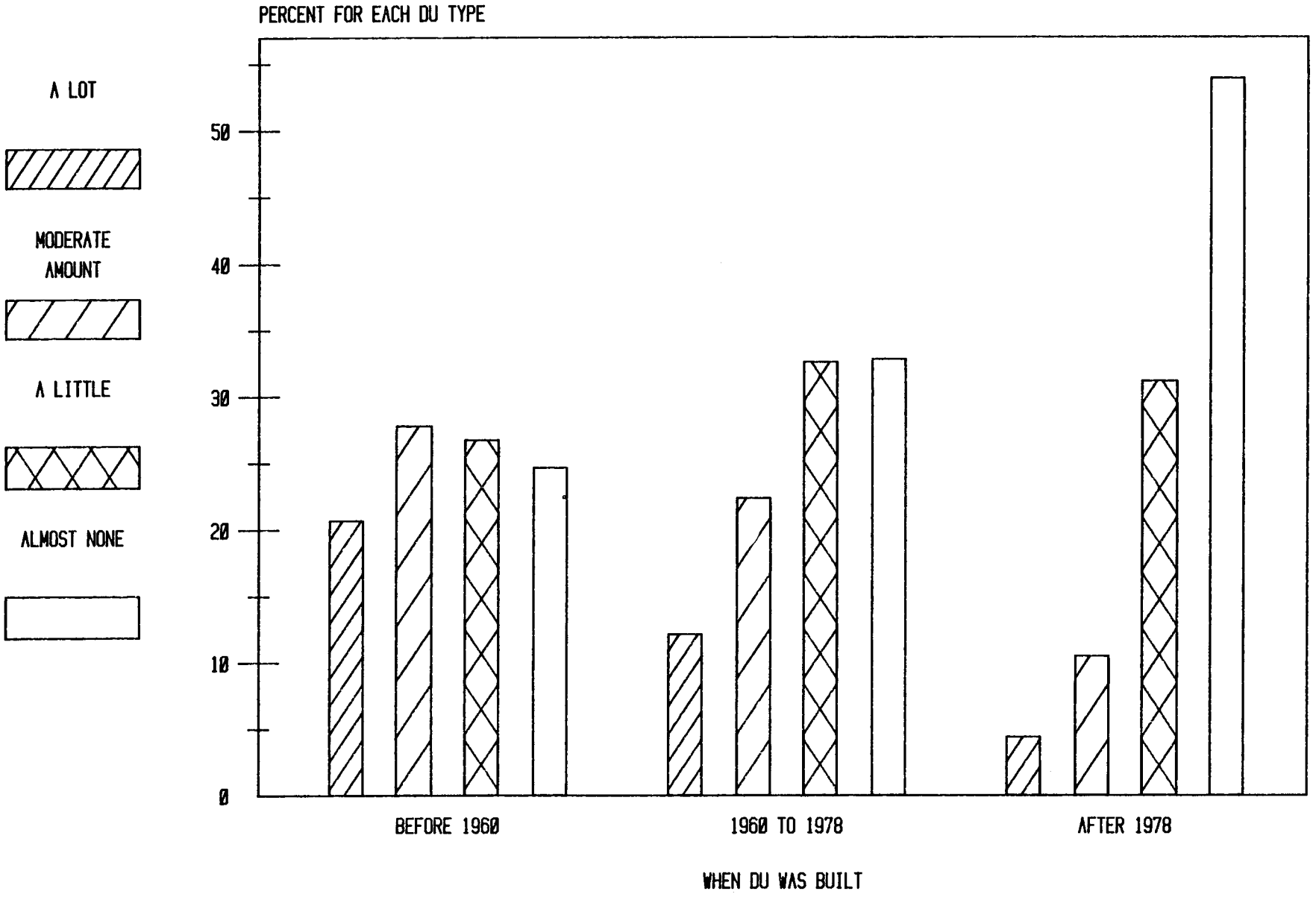
OPINIONS ON EFFICIENCY OF HOMES

HOW MUCH IMPROVEMENT CAN BE MADE

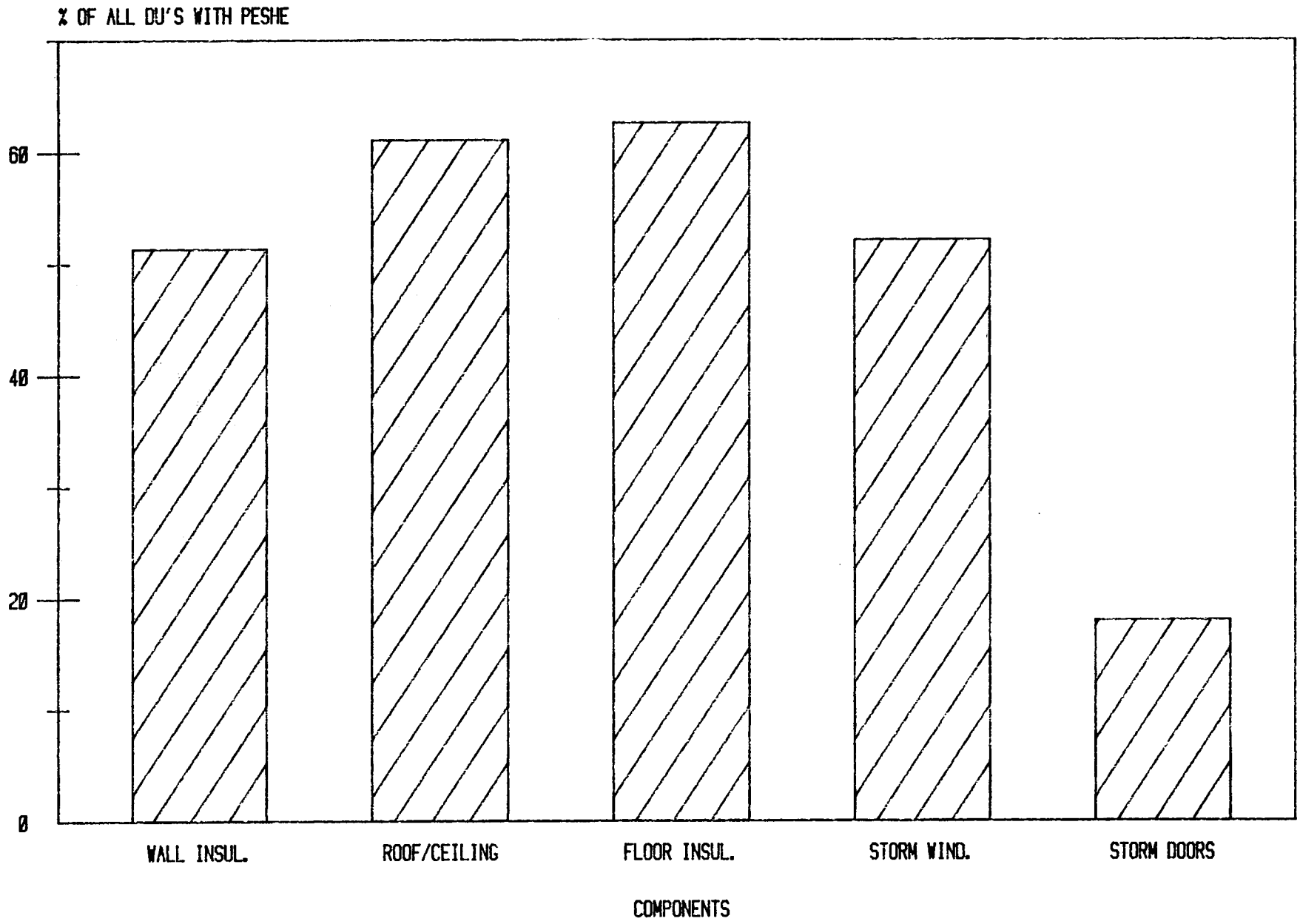


HOW MUCH IMPROVEMENT CAN BE MADE TO DU

BY THE AGE OF THE BUILDING



ENVELOPE INDEX COMPONENTS: WITH PESHE



CONSERVATION INDEX RATINGS--PART I

For Homes with Permanently-Installed Electric Space Heating Equipment

Mean Values

Climate Zone

Zone I	2.3
Zone II	2.7
Zone III	3.0

Utility Type

Public	2.2
Private	2.7

Type of Dwelling

Mobile Home	3.3
Single Family DU	2.4
2, 3, 4 Plexes	2.1
5+ Units	2.0

CONSERVATION INDEX RATINGS--PART II

Year DU Built	
Before 1960	2.0
1960 - 1978	2.7
After 1978	3.1

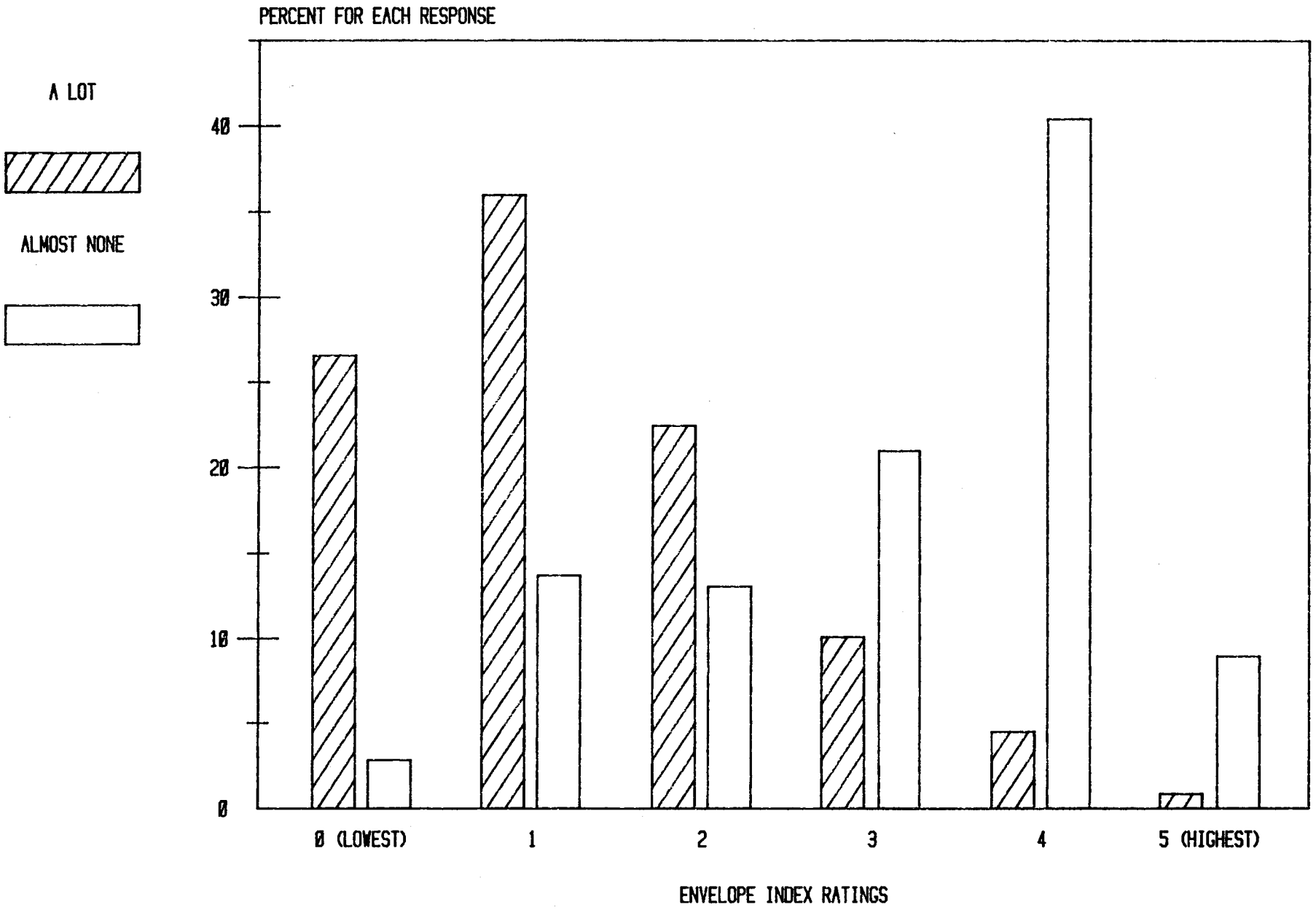
Tenure	
Own	2.9
Rent	1.7

Income	
Less than $16,000	2.3
$16,000 - $35,000	2.5
More than $35,000	2.7

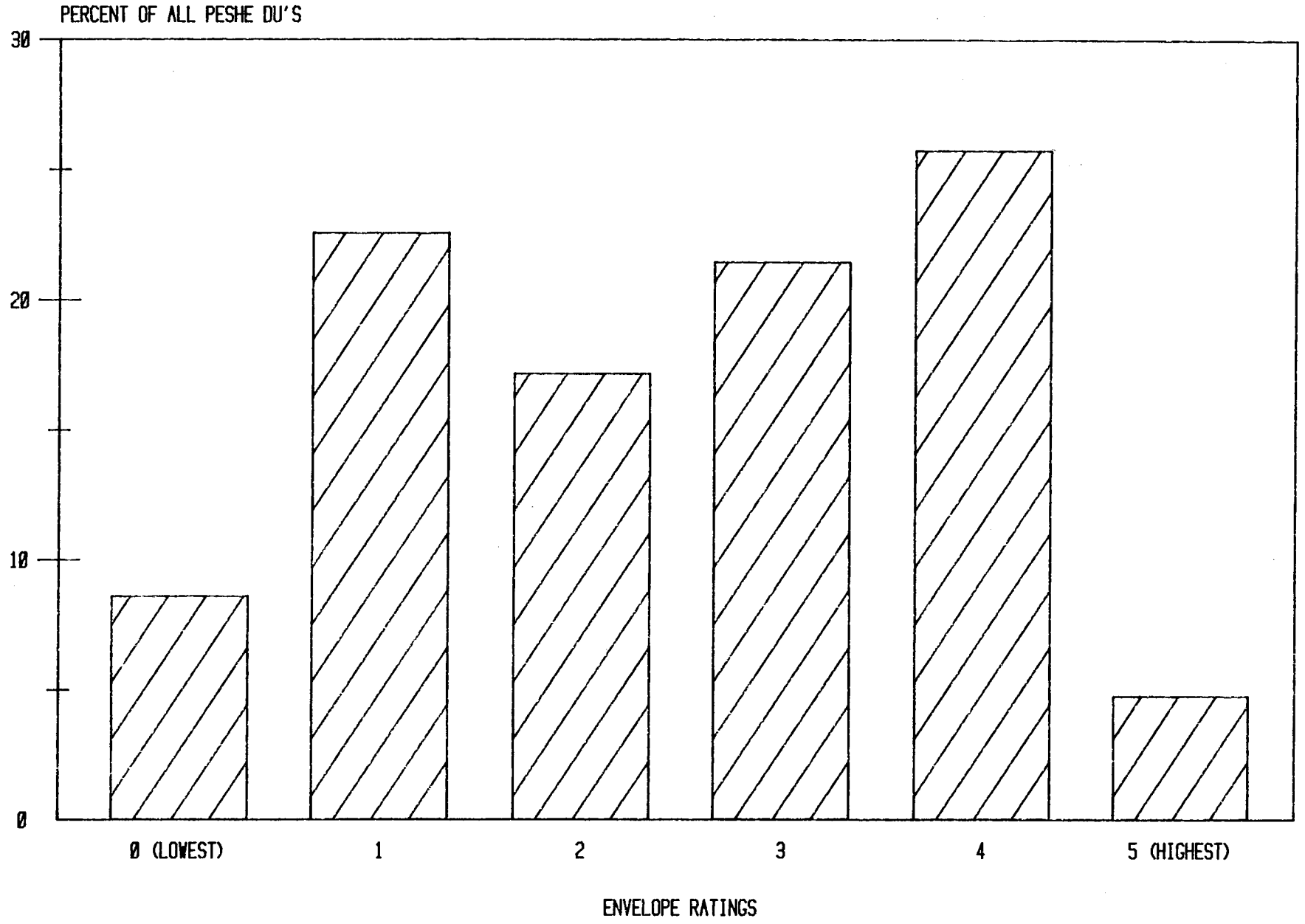
Program Participation	
No Participation	2.4
Audit Only	2.7
Audit and Loan	2.9

HOW MUCH CAN EFFICIENCY BE IMPROVED?

BY ENVELOPE INDEX RATINGS



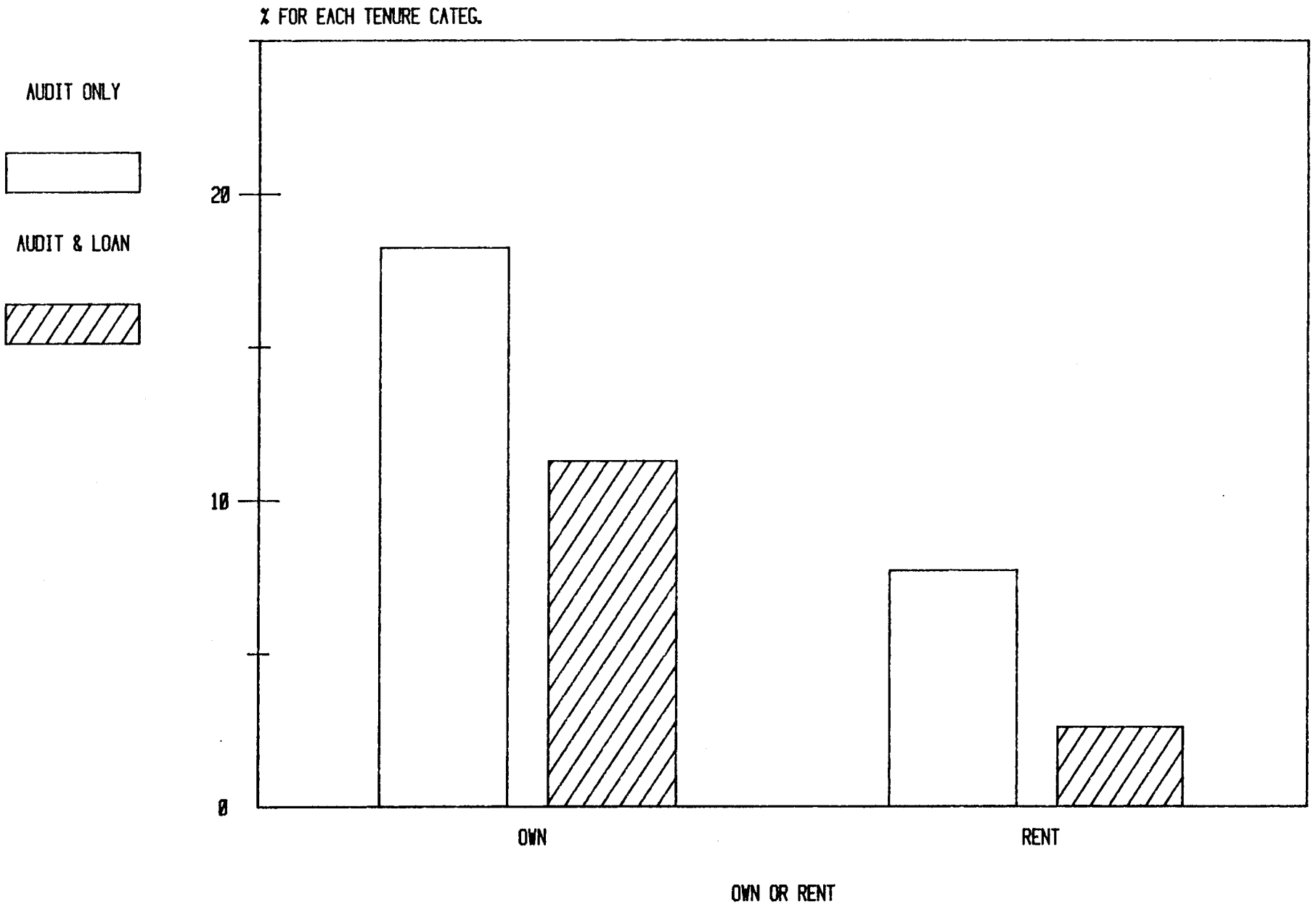
ENVELOPE INDEX RATINGS FOR PESHE HOMES



CONSERVATION MEASURES

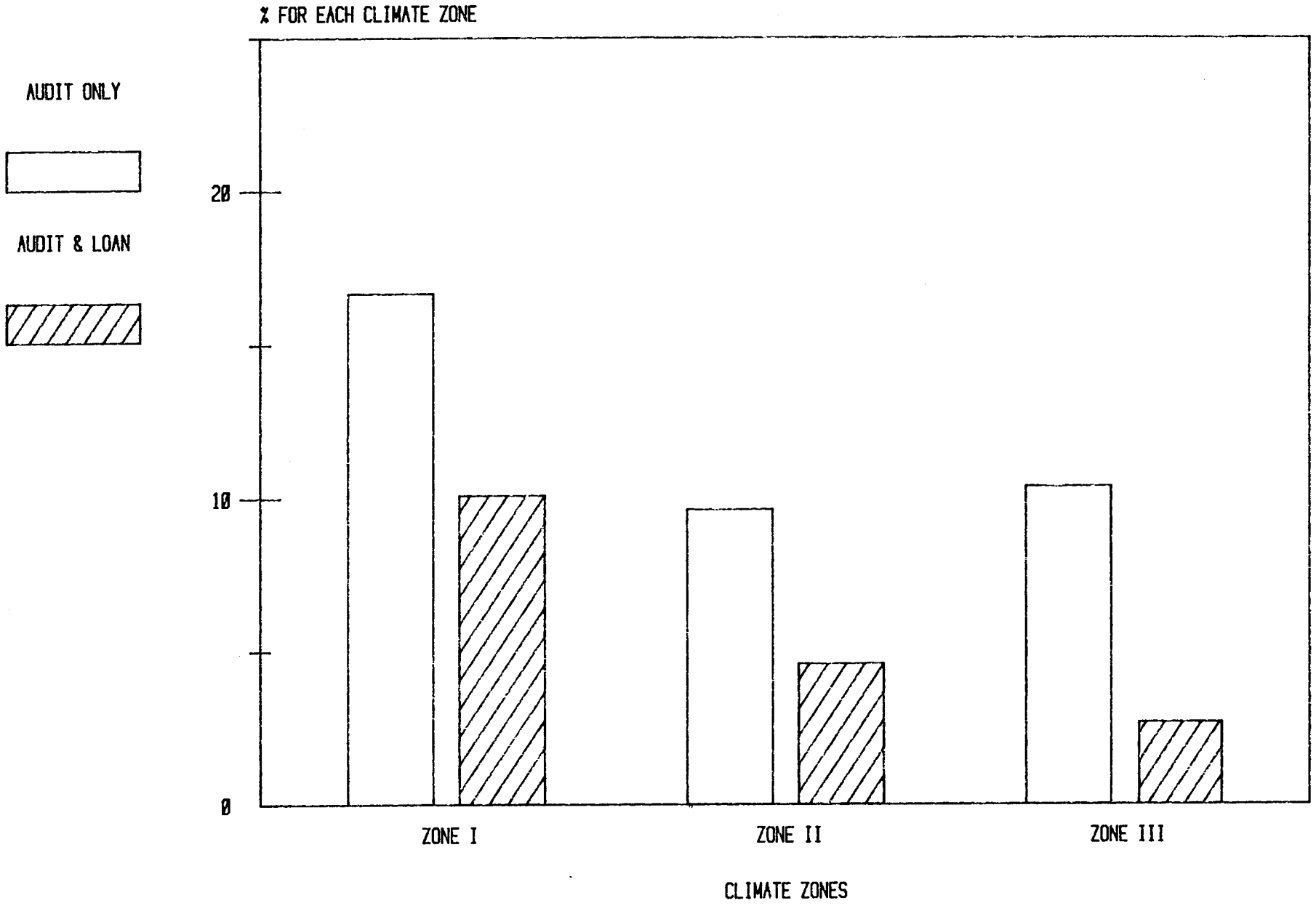
PROGRAM PARTICIPATION BY OWN/RENT

PESHE HOMES SERVED BY PUBLIC UTILITIES



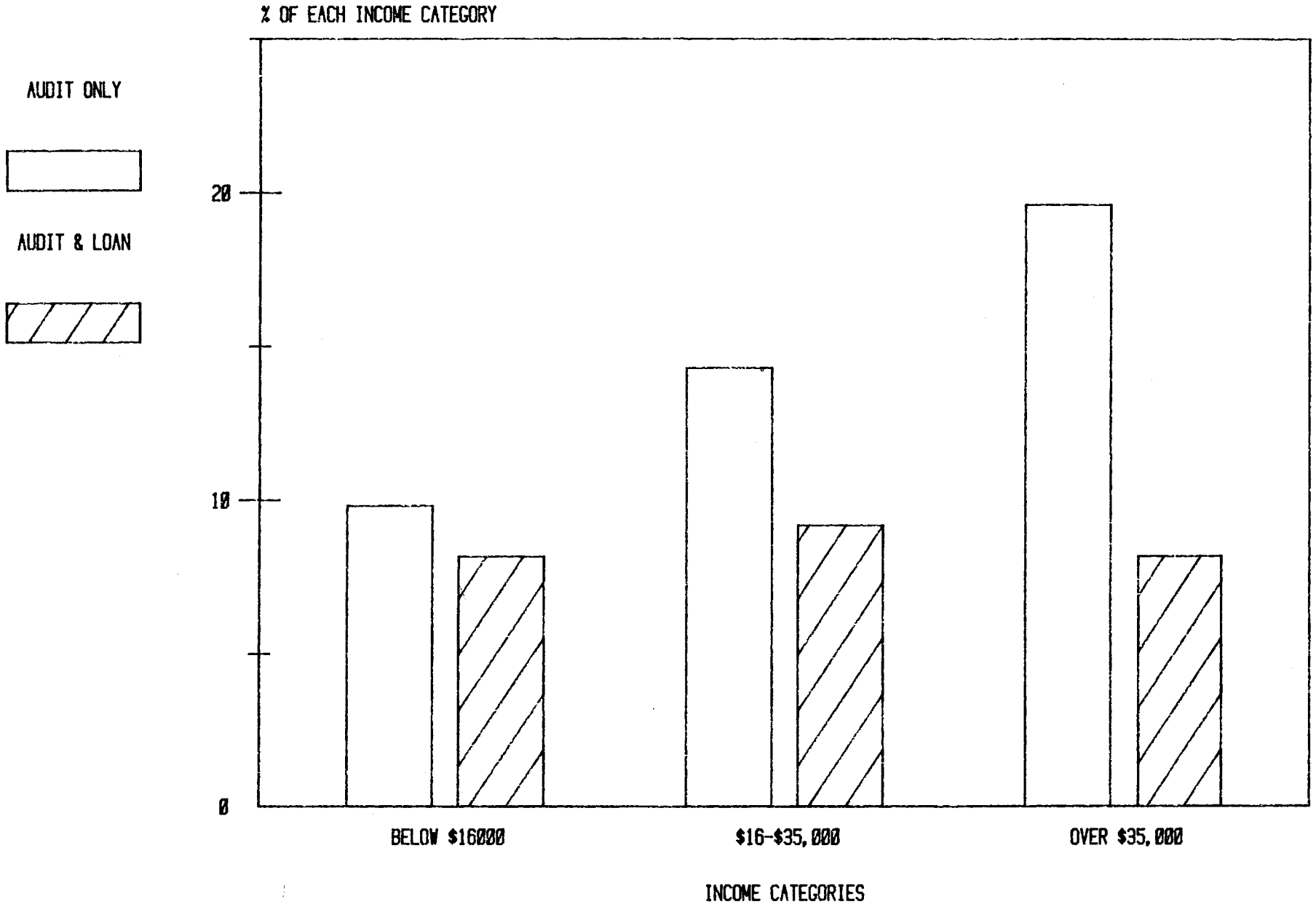
PROGRAM PARTICIPATION BY CLIMATE ZONE

PESHE HOMES SERVED BY PUBLIC UTILITIES



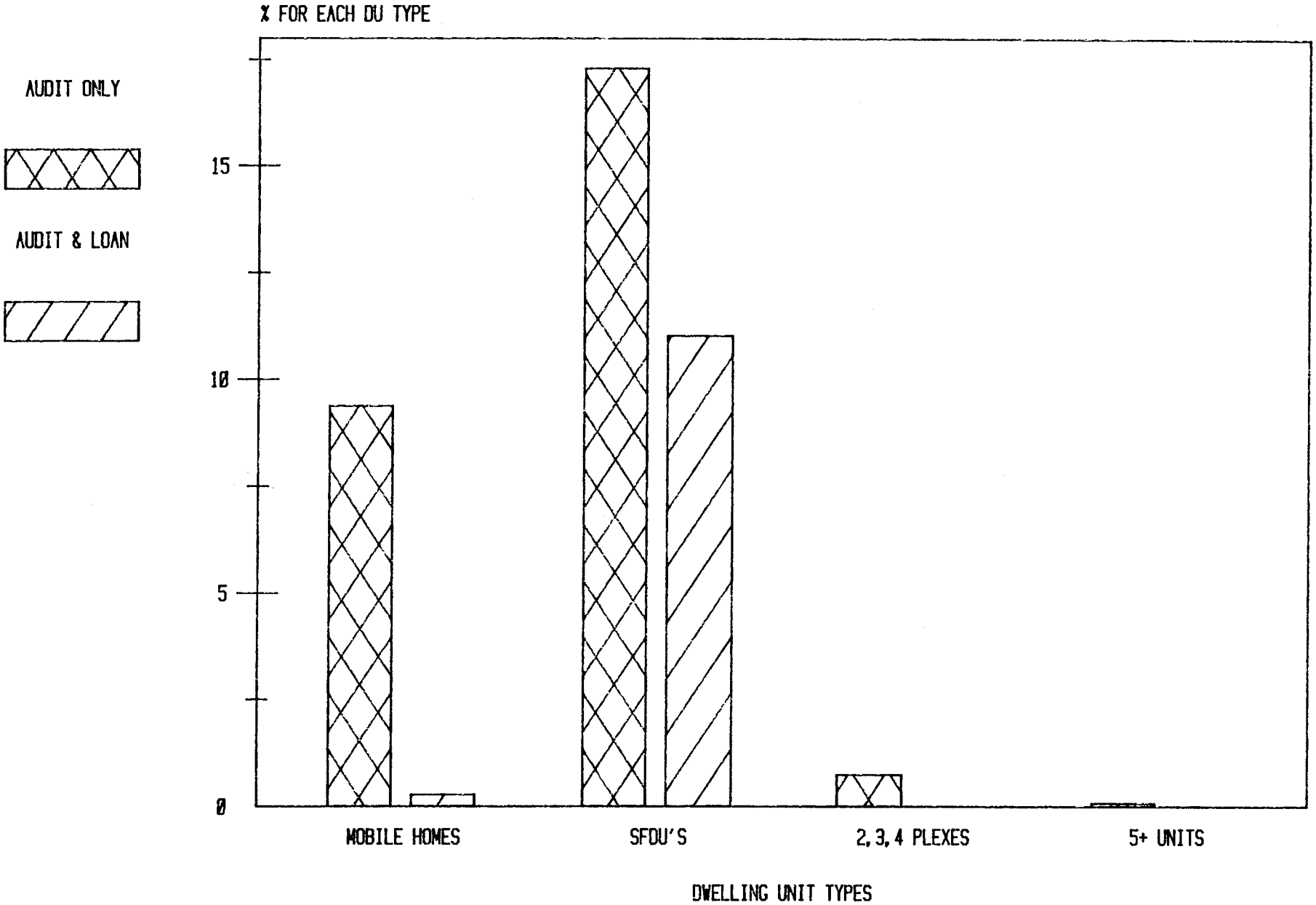
PROGRAM PARTICIPATION BY INCOME CATEGORY

PESHE HOMES SERVED BY PUBLIC UTILITIES

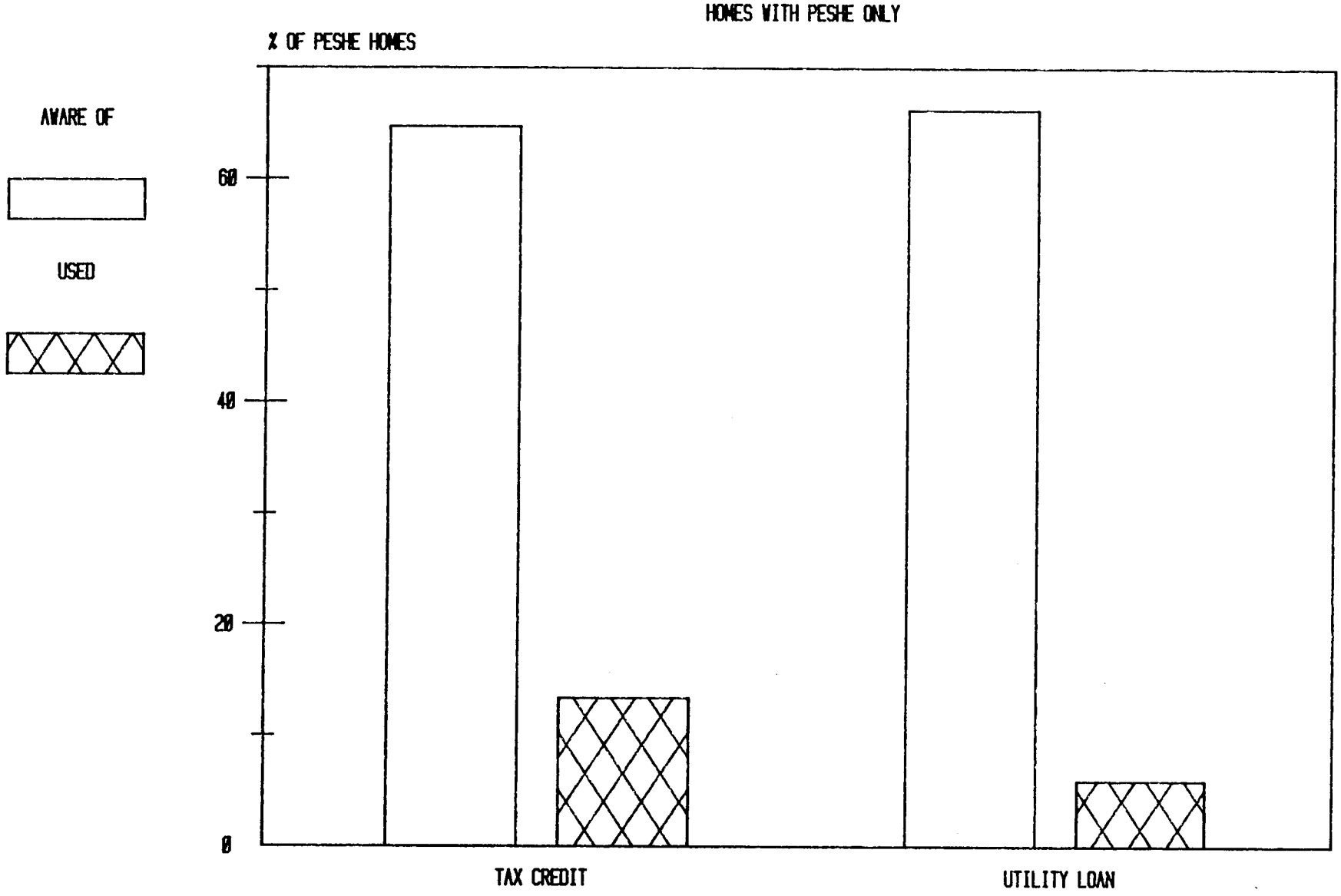


PROGRAM PARTICIPATION BY DU TYPE

PESHE DU'S SERVED BY PUBLIC UTILITIES

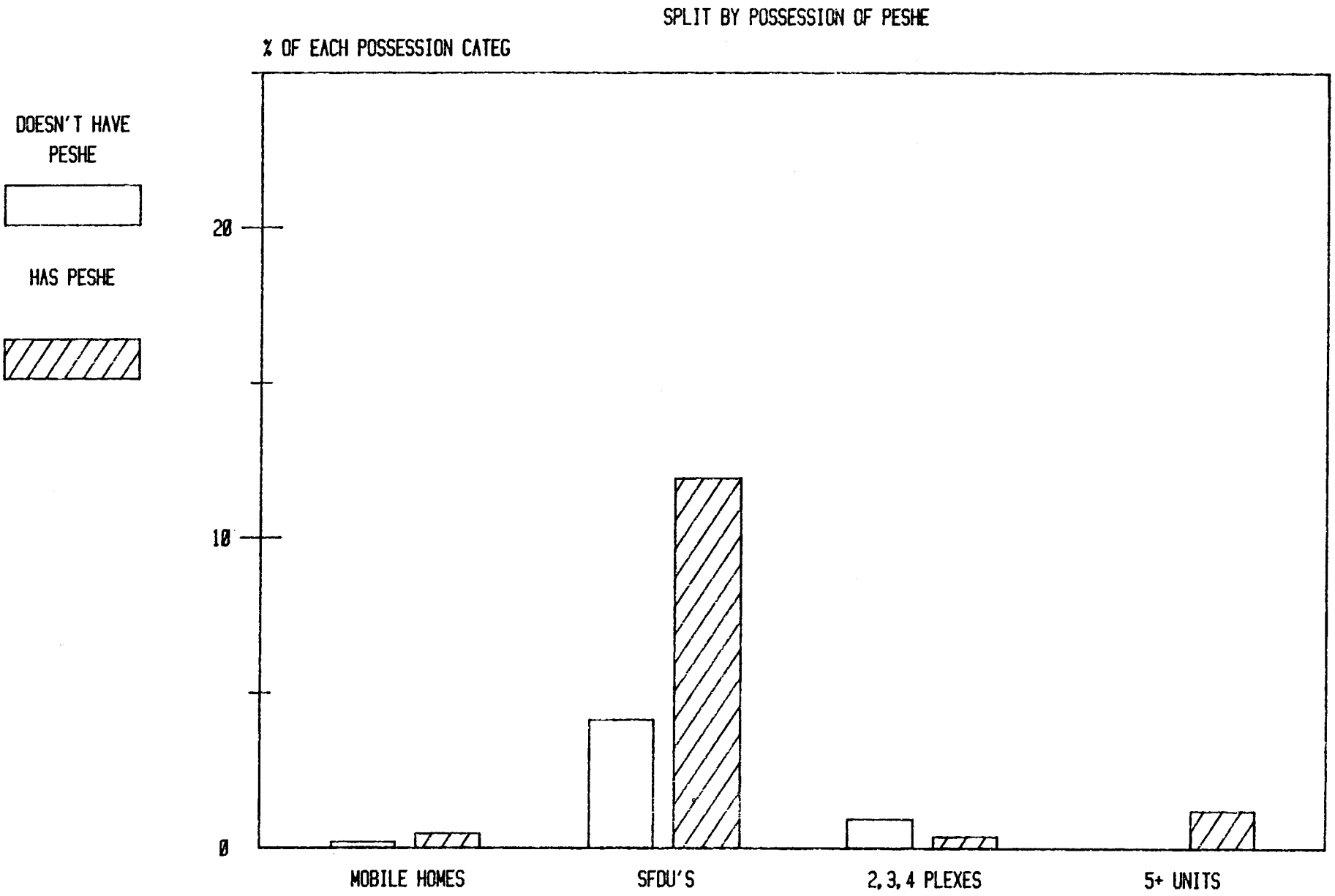


USE OF FEDERAL TAX CREDIT, UTILITY LOAN

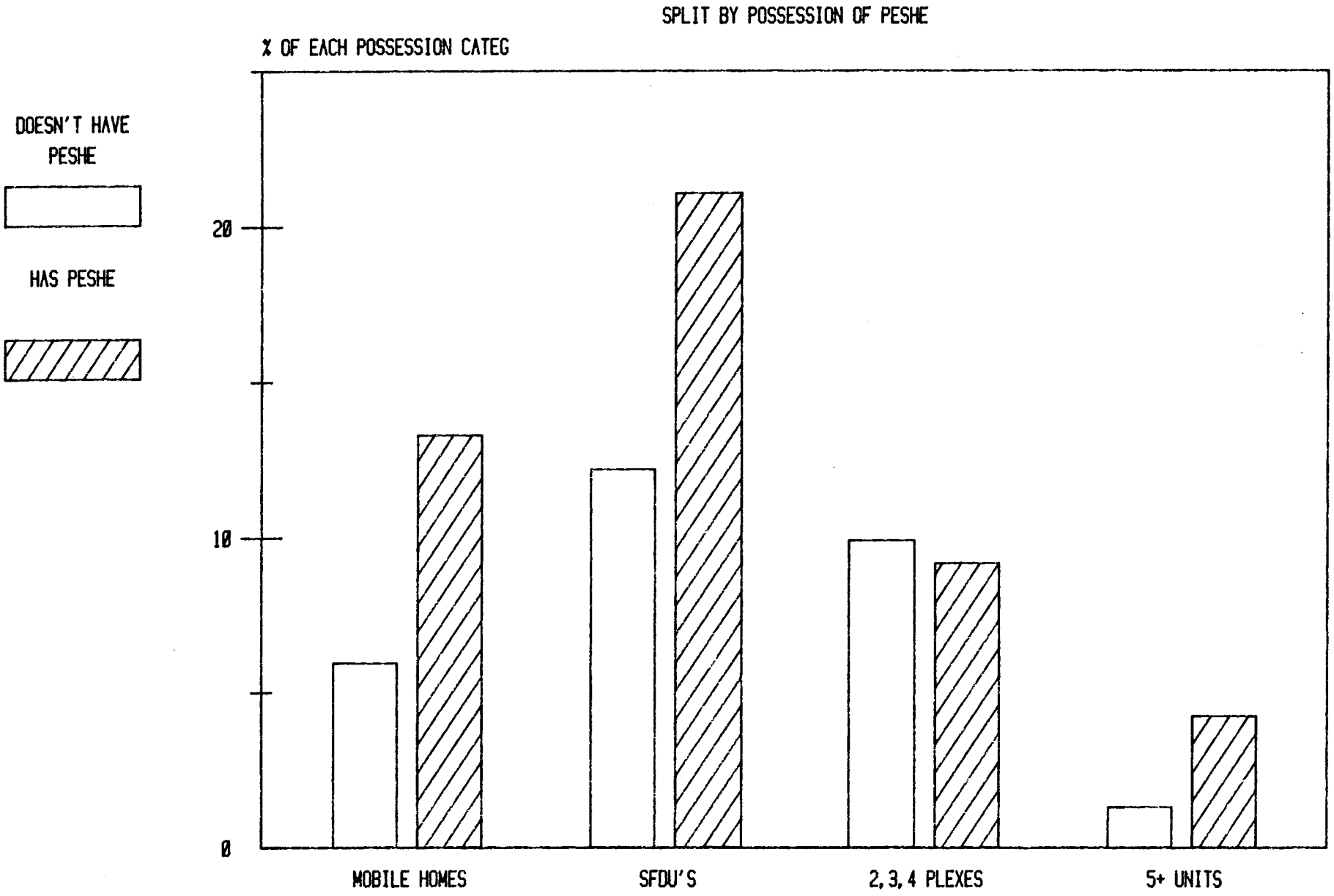


PROGRAM EFFECTS

AUDIT AND LOAN BY DWELLING UNIT TYPE

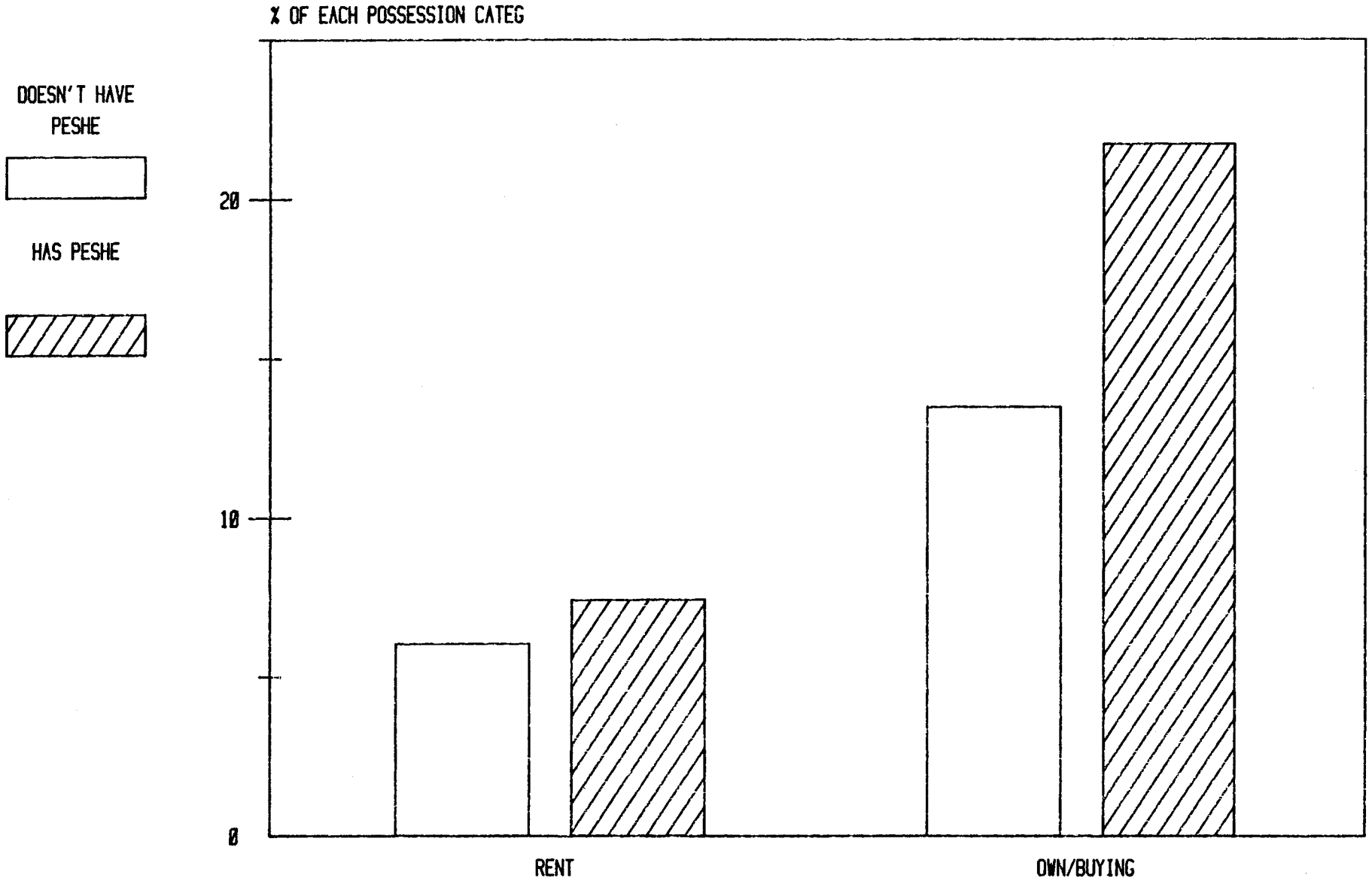


AUDIT ONLY BY DWELLING UNIT TYPE



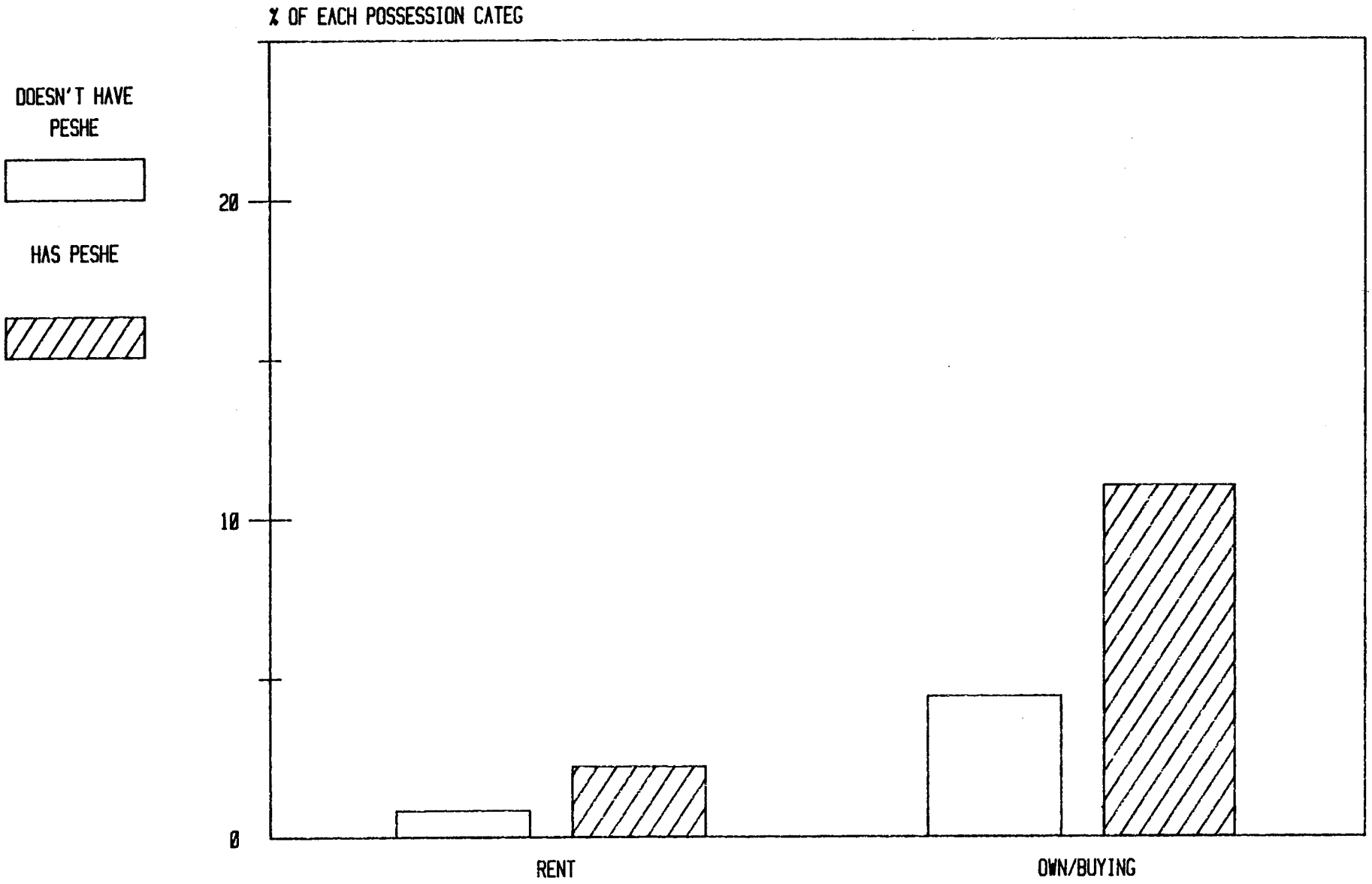
AUDIT ONLY BY TENURE

SPLIT BY POSSESSION OF PESHE



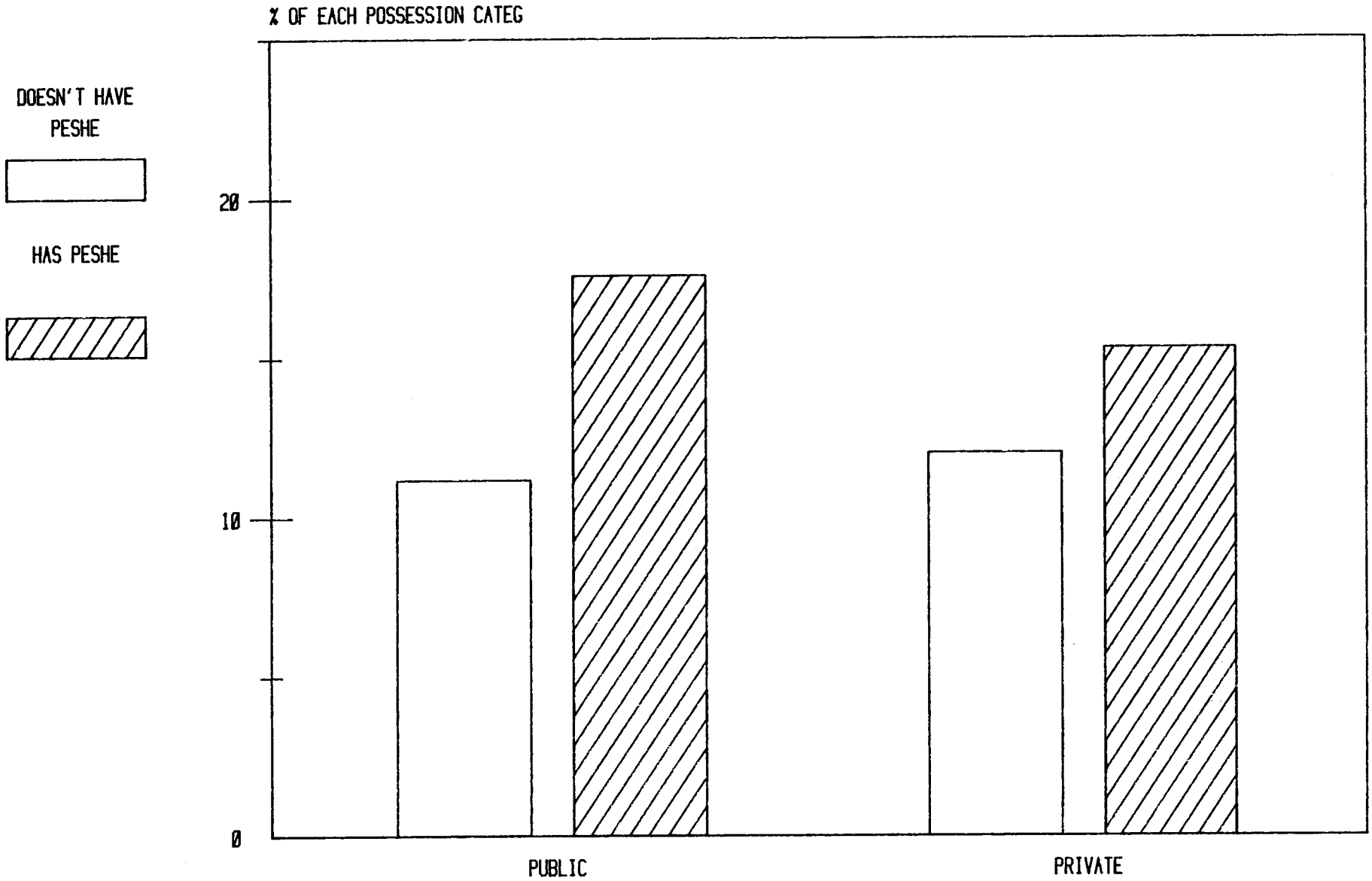
AUDIT AND LOAN BY TENURE

SPLIT BY POSSESSION OF PESHE



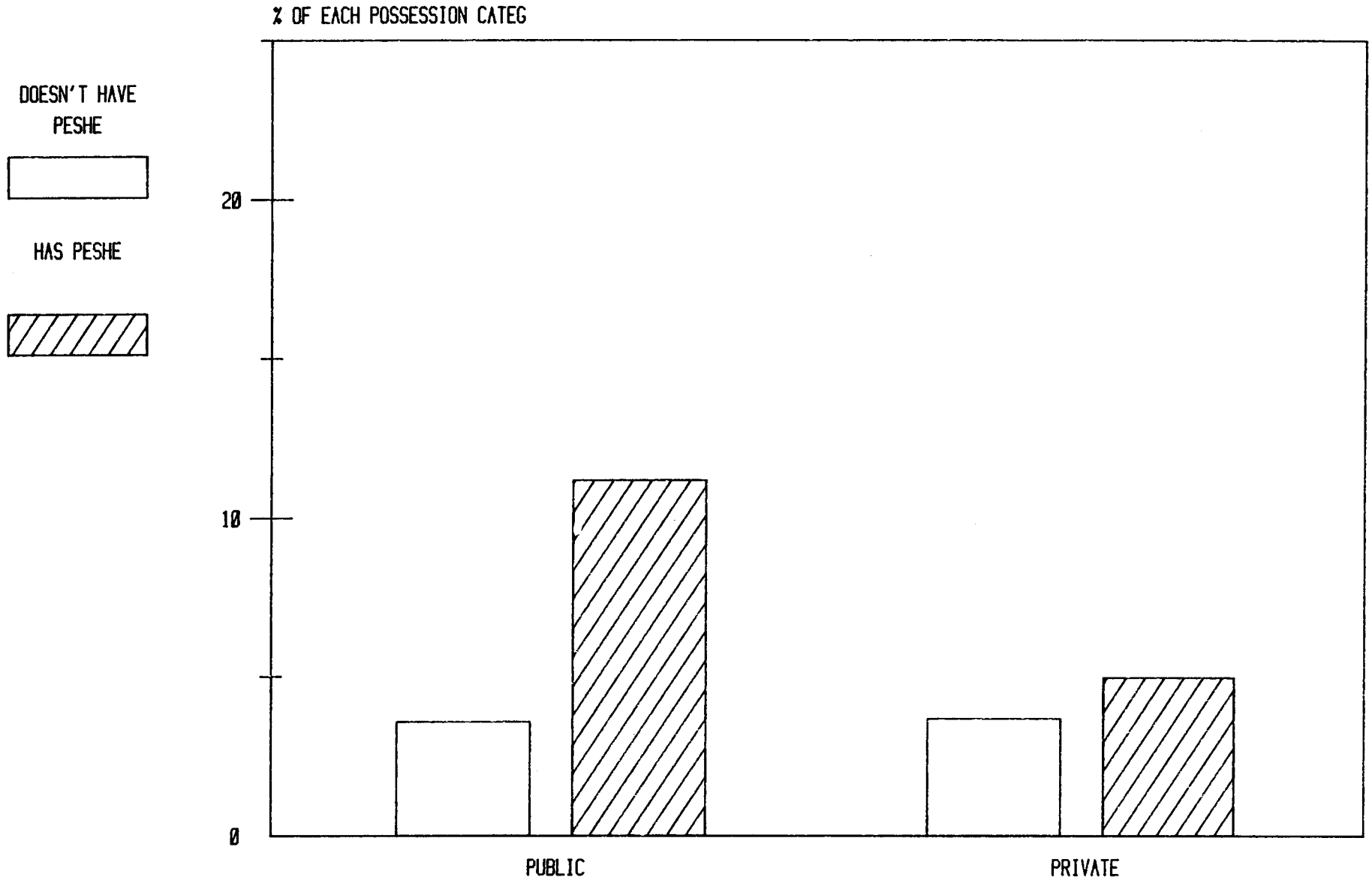
AUDIT ONLY BY UTILITY TYPE

SPLIT BY POSSESSION OF PESHE



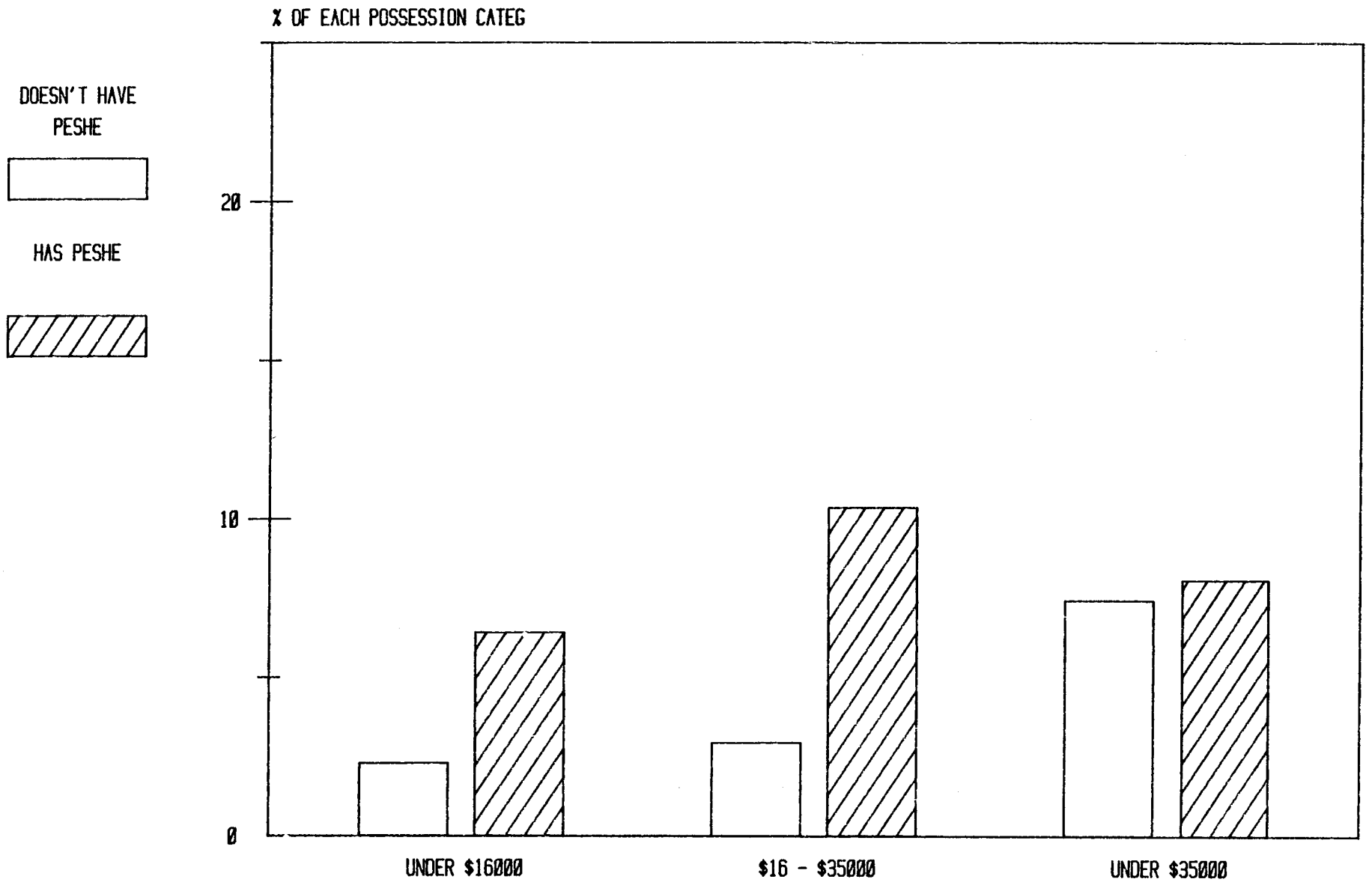
AUDIT AND LOAN BY UTILITY TYPE

SPLIT BY POSSESSION OF PESHE



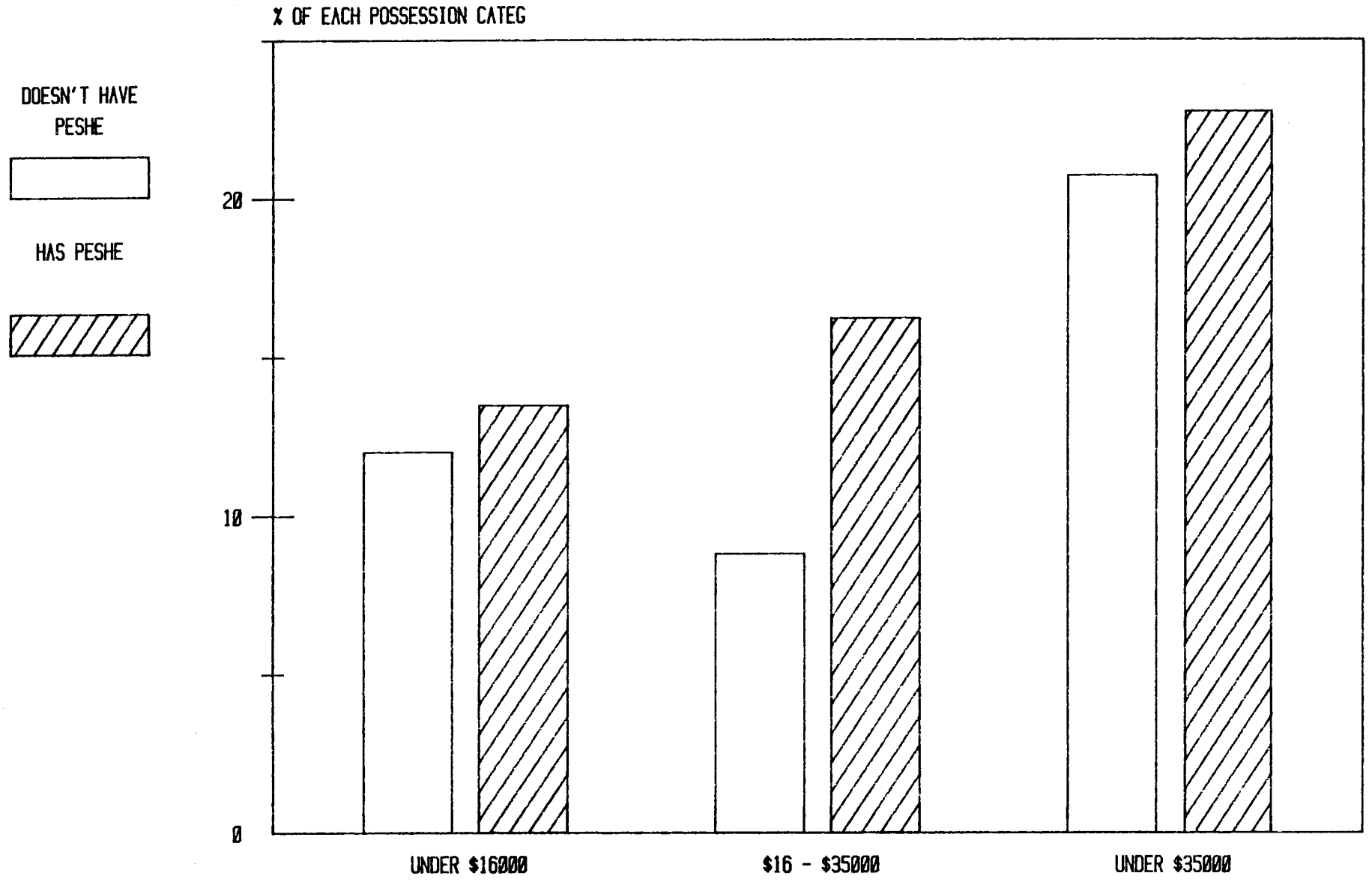
AUDIT AND LOAN BY INCOME CATEGORY

SPLIT BY POSSESSION OF PESHE



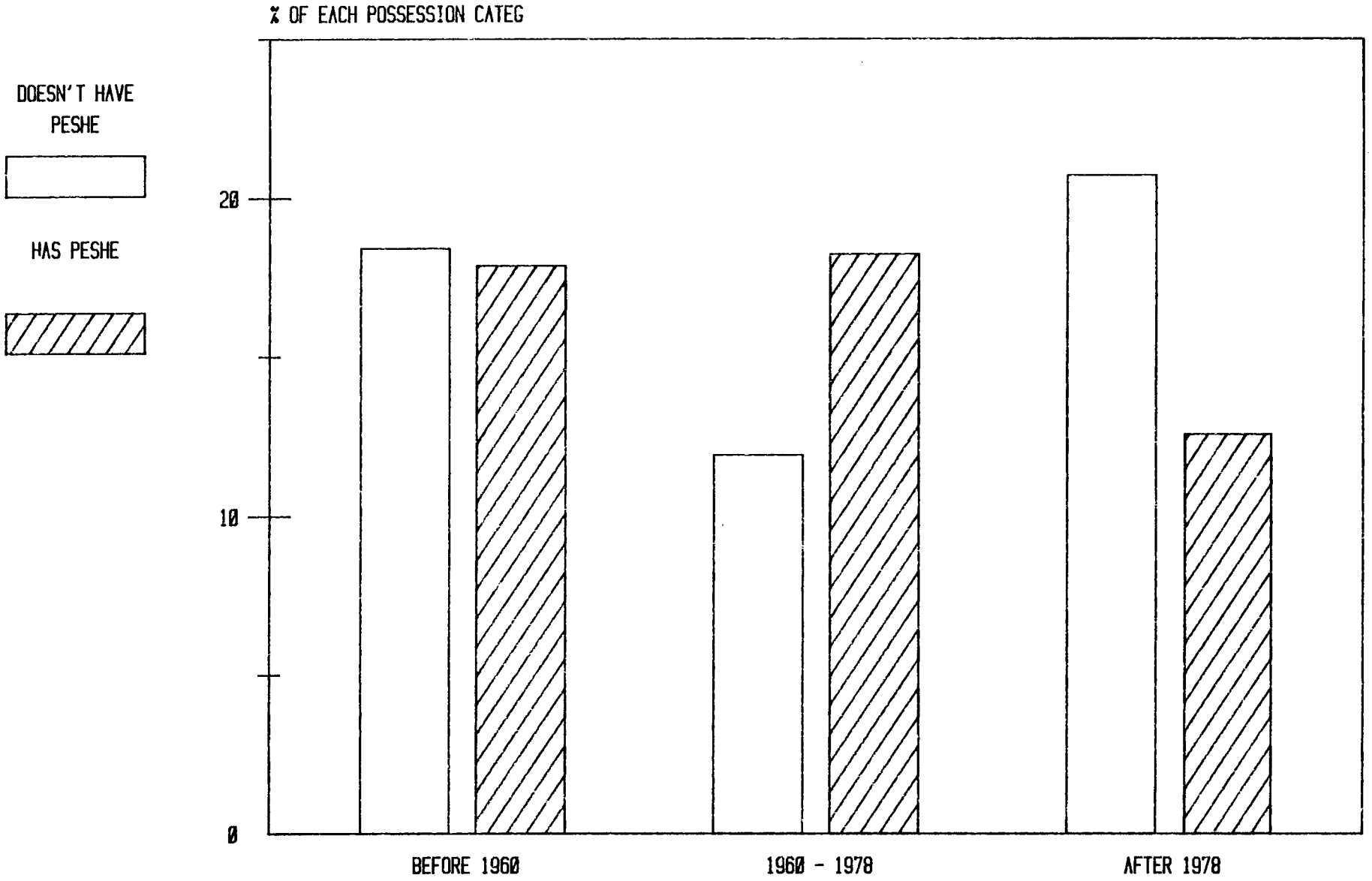
AUDIT ONLY BY INCOME CATEGORY

SPLIT BY POSSESSION OF PESHE



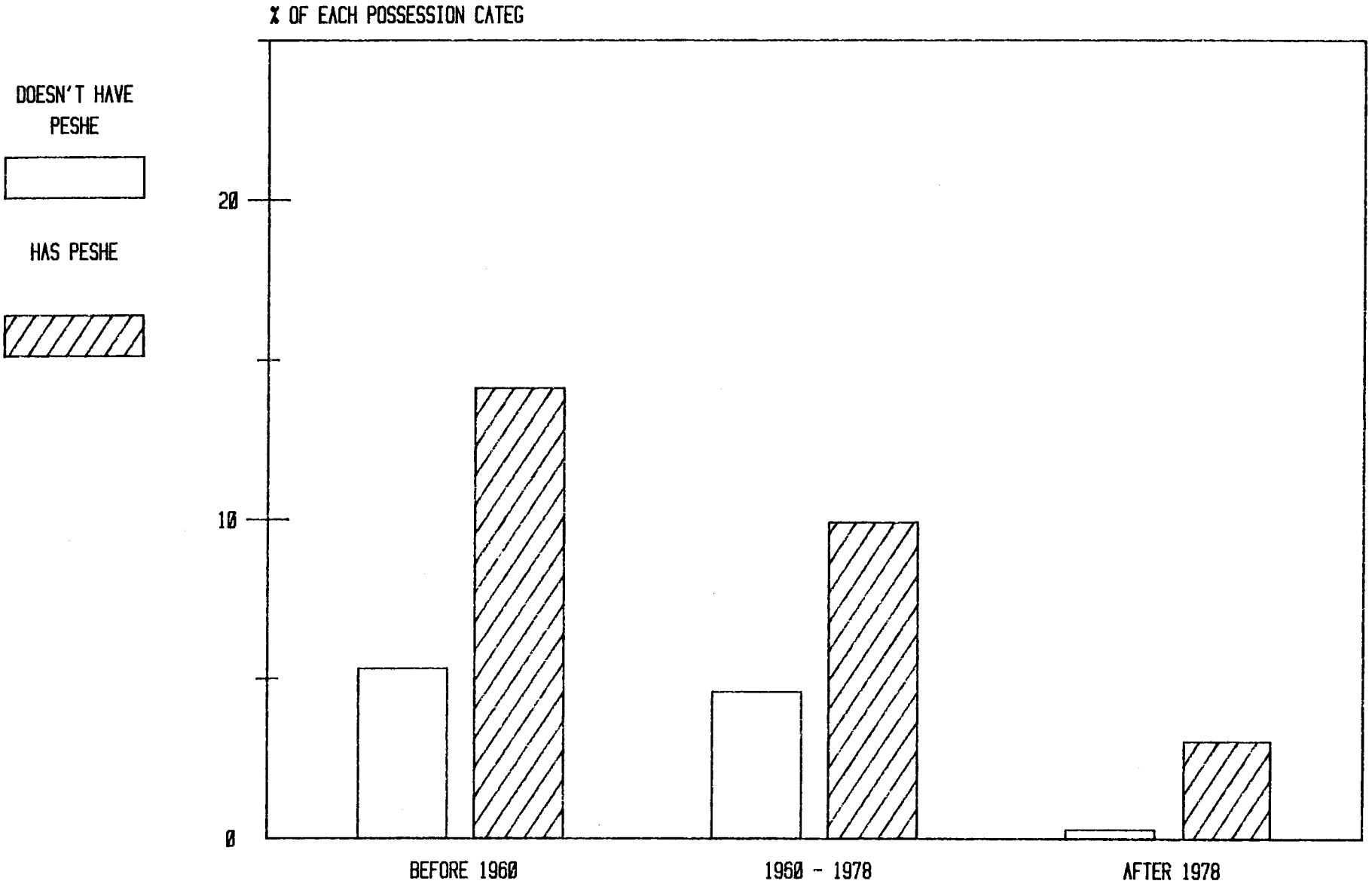
AUDIT ONLY BY AGE OF BUILDING

SPLIT BY POSSESSION OF PESHE

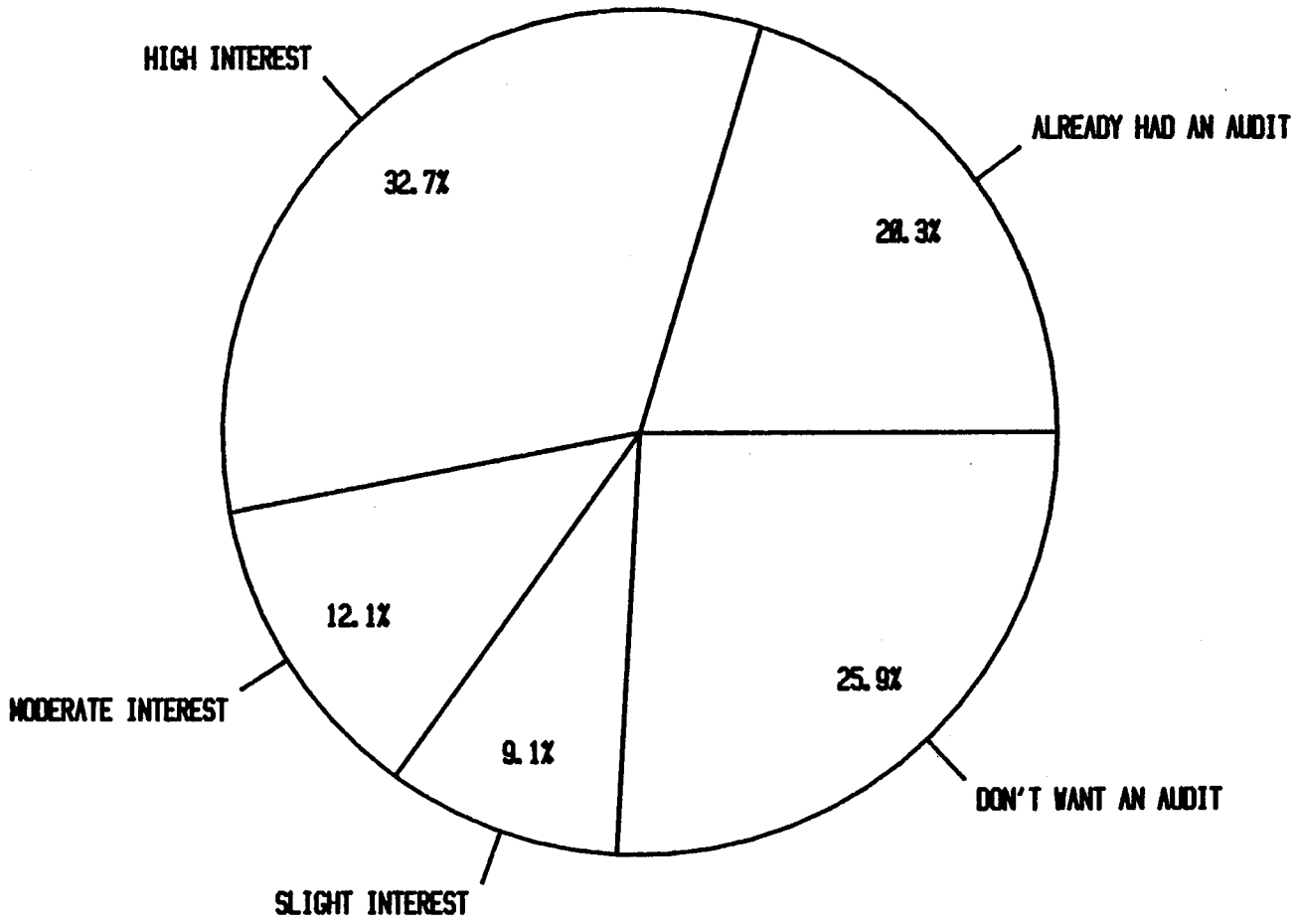


AUDIT AND LOAN BY AGE OF BUILDING

SPLIT BY POSSESSION OF PESHE

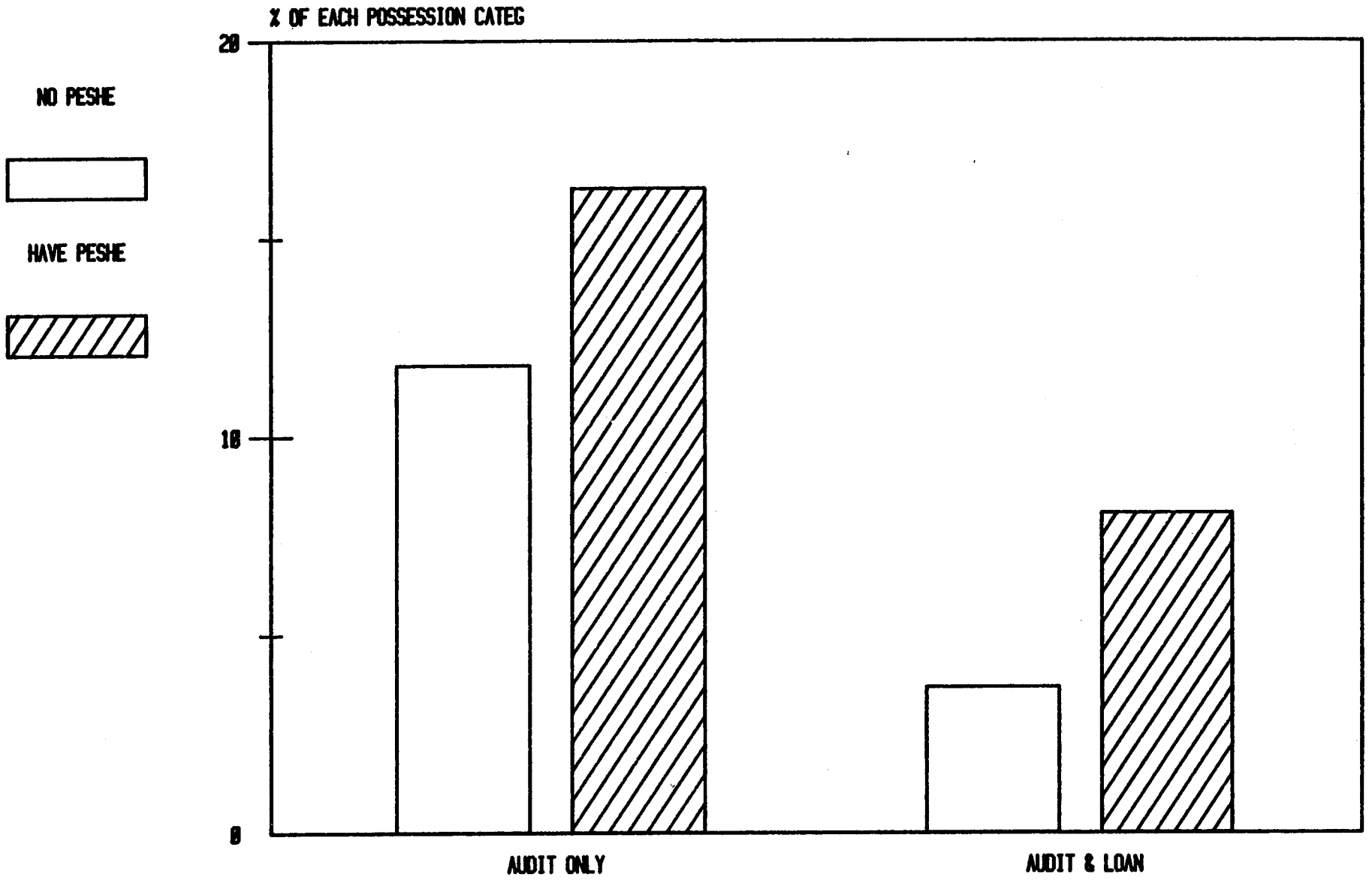


PARTICIPANT INTEREST IN AUDITS

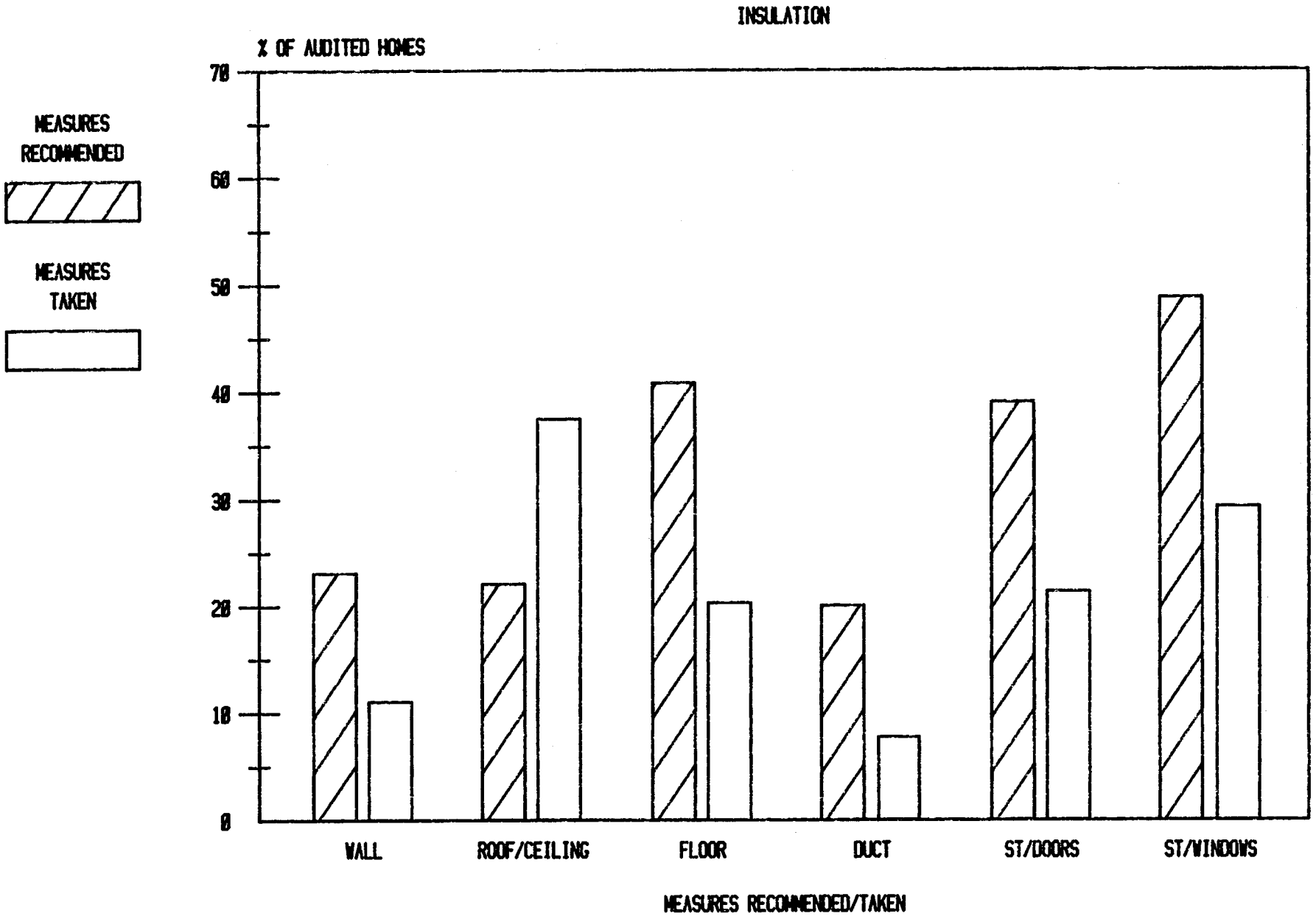


OVERALL PROGRAM PARTICIPATION

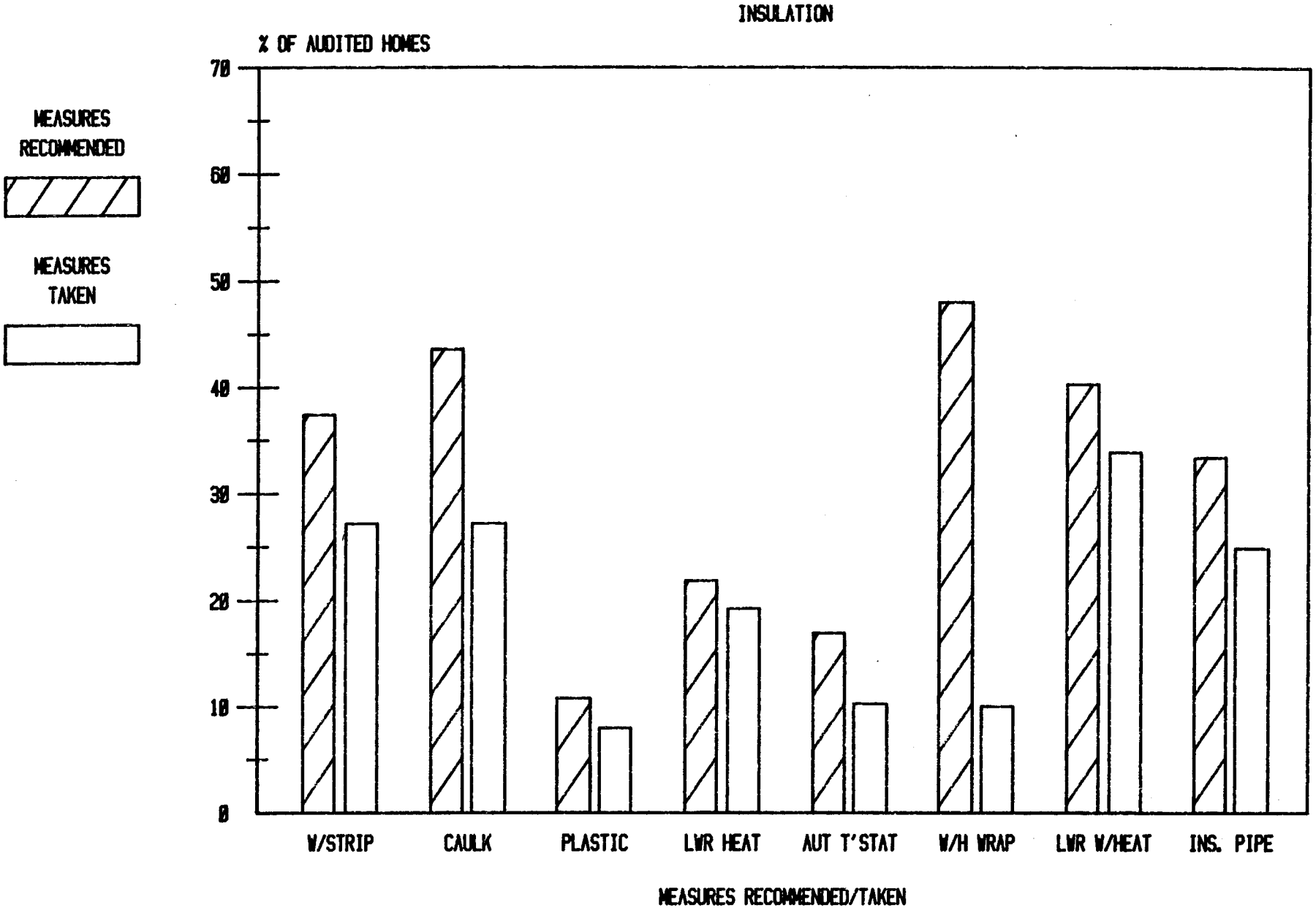
SPLIT BY POSSESSION OF PERM ELEC EQUIP



ACTIONS TAKEN BY AUDITED HOMES -- PART 1

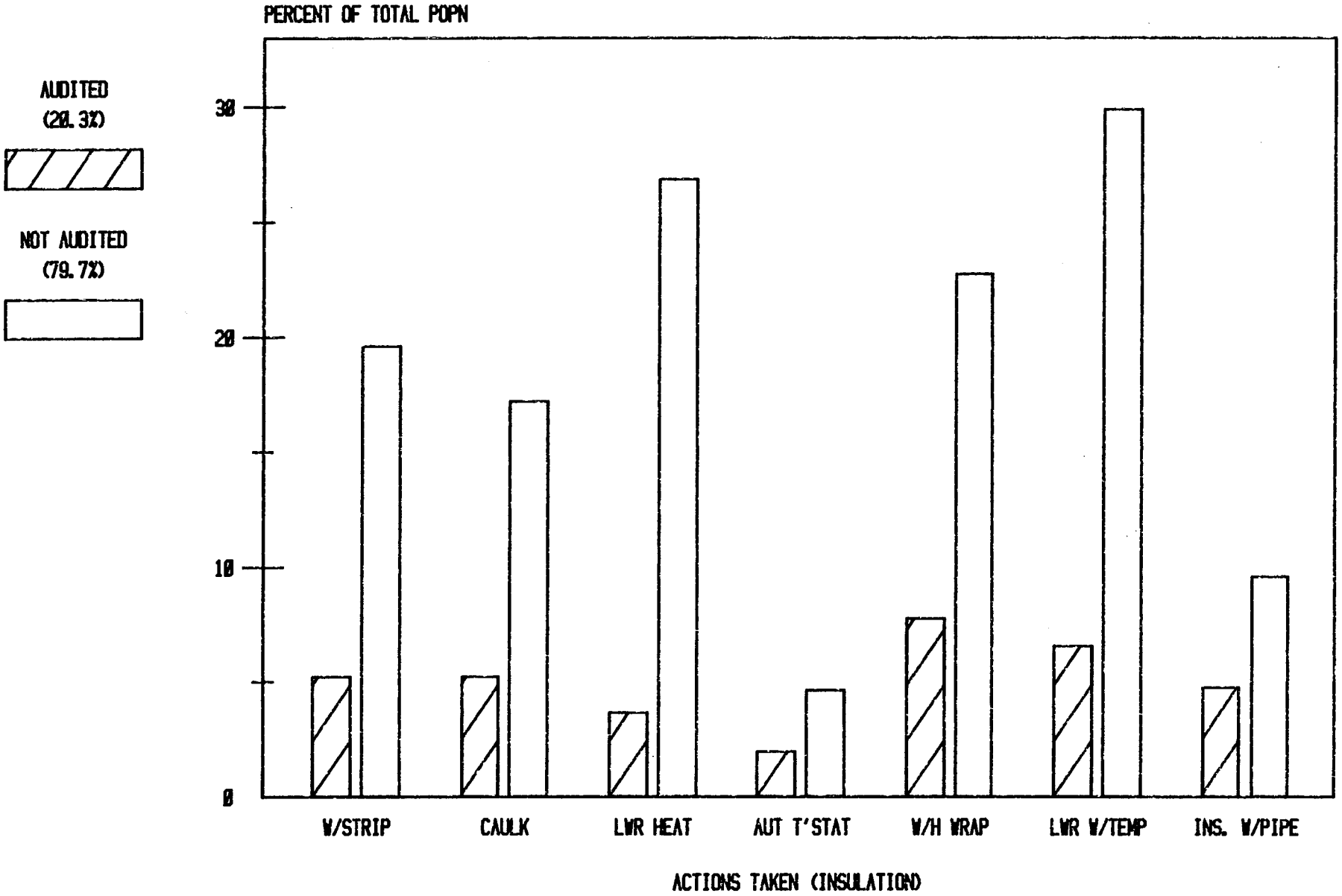


ACTIONS TAKEN BY AUDITED HOMES -- PART 2

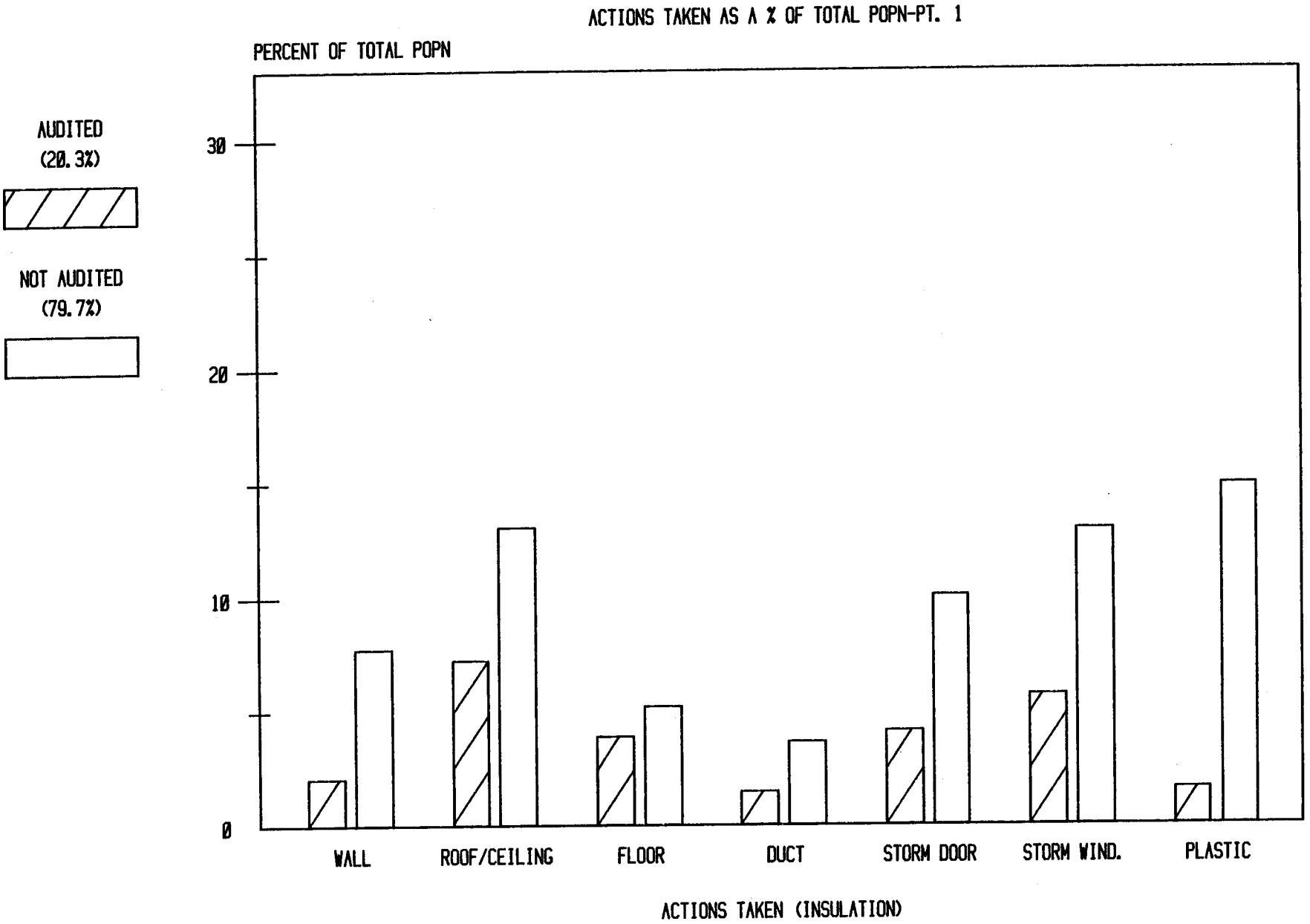


COMPARISON OF AUDITED & OTHER HOMES

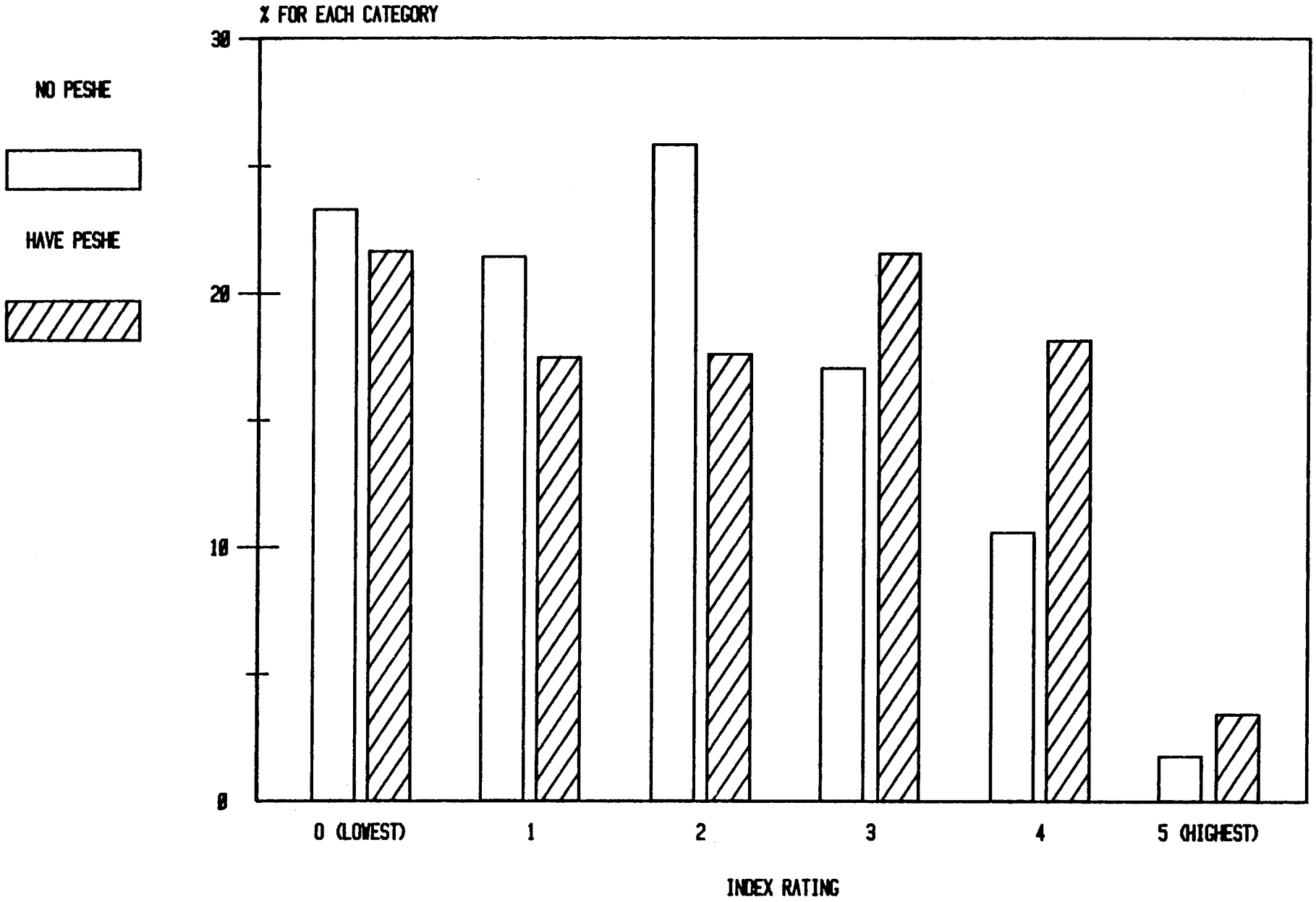
ACTIONS TAKEN AS A % OF TOTAL POPN-PT. 2



COMPARISON OF AUDITED & OTHER HOMES

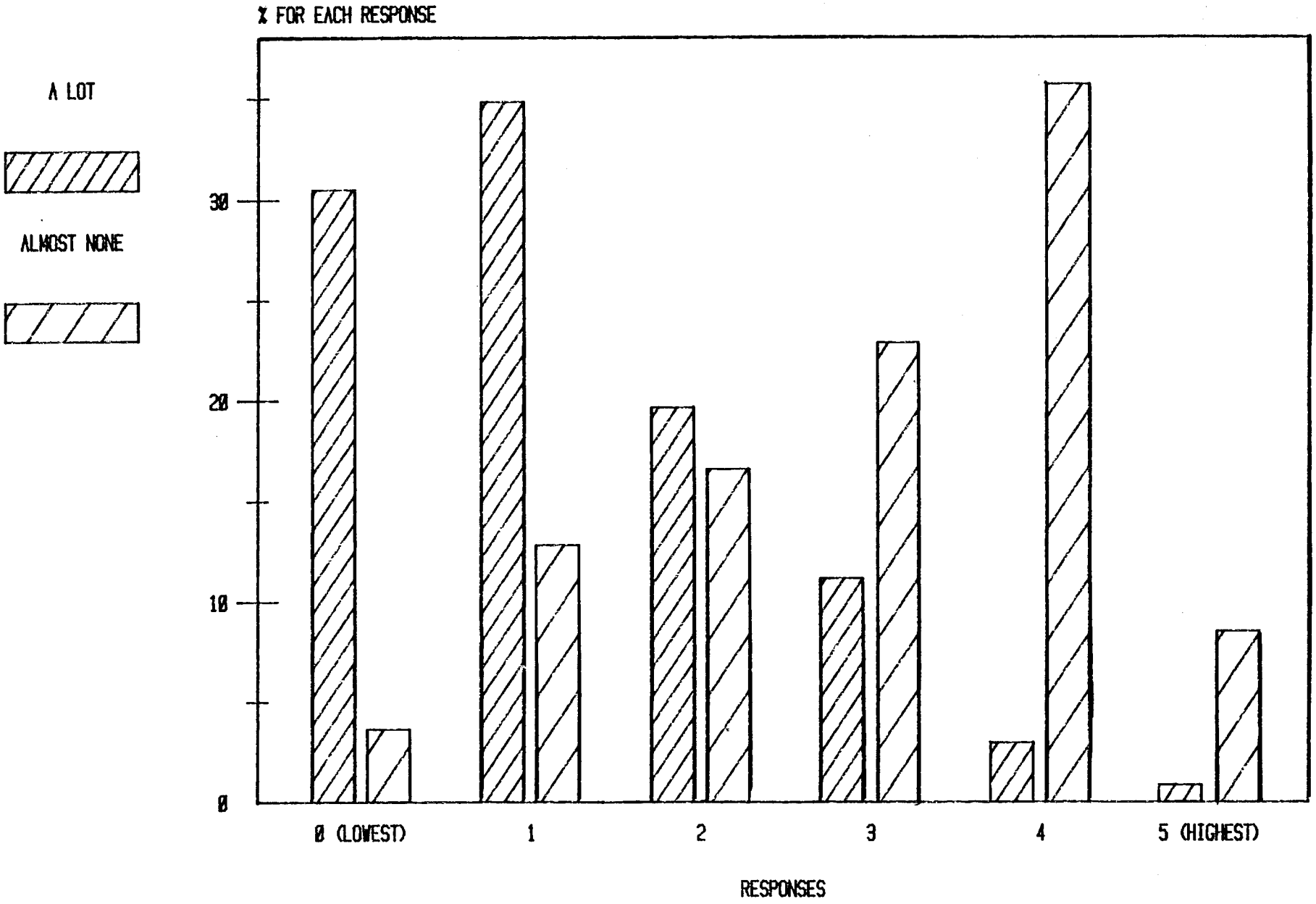


% OF PESHE/NON-PESHE FOR EA INDEX RATING

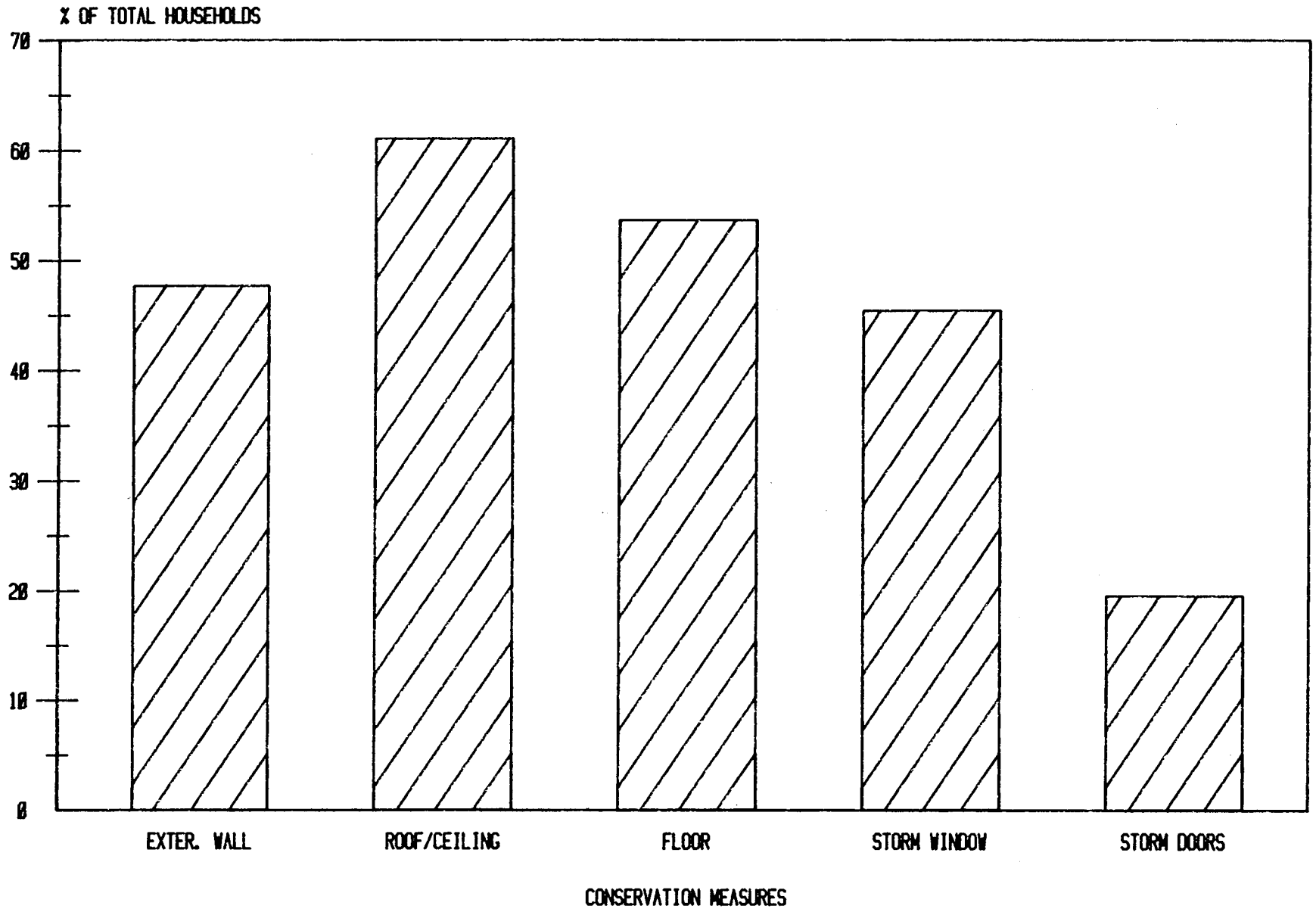


HOW MUCH CAN EFFICIENCY BE IMPROVED

BY ENVELOPE INDEX RATING

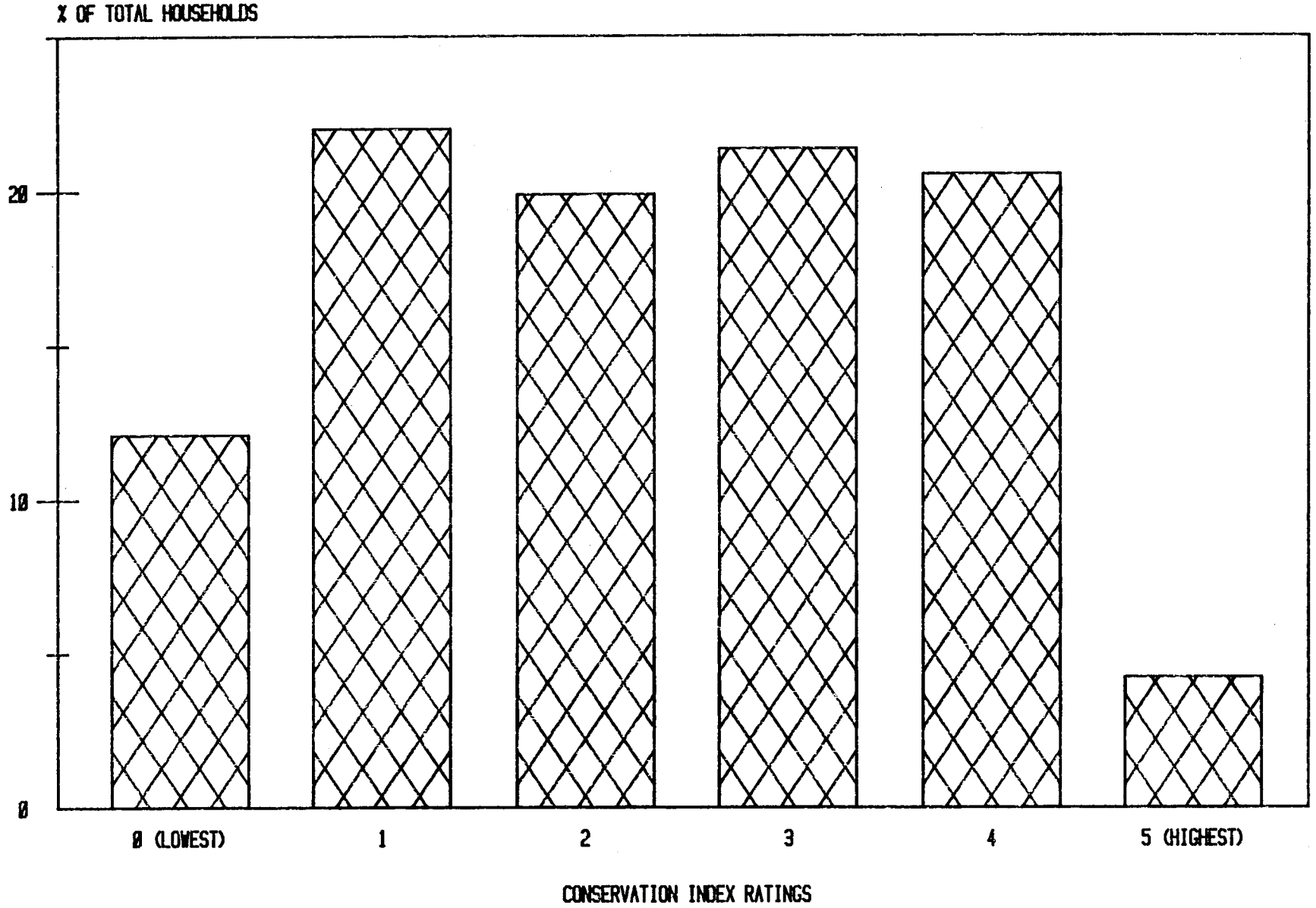


CONSERVATION INDEX MEASURES



DISTRIB. OF HOMES BY CONSERVATION INDEX

MEAN EQUALS 2.3



CONSERVATION INDEX RATINGS--PART I

Mean Values

Climate Zone

I	2.1
II	2.5
III	2.7

State

WA	2.1
OR	2.4
ID	2.6
MT	3.1

Utility Type

Public	2.1
Private	2.4

CONSERVATION INDEX RATINGS--PART II

Mean Values

Type of Dwelling

Mobile Home	3.2
Single Family D.U.	2.2
2, 3, 4 Units Plexes	2.1
5+ Units	2.0

Year DU Built

Before 1960	2.1
1960 - 1978	3.0
After 1978	3.4

Tenure

Own	2.6
Rent	1.6

Income

Less than $16,000	2.2
$16,000 - $35,000	2.3
More than $35,000	2.6

CONSERVATION INDEX RATINGS--PART III

Mean Values

Space Heating Fuel

Wood	2.3
Electricity	2.4
Natural Gas	2.1
Fuel Oil	2.0
Other	2.5

Program Participation

(For Households With Permanently Installed Electric Space Heating Equipment)

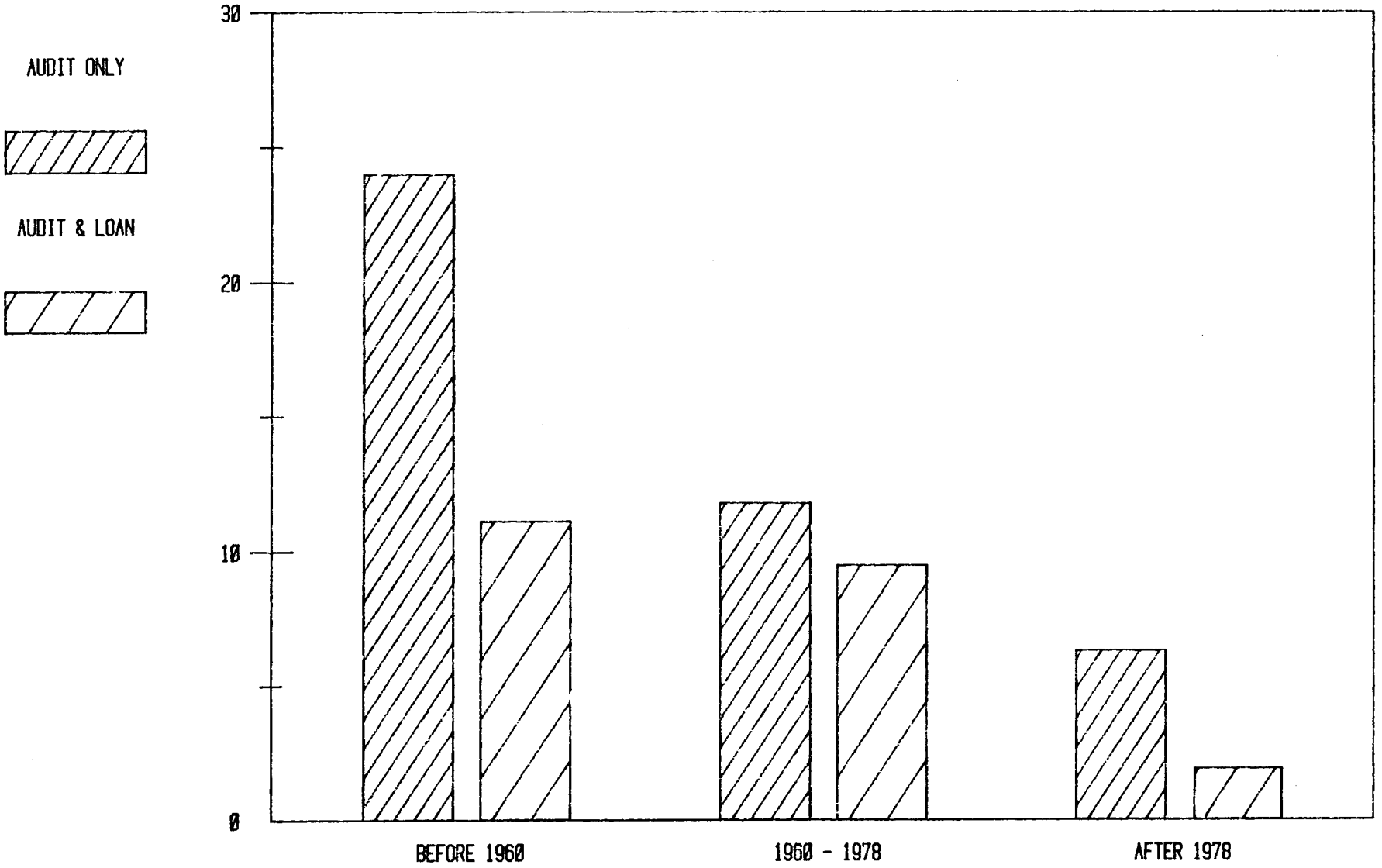
No Participation	2.0
Audit Only	2.5
Audit and Loan	2.8

SUMMARY

- OVERALL, THE BPA RESIDENTIAL WEATHERIZATION PROGRAM APPEARS TO BE SUCCESSFUL, HOWEVER, THERE ARE WEAKNESSES OF PARTICIPATION AMONG RENTAL UNITS, ESPECIALLY IN MULTIFAMILY BUILDINGS AND AMONG THE LOWER AND UPPER INCOME GROUPS.

PROGRAM PARTICIPATION BY AGE OF BUILDING

PESHE HOMES SERVED BY PUBLIC UTILITIES



PROGRAM PARTICIPATION BY UTILITY TYPE

PESHE HOMES ONLY