Residential Retrofit Planning Study

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County of San Luis Obispo
Department of Planning and Building
San Luis Obispo, California 93408

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San Luis Obispo County Retrofit Planning Study

Executive Summary

The potential market in San Luis Obispo County (SLOC) for home retrofits represents a huge opportunity for jurisdictions and the battered home building industry. The San Luis Obispo County Retrofit Planning Study identified 19,198 single family, owner occupied (SFOO) housing units[1] that are not "under water" and whose vintage (built 1990 or before) is ideal for energy saving improvements. Data gathering and research activities were conducted by ConSol to determine approximate costs for energy efficiency improvements in SLOC, considering size of homes and local rates for work. MICROPAS[2] compliance software was used to create a baseline home design for each decade for both climate zones in SLOC. A number of energy improvements were then modeled in the baseline home and their energy impacts were recorded. These energy improvements were then grouped into three packages that resulted in different levels of energy savings. As the packages were developed, the modeled effect on the improvement, building science principles and the marketability of the final package were all considered. The analysis revealed the potential for homeowner utility bill savings, carbon reduction and job creation for different levels of market penetration.

The estimated payback periods for each package and for each individual component were also calculated for both climate zones in the county. Modeling results indicated a significant opportunity for energy savings, especially in the inland region (Climate Zone 4). The development of an organized retrofit program that educates and markets to homeowners throughout the county is likely to have a substantial effect on local governments' abilities to meet their AB 32 carbon reduction goals[3] and on local economic activity. There are currently several rebate programs available for retrofit work in SLOC that can cover 50 percent or more of the cost of a retrofit, according to the analysis conducted for this study. This study suggests that the residents, governments and contractors in SLOC would benefit significantly from a retrofit program that promotes home energy retrofits.

[1] The 19,198 identified housing units include 3,102 units which were returned as having "unknown" equity. It is likely that some of these "unknown" equities are actually negative equity, but as the exact number of negative is not known all were included in the analysis.

[2] MICROPAS is certified by the California Energy Commission for Title 24 energy calculations and is copyrighted by Enerercomp, Inc.

[3] Assembly Bill 32 – signed into law by Governor Arnold Schwarzenegger on September 26, 2007 – established mandatory greenhouse gas reduction targets: by 2020 decrease levels to 25% below 1990 levels, and by 2050 decrease levels to 80% below 1990 levels. This report presents emissions reductions in the commonly used unit of metric ton of carbon dioxide equivalency (MTCO2e). http://www.energy.ca.gov/2007_energypolicy/documents/2007-12-05_meeting/2007-12-05_EXECUTIVE_SUMMARY.PDF

<u>Packages:</u>
For both climate zones (CZs), three efficiency improvement Packages were developed. Package 1 lays the foundation for the higher cost improvements in Packages 2 and 3. Package 1 improves the air sealing of both the ducts and the envelope of the home. All elements of Package 1 should be done prior to replacing any equipment, so that the HVAC equipment can be sized properly and deliver space heating and cooling most efficiently. Thus, all Package 1 improvements are included in Packages 2 and 3, each of which saves progressively more energy due to higher efficiency features. The Packages are summarized below in Table 1 (CEC Climate Zone 4 – Inland) and Table 2 (Climate Zone 5 – Coastal).

Climate Zone 4 (Inland)

Package 1	**Package 2**	**Package 3**
Air Sealing Envelope to SLA 3.8	All of Package 1 plus:	All of Package 1 plus:
Seal and Insulate Ducts to R-6	Upgrade A/C Unit to SEER 14.5	Upgrade A/C Unit to SEER 16
Insulate Attic to R-30	Upgrade Furnace to AFUE 80%	Upgrade Furnace to AFUE 80%
Insulate HVAC Equipment Platform to R-19	Upgrade Hot Water Heater to .62 EF Storage Water Heater	Upgrade Water Heater .80 EF Tankless Water Heater
	Replace Windows to .40 /.40 (SHGC/U-factor) [4]	Replace Windows to .30 /.30 (SHGC/U-factor)

Table 1. Summary of package elements modeled for Climate Zone 4.

Climate Zone 5 (Coastal)

Package 1	**Package 2**	**Package 3**
Air Sealing Envelope to SLA 3.8	All of Package 1 plus:	All of Package 1 plus:
Seal and Insulate Ducts to R-6	Upgrade A/C Unit to SEER 14.5	Upgrade A/C Unit to SEER 14.5
Attic Insulation to R-30	Upgrade Furnace to AFUE 80%	Upgrade Furnace to AFUE 90%
Insulate HVAC Equipment Platform to R-19	Upgrade Hot Water Heater to .62 EF Storage Water Heater	Upgrade Water Heater .80 EF Tankless Water Heater
	Replace Windows to .40 /.40 (SHGC/U-factor)	Replace Windows to .40 /.40 (SHGC/U-factor)

Table 2. Summary of package elements modeled for Climate Zone 5.

<u>Estimated Energy Savings and Carbon Reduction:</u>
The estimated energy savings and carbon reductions (percent savings) for each of the three Packages were calculated for homes built in different decades including homes built prior to 1960 and the three decades starting in 1960, 1970, and 1980. These analyses were performed for both climate zones and the energy savings results are provided in Tables 3 and 4.

[4] Glazing is considered to be any transparent openings in the building envelope (windows, glass doors and skylights). Glazing products are rated by U-factor and solar heat gain coefficient (SHGC). SHGC is a measure of how much incident heat radiation from the sun can pass through the material; the U-factor describes the insulating value of the window. Space cooling favors low U-factors and SHGCs; space heating favors low U-factors and high SHGCs. For complete definitions, see: http://resourcecenter.pnl.gov/cocoon/morf/ResourceCenter/article/1479

Climate Zone 4				
Percent Savings	**pre-1960s**	**1960s**	**1970s**	**1980s**
Package 1	10.9%	7.0%	14.8%	13.3%
Package 2	48.8%	44.3%	49.8%	48.4%
Package 3	53.0%	48.9%	53.9%	54.8%

Table 3. Distribution of energy saving effect of Packages on homes by decade in Climate Zone 4.

Climate Zone 5				
Percent Savings	**pre-1960s**	**1960s**	**1970s**	**1980s**
Package 1	9.3%	5.7%	14.5%	14.0%
Package 2	45.1%	41.0%	45.1%	43.8%
Package 3	52.6%	49.2%	52.7%	53.3%

Table 4. Distribution of energy saving effect of Packages on homes by decade in Climate Zone 5.

Table 5 shows the *per home* carbon reduction resulting from converting the energy savings into carbon reduction[5].

Carbon Reduction per Home (MTCO2e/year)

	Package 1	Package 2	Package 3
CZ 4	1.1	4.2	4.6
CZ 5	0.9	3.4	4.1

Table 5. Distribution of carbon reduction effects of packages on homes by decade in both climate zones.

Although the energy and carbon reduction provide a strong argument for the creation of a retrofit program to help improve environmental conditions and lessen the need to build more power plants, to many homeowners the bottom line is the impact on their monthly budgets. Using the average energy savings for each package in both climate zones, Table 6 provides an estimate of the impact of the three retrofit packages on monthly utility bills. The final row assumes that the improvement packages have been financed through an Energy Efficient Mortgage (EEM)[6]. All three packages demonstrate "cash flow positive" impact, meaning that the money saved on utility bills from the energy savings is greater than the estimated monthly payment on an EEM for the work[7].

[5] For a complete explanation of energy savings and carbon reduction see pages 22 through 26.
[6] The rough calculation used to estimate the monthly payment on an EEM is: (5*Loan Amount)/1000.
[7] Please note that cost estimates are rough calculations and that actual energy savings would vary along with costs and loan payments.

COST SAVINGS		**Pkg 1**	**Pkg 2**	**Pkg 3**
THERMS				
	CZ 4	130.99	492.81	557.83
	CZ 5	137.80	512.99	638.81
	Total	*268.8*	*1005.8*	*1196.6*
	Average Annual CZ 4-5	134.4	502.9	598.3
	Average Monthly CZ 4-5	11.2	41.9	49.9
KWH				
	CZ 4	2628.3	10809.4	11464.7
	CZ 5	1299.0	4644.4	4644.4
	Total	*3927.2*	*15453.8*	*16109.1*
	Average Annual CZ 4-5	1963.6	7726.9	8054.5
	Average Monthly CZ 4-5	163.6	643.9	671.2
MONTHLY COST SAVINGS				
	Therms	$11.20	$41.91	$49.86
	KWH	$24.55	$96.59	$100.68
	Total	$35.74	$138.49	$150.54
EEM Monthly Estimated Loan Payment		-18	-75	-88
CASH IMPACT AFTER FINANCING COSTS		**$ 18.24**	**$ 63.49**	**$ 63.04**

Table 6. Impact of three packages of improvements on homeowner monthly budget.

Job Creation:

One of the most compelling numbers that was calculated as part of this study was the potential job creation resulting from homeowner purchase of the improvement Packages. Using the federal government's estimate of investment needed to create one job ($92,000), job creation was modeled under several scenarios. The first assumption of the job creation calculation is that under all scenarios, 25 percent of households will choose Package 1, 50 percent will choose Package 2 and 25 percent will choose Package 3. Second, four different market penetration scenarios assume that the percent of houses being retrofitted is the same in both climate zones. For example, as there are 6,614 identified housing units in Climate Zone 4 and 12,584 in Climate Zone 5, 1 percent market penetration means that 66 in Climate Zone 4 are retrofitted and 126 are retrofitted in Climate Zone 5.

Table 7 summarizes the potential for job creation and carbon reduction in each climate zones in SLOC under market penetration rates of 1, 5, 20 and 100 percent of the identified housing units that are either not "underwater" or have unknown equity level. Table 8 demonstrates the county-wide potential for job creation and carbon reduction under each market penetration scenario. Both tables serve to emphasize the potential economic and environmental benefits of a retrofit program in SLOC.

	1% Penetration		**5% Penetration**		**20% Penetration**		**100% Penetration**	
	CZ 4	**CZ 5**	**CZ 4**	**CZ 5**	**CZ 4**	**CZ 5**	**CZ 4**	**CZ 5**
Housing Units Retrofitted	66.14	125.84	330.7	629.2	1322.8	2516.8	6614	12584
Job Creation Potential	11	19	53	97	211	387	1055	1936
Carbon Reduction (MTCO2e/yr)	226	370	1132	1850	4528	7399.4	22640	36997

Table 7. Potential job creation and carbon reduction by climate zone under different levels of market potential.

Market Penetration Rate	**1%**	**5%**	**20%**	**100%**
Housing Units Retrofitted	191.98	959.9	3839.6	19198
Job Creation Potential	30	150	598	2991
Carbon Reduction (MTCO2e/yr)	596	2982	11927.4	59637

Table 8. Potential job creation and carbon reduction throughout SLOC under different levels of market penetration.

Introduction

This study provides results of an investigation into the characteristics of existing housing stock in San Luis Obispo County (SLOC) – including age, size and climate zone location – and, using California Energy Commission-certified computer home-energy modeling software (MICROPAS), predicts the impacts of different energy improvements on homeowner utility bills, county-wide carbon reduction and the home building job market. The energy savings predictions are provided by housing decade (according to date built) and climate zone.

San Luis Obispo County is located on the Central California Coast, bordered to the north by Monterey and Kings Counties, to the east by Kern County and to the south by Santa Barbara County. In 2008, the *US Census* estimated the population at 262,238[8] with an average household income level of $57,722 (California average: $61,154) and an average median home value of $562,900 (California average: $510,200; US average: $192,400). The county is marked by two distinct climate areas, demarcated by the California Energy Commission (CEC): Climate Zones 4 and 5. These two climate zones (CZs) present different opportunities for energy savings for homeowners. Pacific Gas and Electric (PG&E) describes Climate Zone 4 as:

> "Seasons are sharply defined. Summers are hot and dry with a large daily temperature swing. Summers are hot enough that cooling is necessary. Winters are cool but not severe. Heating is necessary on many days in the winter."[9]

While the mild coastal Climate Zone 5 is described as:

> "Summers are warm with afternoon winds blowing until sunset, which naturally cools the region. The air is usually moist. Fog and cloud cover commonly blocks the sun in the morning and evenings. Winters are cold but not severe enough to frost."[10]

The dramatic differences in climate within SLOC necessitate a climate zone-based approach to the analysis of housing and energy usage. This study considers each climate zone separately whenever necessary to provide an accurate picture of the effect of energy improvements on the existing housing stock throughout the county.

Summary of SLOC Housing Statistics

This section presents general housing statistics that describe the housing stock in SLOC by decade (pre-1960s, 1960s, 1970s and 1980s) and by climate zone (CZs 4 and 5). Data was gathered from the *US Census* to provide numbers for all housing units by decade and to estimate the mix of single-family, owner-occupied (SFOO) homes based on the percent identified in the 2000 Census. *REiSource* data is the result of a search of parcels in SLOC that are SFOO housing units that were built in or before 1990 and that have zero, unknown or positive equity. The *REiSource* data was used to calculate the average size and value of homes by decade throughout the county. Table 9 summarizes the findings of the research; a complete listing of housing units and *REiSearch* parcels by climate zone and jurisdiction is attached as Appendix A.

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[8] Source: http://factfinder.census.gov

[9] Source: http://www.pge.com/includes/docs/pdfs/about/edusafety/training/pec/toolbox/arch/climate/california_climate_zone_04.pdf

[10] Source: http://www.pge.com/includes/docs/pdfs/about/edusafety/training/pec/toolbox/arch/climate/california_climate_zone_05.pdf

	TOTALS BY DECADE	**BEFORE 1940**	**1940-59**	**1960-69**	**1970-79**	**1980-89**	**1990-2000**	**1990 ONLY**	**TOTALS**
Climate Zone 4	*2000 US Census Data*	1221	2708	2129	4507	6607	3976	NA	21148
	REiSource Qualified Parcels by Decade	388	722	438	1642	3031	0	393	6614
	2000 US Census Data	3936	9871	9271	17095	13337	8872	NA	62382
Climate Zone 5	REiSource Qualified Parcels by Decade	693	2190	1858	3075	4264	0	504	12584

Table 9. Housing units in SLOC by decade, separated by climate zone.

For both climate zones, averages of equity, year built, size and assessed values have been calculated by jurisdiction (which include rural areas of SLOC). These numbers reflect data related to the parcel search conducted of SFOO units with positive or unknown equity. Tables 10 and 10 demonstrate the averages per jurisdiction, separated into climate zones for the *REiSource* search of housing units.

CITY	**Equity %**	**Average Year Built**	**Average Sq Ft**	**Assessed Value**
Atascadero	42.0	1971	1838	$ 276,251.66
CA Valley and Santa Margarita	40.5	1963	1481	$ 213,248.11
Creston	43.2	1977	1821	$ 309,606.45
Paso Robles	41.2	1977	1697	$ 237,628.22
San Miguel	42.4	1970	1614	$ 242,021.38
Shandon	39.3	1966	1317	$ 117,647.19
Templeton	44.5	1980	1992	$ 331,684.14
Average for CZ 4	41.9	1972	1680	$ 246,869.59

Table 10. Climate Zone 4 cities' statistics.

Climate Zone 5				
CITY	**Equity %**	**Average Year Built**	**Average Sq Ft**	**Assessed Value**
Arroyo Grande	45.4	1972	2017	$ 351,345.88
Cambria	51.7	1975	1709	$ 385,513.08
Cayucos	52.5	1963	1641	$ 394,070.71
Grover Beach	43.6	1970	1519	$ 248,502.42
Los Osos	44.7	1974	1663	$ 300,079.62
Morro Bay	48.9	1965	1560	$ 321,250.18
Nipomo	45.1	1980	2018	$ 319,066.26
Oceano	41.7	1968	1413	$ 217,670.38
Pismo Beach	48.9	1976	1866	$ 418,075.76
SLO	48.0	1965	1941	$ 386,191.92
Shell Beach	61.5	1968	1779	$ 386,283.74
Avila Beach	54.5	1929	1718	$ 187,267.00
Santa Maria	47.3	1979	1932	$ 283,287.57
Average	48.8	1968	1752	$ 322,969.58

Table 11. Climate Zone 5 cities' statistics.

Base Energy Features

One objective of this project was to determine energy-savings packages and to estimate the percent energy savings for each. To do this analysis, it was necessary to develop a set of homes and base energy features for each decade of homes. Several factors contributed to the development of "base" models of the existing housing stock in SLOC. First, the number and average size of homes per decade according to the *REiSource* data was calculated. Relevant information from the energy audit reports from the San Luis Obispo Green Build (SLOGB)-sponsored home energy audit sweepstakes (five energy audit reports provided actual housing data), and the results of the SLOGB member survey were incorporated. Finally, the model was informed by referencing Building Energy Efficiency Standards (Title 24) "vintage tables" developed by the CEC which provide default values for homes by decade for the state's Home Energy Rating System Phase 2 (HERS II, for home energy evaluation of new or existing buildings) program. After compiling the base model components, MICROPAS software was utilized for the final modeling of baseline performance by decade and climate zone.

MICROPAS – the energy modeling software used to calculate the base home performance by decade and climate zone – considers the impacts of the climate zone, the building design, the building envelope (walls, windows, doors, etc.), the mechanical equipment (HVAC and water heating) and the quality of construction on the space heating, space cooling, mechanical ventilation and water heating loads. In addition, results were further developed with estimates on lighting energy use, based on existing research by the Department of Energy's Building America program. Table 12 lists the base conditions that were used in the energy analysis using MICROPAS for homes by decade.

	per-1960s	1960s	1970s	1980s	1990
<u>Envelope</u>:					
Wall Insulation	none	none	none	R-13	R-13
Attic Insulation	none	R-11	R-11	R-19	R-19
Floor Insulation	none	none	none	none	none
Roofing Material	Asphalt	Asphalt	Asphalt	Asphalt	Asphalt
Reflectance/Emittance[11]	0.08/0.85	0.08/0.85	0.08/0.85	0.08/0.85	0.08/0.85
Specific Leakage Area[12]	4.9	4.9	4.9	4.9	4.9
<u>Glazing</u>					
U-factor	1.28	1.28	1.28	1.28	0.79
SHGC	0.83	0.83	0.83	0.83	0.73
<u>HVAC System</u>:					
Heating Equipment	Gas furnace	Gas furnace	Gas furnace	Gas furnace	Gas furnace
Efficiency (AFUE)	0.47	0.48	0.6	0.62	0.62
Cooling Equipment	Window Unit A/C	Window Unit A/C	A/C Split	A/C Split	A/C Split
Efficiency (SEER)	5.6	6	6.4	7.1	7.8
Duct System	none	none	Yes	Yes	Yes
Location	N/A	N/A	Attic	Attic	Attic
R-value	N/A	N/A	2.1	2.1	4.2
<u>Water Heating System</u>:					
Water Heater Type	40 g. Storage	40 g. Storage	40 g. Storage	40 g. Storage	40 g. Storage
Fuel Source	Gas	Gas	Gas	Gas	Gas
Efficiency	0.525	0.525	0.525	0.525	0.525
Insulation	R-12	R-12	R-12	R-12	R-12
Pipe Insulation	none	none	none	none	none

Table 12. Assumed energy features in existing housing units by decade.

These features were modeled in MICROPAS for each time period for each of four different sizes of homes: 945, 1228, 1569 and 2123 square feet of conditioned floor area CFA). The energy consumption profiles of the four models were averaged for each decade. The averaged energy consumption was then applied to the average home size by decade among the *REiSource* housing units, producing a weighted average home for the decade. One assumption was made about the housing stock by decade, which is reflected in the baseline energy models of the homes. It is assumed that the energy features in homes have not been upgraded, so a home built in the 1960s still contains the original inefficient features. One of the results of this assumption is that homes built before the 1970s do not contain duct systems for heating and cooling systems. Although it is certainly the case that many of these homes have been upgraded, it is unknown how many and therefore the baseline will be developed to demonstrate improvement effects on the original home. Table 13 shows the average home size from the *REiSource* search:

[11] The reflectance and emittance values are measures of the roofing material's ability to, respectively, reflect back incident heat radiation from the sun and release heat to the atmosphere that was absorbed by the material. In warm areas with significant sun heat, higher reflectance and emittance values (which range from 0 to 1) are desirable.
[12] Specific Leakage Area, or SLA, is a measure of the leakiness of the envelope of the building. New homes in California typically have SLAs around 3 to 3.8.

Time Period	Avg. SqFt	# Units
1980-1990	2001	8185
1970-1979	1812	4718
1960-1969	1650	2296
1950-1959	1515	2052
1940-1949	1464	860
1939 and older	1546	1087

Table 13. Decadal housing size and number of units used to develop models.

Climate Zone 4

Due to the increased requirements for heating and cooling, SLOC cities and towns located in Climate Zone 4 are likely to consume more energy than their fellow county residents along the coast (in Climate Zone 5). The higher number of heating and cooling days in Climate Zone 4 results in a larger demand for space conditioning. Table 14 shows the monthly consumption estimates for homes in Climate Zone 4, based on the MICROPAS modeling results[13].

	1930s	1940s	1950s	1960s	1970s	1980s
Therms	115.5	109.4	113.2	114.0	125.9	81.3
kWh	1781.1	1689.8	1746.6	1490.9	2164.2	977.5

Table 14. Decadal calculations for average kilowatt-hour and therm demand in Climate Zone 4.

The dip in kWh demand from the 1950s to the 1960s is likely due to the introduction of R-11 attic insulation and a slight increase in assumed efficiency in A/C units. Established in 1978, California's Building Energy Efficiency Standards or Title 24 began to have a profound effect on housing construction and subsequently residential energy consumption during the 1980s. The significant therm and kWh reduction in the 1980s can be attributed to increases in attic insulation from R-11 to R-19 and assumed wall insulation of R-13 value. Both insulation levels became the minimums in Climate Zone 4 as a result of Title 24. The spike in demand during the 1970s can likely be attributed to ducted central heating and cooling systems prior to Title 24 energy code requirements.

Climate Zone 5

Climate Zone 5 in SLOC covers the coastal region of the county which benefits from cool Pacific breezes and moderate temperatures during most of the year. The moderate climate in the Central Coast region makes it a desirable place to live and also results in fewer heating and cooling days than are experienced in the inland region of the county. The following table (Table 15) shows the monthly consumption estimates for homes in Climate Zone 5, based on the MICROPAS modeling results.

	1930s	1940s	1950s	1960s	1970s	1980s
Therms	119.1	112.8	116.7	117.7	132.0	80.4
kWh	955.8	908.2	937.8	812.5	1147.1	514.0

Table 15. Decadal calculations for average kilowatt-hour and therm demand in Climate Zone 5.

[13] MICROPAS calculates the energy demand due to water heating and space cooling and heating. Improvements in insulation and air sealing (as well as improvements in equipment) impact these loads. The final home models for each decade also include demand for lighting, based on DOE Building America research.

Estimated natural gas demand (therms) is very similar in both climate zones from decade to decade, with the cooler temperatures along the coast accounting for slightly higher demand for most years. Electricity demand (kWh), however, is significantly different between the two climate zones with inland housing units modeled to consume almost double that of the coastal units. Space cooling during the hot summers in inland SLOC would account for the great difference among the two climate zones.

With these demand profiles as the base, a number of energy efficiency upgrades were modeled to predict energy savings effects from each. Finally, based on their individual results, efficiency measures were grouped into packages and their cumulative effects modeled as packages. It is important to note that package components do not have simple additive energy savings because each of the improvements affects the others.

Energy Features Modeled

After establishing the baseline home performance in SLOC by decade in both climate zones, the savings from different individual energy-feature upgrades were analyzed using the energy-modeling software. Graphs showing the total costs and payback in years for the modeled improvements are in Appendix B.

Development of Packages of Improvement Features

The most important factor in the development of the three packages of energy efficiency features was the payback period of the individual improvements. Two other factors, however, also influenced the development of the packages: building science and marketability. At the core of building science is the concept of the home as a system, where improving energy efficiency requires a holistic approach. Rather than simply replacing an older A/C unit with a new, more efficient or larger one, building science shows that, considering both cost-effectiveness and comfort, one should first evaluate the envelope and duct system for leakage, and seal most leaks. After sealing and insulating the envelope and duct system, HVAC equipment can be evaluated and "sized" properly, often resulting in a decrease equipment size compared to that typically installed in homes with leaks and poor insulation. In addition to building science principles, the marketability of the improvement packages was considered in their development. Although upgrading windows is quite expensive and does not result in a large impact on energy demand (i.e. long payback period), it is a visible improvement that can also result increased home value. The graphs for all three packages are included in Appendix B of this report.

Package 1

For both climate zones, the improvement features in Package 1 were developed following the building science principles described previously. Package 1 represents the basic and required improvements that need to be undertaken before replacing equipment or windows: seal and insulate duct system (if present) to R-6, lower SLA to 3.8, insulate attic to R-30 and insulate HVAC equipment platform to R-19. The cost for this package is low, and allows adoption even by those homeowners who may not have funding to invest in significant home improvement. In addition, Package 1 is designed to align with the investor-owned utilities' (IOU) statewide rebate program for a prescriptive rebate of $1,000.

Package 2

Packages 2 and 3 build on the foundation set by the improvements in Package 1. Package 2 includes all the measures in Package 1 plus upgrades to A/C, furnace and hot water heater equipment. In addition, Package 2 includes window upgrades to vinyl framed dual pane, low emissivity windows with a solar heat gain coefficient value (SHGC) of 0.4 and a U-factor of 0.4[14].

Package 3

Package 3, which also requires all of Package 1, is the most extensive package with high efficiency equipment and windows, resulting in more savings than Package 2, at a slightly higher cost. In Climate Zone 5, Package 3 includes a highly efficient furnace (AFUE 90) as space heating accounts for a larger percentage of the energy consumption profile than space cooling. Additionally, the window upgrade remains the same as in Package 2 (0.4/0.4). As there are more heating days in Climate Zone 5, homes will benefit from a higher SHGC than for Climate Zone 4, which will allow more solar heat through the windows to warm the house. For Climate Zone 4 the A/C is increased to a 14.5 SEER high efficiency unit to lower the energy needed to cool homes. Windows in the Climate Zone 4 Package 3 model are 0.3/0.3 because the improved insulating and solar heat reflecting qualities of lower SHGC and U-factor windows will work to keep homes cooler during hot summers. Tables 16 and 17 show the percent energy savings above the baseline for each package, in both climate zones.

Climate Zone 4

Percent Savings	pre-1960s	1960s	1970s	1980s
Package 1	10.9%	7.0%	14.8%	13.3%
Package 2	48.8%	44.3%	49.8%	48.4%
Package 3	53.0%	48.9%	53.9%	54.8%

Table 16. Percent savings from three packages of improvements in Climate Zone 4.

Climate Zone 5

Percent Savings	pre-1960s	1960s	1970s	1980s
Package 1	9.3%	5.7%	14.5%	14.0%
Package 2	45.1%	41.0%	45.1%	43.8%
Package 3	52.6%	49.2%	52.7%	53.3%

Table17. Percent savings from three packages of improvements in Climate Zone 5.

kWh and Therm Energy Savings per Home

Tables 18 and 19 detail the energy saving effect of the different improvements and packages on homes in Climate Zones 4 and 5. The columns of savings for each decade in the tables represent the modeled estimate of annual savings for a home built in that decade. The final column, Average Savings per Home (all decades), is the weighted average savings for a given home in the climate zone, considering the number of homes and associated savings per decade. Note that the first row (Base) does not represent any *savings*, but rather is the modeled annual *usage* by decade against which savings for improvements were calculated.

[14] SHGC is a measure of how well a window absorbs or reflects heat from the sun; the U-factor describes the insulating value of the window. Lower values for each indicate better performing windows. For complete definitions, see: http://resourcecenter.pnl.gov/cocoon/morf/ResourceCenter/article/1479

ANNUAL SAVINGS PER DECADE & AVERAGE FOR ALL HOMES, CLIMATE ZONE 4

		1930s	1940s	1950s	1960s	1970s	1980s	Average Savings per Home (all decades)
Base	**therm**	**1386.57**	**1313.03**	**1358.77**	**1367.52**	**1511.16**	**975.95**	**-**
	kwh	**21373.50**	**20277.80**	**20959.27**	**17891.24**	**25970.00**	**11729.90**	**-**
R-30	therm	128.24	121.44	125.67	46.32	27.72	14.20	**44.54**
	kwh	5529.92	5236.61	5419.03	1819.42	1999.38	763.45	**2161.35**
R-4.2 Tight Ducts		NO	DUCTS	IN	BASE			
	therm	-	-	-	-	125.03	81.15	**40.35**
	kwh	-	-	-	-	3867.32	1667.57	**974.31**
80% AFUE	therm	457.27	433.01	448.10	428.30	296.35	138.65	**276.35**
	kwh	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
13.0 SEER	therm	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
	kwh	9158.01	8672.26	8974.37	6806.18	9744.64	3200.32	**6439.48**
80% CFL	therm	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
	kwh	945.51	916.38	934.50	982.46	1040.00	1106.79	**1039.43**
90% AFUE	therm	529.62	501.53	519.00	499.70	395.06	191.75	**346.53**
	kwh	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
0.62 EF	therm	49.32	46.70	48.33	52.64	57.80	63.80	**57.75**
	kwh	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
0.40 / 0.40 Windows	therm	74.63	70.67	73.14	137.73	105.10	121.55	**109.33**
	kwh	4649.80	4403.17	4556.56	4463.31	5994.15	4529.4	**4885.53**
Tankless W/H	therm	103.85	98.34	101.77	110.84	121.72	134.35	**121.61**
	kwh	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
PACKAGE 1	**therm**	**100.76**	**95.42**	**98.74**	**66.91**	**193.88**	**128.55**	**130.99**
	kwh	**3630.35**	**3437.80**	**3557.56**	**1975.37**	**4427.57**	**1323.21**	**2628.29**
PACKAGE 2	**therm**	**578.98**	**548.27**	**567.37**	**530.81**	**592.30**	**388.85**	**492.81**
	kwh	**12451.94**	**11791.49**	**12202.26**	**9364.25**	**16676.07**	**7162.63**	**10809.41**
PACKAGE 3	**therm**	**636.14**	**602.40**	**623.38**	**591.36**	**658.80**	**458.70**	**557.83**
	kwh	**13293.55**	**12588.46**	**13026.99**	**10162.13**	**17552.29**	**7568.53**	**11464.73**

Table 18. Annual savings per decade and average for all homes for individual and packages of improvements for Climate Zone 4.

ANNUAL SAVINGS PER DECADE & AVERAGE FOR ALL HOMES, CLIMATE ZONE 5

		1930s	1940s	1950s	1960s	1970s	1980s	Average Savings per Home (all decades)
Base	**therm**	**1429.66**	**1353.83**	**1401.00**	**1411.86**	**1583.46**	**964.65**	--
	kwh	**11469.03**	**8622.68**	**21243.78**	**20595.17**	**59746.76**	**46440.10**	--
R-30	therm	126.50	119.79	123.96	43.77	23.19	13.20	**42.34**
	kwh	2786.48	2087.64	5154.74	1751.71	4281.41	1688.19	**1005.02**
R-4.2 Tight Ducts		NO	DUCTS	IN	BASELINE			
	therm	-	-	-	-	139.12	84.20	**38.51**
	kwh	-	-	-	-	7946.25	4843.90	**342.18**
80% AFUE	therm	474.04	448.90	464.54	445.01	313.66	135.40	**284.63**
	kwh	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
13.0 SEER	therm	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
	kwh	3766.28	2821.71	6967.28	5548.78	16704.99	6410.72	**2390.50**
80% CFL	therm	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
	kwh	945.51	725.01	1764.11	2075.18	4514.02	8334.01	**1039.43**
90% AFUE	therm	549.06	519.94	538.05	519.21	418.25	187.20	**356.59**
	kwh	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
0.62 EF	therm	49.28	46.67	48.29	52.59	57.76	63.75	**57.71**
	kwh	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
0.40 / 0.40 Windows	therm	90.33	85.53	88.51	158.65	125.07	131.85	**124.33**
	kwh	3104.77	2326.11	5743.56	5931.81	17333.08	14520.66	**2772.14**
Tankless W/H	therm	103.58	98.09	101.51	110.55	121.40	134.00	**121.30**
	kwh	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
PACKAGE 1	**therm**	**102.04**	**96.62**	**99.99**	**66.33**	**211.55**	**133.90**	**137.80**
	kwh	**1790.82**	**1341.69**	**3312.86**	**1841.08**	**9888.15**	**4766.66**	**1298.95**
PACKAGE 2	**therm**	**599.23**	**567.45**	**587.21**	**549.45**	**636.37**	**395.85**	**512.99**
	kwh	**5737.20**	**4298.34**	**10613.32**	**8684.49**	**33173.72**	**19519.03**	**4644.36**
PACKAGE 3	**therm**	**731.68**	**692.87**	**717.01**	**687.72**	**788.22**	**501.35**	**638.81**
	kwh	**5737.20**	**4298.34**	**10613.32**	**8684.49**	**33173.72**	**19519.03**	**4644.36**

Table 19. Annual savings per decade and average for all homes for individual and packages of improvements for Climate Zone 5.

Carbon Reduction from Packages

A homeowner's investment in an energy-efficiency retrofit will result in decreased energy bills plus increased comfort and home value. The reduction in energy demand will benefit jurisdictions throughout SLOC in the form of reduced carbon emissions, providing progress toward meeting their AB 32 goals. The savings detailed in Tables 17 and 18 have been converted into carbon reduction[15] for the three packages of improvements in Table 20.

Carbon Reduction per Home (MTCO2e/year)

	Package 1	Package 2	Package 3
CZ 4	1.1	4.2	4.6
CZ 5	0.9	3.4	4.1

Table 20. Carbon reduction per home from each of three packages in both SLOC climate zones

If the carbon reduction calculations per home are applied to a small percent of the parcels identified by the *REiSource* search, more significant reduction could be realized throughout the county. Tables 21 and 22 demonstrate the carbon reduction resulting from one percent of the identified housing units retrofitting their homes with the three different packages. The numbers reflect the proportion of houses in Climate Zone 4 (6,614 units) and Climate Zone 5 (12,584 units) and the carbon reduction per home calculation from Table 20. Therefore, in Table 21 the column for Package 1 assumes that *one percent* of all of the houses identified in the *REiSource* search choose the improvements in Package 1. The Package 2 column assumes *one percent* of all (19,198 units) choose Package 2; the Package 3 column assumes the same one percent choose Package 3 improvements. The same logic applies to Table 22, except that the savings reflects a *five percent* market penetration.

Carbon Reduction
1% Market Penetration (MTCO2e/year)

	Package 1	**Package 2**	**Package 3**
CZ 4	72.75	277.79	304.24
CZ 5	113.26	427.86	515.94

Table 21. Carbon reduction resulting from a 1% market penetration for each of the three packages in both climate zones.

Carbon Reduction
5% Market Penetration(MTCO2e/year)

	Package 1	**Package 2**	**Package 3**
CZ 4	376.30	1332.87	1485.97
CZ 5	578.86	2132.99	2554.55

Table 22. Carbon reduction resulting from a 5% market penetration for each of the three packages in both climate zones.

In addition to the carbon savings, the money invested in retrofits will have economic benefits for the community. The federal government calculates that one new job is created for every $92,000 invested[16]. Using the previous calculation for average carbon reduction per home for each of the three packages (Table 20), and then calculating the average cost for each package, an estimate of

[15] MTCO2e/yr: metric tons of carbon dioxide equivalent per year
[16] http://www.whitehouse.gov/assets/documents/Job-Years_Revised5-8.pdf

job creation potential can be calculated. Tables 24-27 show the calculated carbon reduction and job savings under a 1%, 5%, 20% and 100% penetration rates. Additionally, the numbers were calculated with an assumed distribution of 25% for Package 1, 50% for Package 2 and 25% for Package 3. As an example, consider the calculation for Package 1 in Climate Zone 4, under the one percent market penetration scenario:

Housing Units in CZ 4: ***6,614***
1% Market Penetration: ***66.14 units***
25% of 66.14 Units Choosing Package 1: ***16.54 units***
Carbon Reduction for Package 1 in CZ 4: ***1.14 MTCO2e/year***
Average Cost for Package 1 in CZ 4: ***$4,192.78***
US Government Estimate for Cost of 1 Job Creation: ***$92,000***

Carbon Reduction:
→ *16.54 units* x *1.14 MTCO2e/year = 18.8 MTCO2e/year*
Job Creation Potential:
→ *16.54 units* x *$4,192.78 = $69,327.53* **→ *$69,327.53 ÷ $92,000 = .75 jobs***

			25%	**50%**	**25%**
# Units		**Per Home**	**Package 1**	**Package 2**	**Package 3**
6614	CZ 4	Carbon Reduction	1.14	4.03	4.49
		Avg. Cost	$ 4,192.78	$ 17,006.78	$ 20,514.67
12584	CZ 5	Carbon Reduction	0.92	3.39	4.06
		Avg. Cost	$ 4,192.78	$ 17,006.78	$ 18,406.78

Table 23. Average per home cost and carbon reduction for each of the three packages.

1%	**Market Penetration Scenario**				
	Package 1: 25%	Package 2: 50%	Package 3: 25%	**Total**	**Jobs Created**
CZ 4- (66.14 units)	16.5	33.1	16.5	**66.14**	
Carbon Reduction	18.8	133.3	74.3	**226.4 MTCO2e/yr**	
Cost for Retrofit Work	$ 69,327.53	$ 562,414.05	$ 339,209.99	**$ 970,951.57**	
Potential Job Creation	0.75	6.11	3.69		**11**
CZ 5- (125.84 units)	31.5	62.9	31.5	**125.84**	
Carbon Reduction	28.9	213.3	127.7	**370.0 MTCO2e/yr**	
Cost for Retrofit Work	$ 131,904.70	$ 1,070,066.28	$ 579,077.14	**$ 1,781,048.13**	
Potential Job Creation	1.43	11.63	6.29		**19**
				Total Job Creation	**30**

Table 24. Jobs created and carbon reduced under 1% market penetration scenario.

5%	**Market Penetration Scenario**				
	Package 1: 25%	Package 2: 50%	Package 3: 25%	**Total**	**Jobs Created**
CZ 4- (330.7 units)	82.7	165.4	82.7	**330.7**	
Carbon Reduction	94.1	666.4	371.5	**1132.0 MTCO2e/yr**	
Cost for Retrofit Work	$ 346,637.67	$ 2,812,070.25	$ 1,696,049.93	**$ 4,854,757.85**	
Potential Job Creation	3.77	30.57	18.44		**53**
CZ 5- (629.2 units)	157.3	314.6	157.3	**629.2**	
Carbon Reduction	144.7	1066.5	638.6	**1849.8 MTCO2e/yr**	
Cost for Retrofit Work	$ 659,523.51	$ 5,350,331.42	$ 2,895,385.71	**$ 8,905,240.63**	
Potential Job Creation	7.17	58.16	31.47		**97**
				Total Job Creation	**150**

Table 25. Jobs created and carbon reduced under 5% market penetration scenario.

20%	**Market Penetration Scenario**				
	Package 1: 25%	Package 2: 50%	Package 3: 25%	**Total**	**Jobs Created**
CZ 4- (1322.8 units)	331	661	331	**1323**	
Carbon Reduction	376.3	2665.7	1486.0	**4528.0 MTCO2e/yr**	
Cost for Retrofit Work	$1,386,550.69	$11,248,280.99	$6,784,199.72	**$ 19,419,031.39**	
Potential Job Creation	15.07	122.26	73.74		**211**
CZ 5- (2516.8 units)	629	1,258	629	**2,517**	
Carbon Reduction	578.9	4266.0	2554.6	**7399.4 MTCO2e/yr**	
Cost for Retrofit Work	$2,638,094.03	$21,401,325.66	$11,581,542.83	**$ 35,620,962.52**	
Potential Job Creation	28.67	232.62	125.89		**387**
				Total Job Creation	**598**

Table 26. Jobs created and carbon reduced under 20% market penetration scenario.

100%	**Market Penetration Scenario**				
	Package 1: 25%	**Package 2: 50%**	**Package 3: 25%**	**Total**	**Jobs Created**
CZ 4- (6614 units)	1654	3307	1654	**6614**	
Carbon Reduction	1881.5	13328.7	7429.9	**22640.1 MTCO2e/yr**	
Cost for Retrofit Work	$6,932,753.46	$56,241,404.93	$33,920,998.58	**$ 97,095,156.97**	
Potential Job Creation	75.36	611.32	368.71		**1,055**
CZ 5- (12584 units)	3,146	6,292	3,146	**12,584**	
Carbon Reduction	2894.3	21329.9	12772.8	**36997.0 MTCO2e/yr**	
Cost for Retrofit Work	$13,190,470.15	$107,006,628.30	$57,907,714.15	**$ 178,104,812.60**	
Potential Job Creation	143.37	1,163.12	629.43		**1,936**
				Total Job Creation	**2,991**

Table 27. Jobs created and carbon reduced under 100% market penetration scenario.

Conclusion: "*Selling Homeowners on Retrofit Improvements"*

The existing housing stock in SLOC presents great opportunities for SLOC contractors and jurisdictions to reduce carbon emissions while stimulating the economy. With many areas of the state and country experiencing extremely high levels of "under water" homes, it is encouraging to know that over 35% of the target market for retrofits (SFOO housing units built 1990 or before) in SLOC are of positive or zero equity. If housing units of unknown equity are included, the number of not "under water" units increases to 19,198 or about 43%. As the numbers for market penetration demonstrates, if only 1% of these homes are retrofitted 30 new jobs will be created and 421 metric tons of carbon dioxide equivalents per year would be avoided.

However, at present the decision to retrofit a housing unit is not up to governments or contractors; it is the homeowner's decision alone. In these uncertain economic times not many homeowners are -likely to be willing to invest up to $20,000 out-of-pocket to lower their utility bills, regardless of the payback period. Thankfully there are several rebate and incentive programs that are or will be soon available to homeowners in SLOC.

The Investor Owned Utilities (IOUs) have developed a statewide home performance retrofit rebate program that is scheduled to launch "this fall" according to the California Public Utilities Commission[17]. PG&E will soon be offering a flat rate prescriptive rebate of $1,000 which aligns with Package 1. Packages 2 and 3 will meet the requirements of the performance rebate program which requires a minimum of 20% energy savings and will reimburse $2,000 for 20% and $500 for each additional 5% savings, up to $3,500. The CEC recently proposed to extend and expand the "Cash for Appliances" program and will vote on approval at its July 28th business meeting. "Cash for Appliances" will soon offer rebates for not only kitchen appliances, but also water heaters (up to $750) and HVAC equipment ($1,000)[18].

The federal government continues to offer tax incentives[19] of up to 30% of the cost of energy efficiency work through the Department of Energy's ENERGY STAR® program. Tax incentives are calculated after subtracting all other available rebates from the total cost. Table 28 provides an example of the tally of the rebates and tax incentives available to mitigate costs for each package.

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[17] ConSol has actively participated in workshops for the development of the rebate program. No firm date has been set for launch.

[18] http://www.cash4appliances.org/

[19] http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US43F&re=0&ee=1

Per Home		**Package 1**	**Package 2**	**Package 3**
CZ 4	Avg. Cost	$ 4,192.78	$ 17,006.78	$ 20,514.67
	Avg. Pack Savings	12%	46%	51%
Rebates	IOU (PG&E)	$ 1,000.00	$ 3,500.00	$ 3,500.00
	PG&E	$ 30.00	-	-
	Cash for Appliances	-	$ 500.00	$ 1,200.00
	Estimated Rebate	$ 1,030.00	$ 4,000.00	$ 4,700.00
	Total After Rebates	$ 3,162.78	$ 13,006.78	$ 15,814.67
	Fed Tax Incentive	$ 948.83	$ 1,500.00	$ 1,500.00
	Est. Final Cost	***$ 2,213.94***	***$ 11,506.78***	***$ 14,314.67***
	Savings % from Rebates	***47%***	***32%***	***30%***
CZ 5	Avg. Cost	$ 4,192.78	$ 17,006.78	$ 18,406.78
	Avg. Pack Savings	11%	42%	50%
Rebates	IOU (PG&E)	$ 1,000.00	$ 3,500.00	$ 3,500.00
	PG&E	$ 30.00	-	-
	Cash for Appliances	-	$ 500.00	$ 1,200.00
	Estimated Rebate	$ 1,030.00	$ 4,000.00	$ 4,700.00
	Total After Rebates	$ 3,162.78	$ 13,006.78	$ 13,706.78
	Fed Tax Incentive	$ 948.83	$ 1,500.00	$ 1,500.00
	Est. Final Cost	***$ 2,213.94***	***$ 11,506.78***	***$ 12,206.78***
	Savings % from Rebates	***47%***	***32%***	***34%***

Table 28. Estimated rebate amounts and final costs for packages by climate zone.

One other potential source of rebates is the *Home Star* bill which is currently being discussed and debated in the US Senate. As it has not yet been passed and there is potential for both changes to the content, or failure to pass the bill, it is not included as part of the calculation in Table 28 for rebates and package costs. *Home Star* consists of two levels of rebate amounts, similar to the IOU program, corresponding to the level and type of retrofit work: *Silver Star* and *Gold Star*. The *Silver Star* rebates will reimburse prescriptive improvements for up to$3,000, while the *Gold Star* program will pay for performance retrofit work that results in a minimum of 20% energy savings with the rebate maximum at $8,000[20]. *Home Star* could be a major tool to encourage homeowners to retrofit their homes, but as yet it is only in discussion and is not included in the above rebate analysis.

Contractor Requirements for Rebates and Financing

Both *Home Star* and the statewide IOU performance rebate programs require that participating contractors be Building Performance Institute (BPI)[21]-certified or similar to take advantage of rebates. (*Home Star* performance work can also be done by a RESNET certified contractor). BPI-certification ensures that a contractor is trained in the basics of building science and understands the house-as-a-system approach to retrofits. All levels of rebates under *Home Star* and the IOU statewide program will require proof of licensing and insurance as well.

[20] http://homestarcoalition.org/documents/HOME_STAR_Fact_Sheet.pdf
[21] http://www.bpi.org/

Appendix A. Cities by Climate Zone, Housing Units by Decade*

Climate Zone 4:

City	Climate Zone	TOTAL HOUSING UNITS 2000	SFOO 2000	% SF OO	BUILT 1939 or BEFORE	1940-59	1960-69	1970-79	1980-89	1990-2000	1990 ONLY	TOTAL
Atascadero	4	9851	5427	55%	533	1,301	1,274	2,696	2,672	1,375	NA	9851
				ESTIMATE	*294*	*717*	*702*	*1485*	*1472*	*757*	NA	5427
			REiSource Data	*Qualified HU*	*177*	*360*	*271*	*955*	*856*		102	2721
California Valley	4		*REiSource Data*	*Qualified HU*	0	0	2	2	3		7	14
Creston	4		*REiSource Data*	*Qualified HU*	2	3	4	18	30		5	62
Paso Robles	4	8783	4504	51%	535	1154	727	1529	2998	1840	NA	8783
				ESTIMATE	*274*	*592*	*373*	*784*	*1537*	*944*	NA	4504
			REiSource Data	*Qualified HU*	*130*	*279*	*134*	*497*	*1611*		200	2851
San Miguel	4	527	202	38%	54	120	24	76	158	95	NA	527
				ESTIMATE	*21*	*46*	*9*	*29*	*61*	*36*	NA	202
			REiSource Data	*Qualified HU*	*10*	*21*	*1*	*8*	*46*		10	96
Santa Margarita	4		*REiSource Data*	*Qualified HU*	*30*	*21*	*9*	*37*	*45*		1	143
Shandon	4	286	156	55%	26	49	15	37	84	85	NA	296
				ESTIMATE	*14*	*27*	*8*	*20*	*46*	*46*	NA	161
			REiSource Data	*Qualified HU*	*7*	*4*	*1*	*8*	*14*		2	36
Templeton	4	1639	1095	67%	69	63	83	157	686	581	NA	1639
				ESTIMATE	*46*	*42*	*55*	*105*	*458*	*388*	NA	1095
			REiSource Data	*Qualified HU*	32	34	16	117	428		64	691
***Blue font indicates numbers taken from US Census. Estimates are for SFOO homes based on the fraction of SFOO in Total Housing Units in 2000, according to the US Census.												*6614*

Table A-1. Climate Zone 4 housing units by jurisdiction and decade.

* Rows showing "*ESTIMATE*" are based on the *Census 2000* data for the percent of all housing units that are classified as "single family owner-occupied" (SFOO). The "*ESTIMATE*" numbers apply the percent of *Census 2000* housing units that are SFOO to the housing units by decade from the census to give an estimate of what percentage of all housing units by decade are represented by the *REiSource* housing units. The "*ESTIMATE*" numbers are solely for comparison purposes.

Climate Zone 5:

City	Climate Zone	TOTAL HOUSING UNITS 2000	SFOO 2000	% SF OO	BUILT 1939 or BEFORE	1940-59	1960 -69	1970-79	1980-89	1990-2000	1990 ONLY (REi)	TOTAL
Arroyo	5	6806	3904	57%	292	1,035	958	1,931	1,371	1,219	NA	6806
Grande				*ESTIMATE*	*167*	*594*	*550*	*1108*	*786*	*699*	NA	3904
			REiSource Data	*Qualified HU*	*111*	*399*	*334*	*710*	*833*		119	2506
Cambria	5	3750	1936	52%	199	342	460	728	1206	815	NA	3750
				ESTIMATE	*103*	*177*	*237*	*376*	*623*	*421*	NA	1936
			REiSource Data	*Qualified HU*	*41*	*60*	*130*	*206*	*440*		19	896
Cayucos	5	2262	618	27%	169	398	461	471	448	315	NA	2262
				ESTIMATE	*46*	*109*	*126*	*129*	*122*	*86*	NA	618
			REiSource Data	*Qualified HU*	*32*	*83*	*33*	*69*	*58*		5	280
Grover	5	5368	2194	41%	163	949	811	1358	1193	894	NA	5368
Beach				*ESTIMATE*	*67*	*388*	*331*	*555*	*488*	*365*	NA	2194
			REiSource Data	*Qualified HU*	*16*	*205*	*83*	*150*	*207*		31	692
Los Osos-	5	6214	3329	54%	74	525	965	2927	1406	278	NA	6175
Baywood				*ESTIMATE*	*40*	*281*	*517*	*1568*	*753*	*149*	NA	3308
			REiSource Data	*Qualified HU*	16	127	250	910	505		16	1824
Morro Bay	5	6286	2277	36%	348	1461	1186	1551	882	858	NA	6286
				ESTIMATE	*126*	*529*	*430*	*562*	*319*	*311*	NA	2277
			REiSource Data	*Qualified HU*	*60*	*364*	*164*	*262*	*141*		40	1031
Nipomo	5	4417	2568	58%	59	324	505	879	1203	1177	NA	4147
				ESTIMATE	*34*	*188*	*294*	*511*	*699*	*684*	NA	2411
			REiSource Data	*Qualified HU*	*21*	*39*	*124*	*205*	*622*		141	1152
Oceano	5	2755	812	29%	194	332	311	895	553	470	NA	2755
				ESTIMATE	*57*	*98*	*92*	*264*	*163*	*139*	NA	812
			REiSource Data	*Qualified HU*	*20*	*51*	*33*	*74*	*96*		3	277

City	Climate Zone	TOTAL HOUSING UNITS 2000	SFOO 2000	% SF OO	BUILT 1939 or BEFORE	1940-59	1960 -69	1970-79	1980-89	1990-2000	1990 ONLY (REi)	TOTAL
Pismo Beach	5	5493	1915	35%	245	873	579	1110	1639	1047	NA	5493
				ESTIMATE	*85*	*304*	*202*	*387*	*571*	*365*	NA	1915
			REiSource Data	*Qualified HU*	*23*	*119*	*76*	*82*	*415*		32	747
San Luis	4/5	19340	6107	32%	2193	3632	3035	5245	3436	1799	NA	19340
Obispo				*ESTIMATE*	*692*	*1147*	*958*	*1656*	*1085*	*568*	NA	6107
			REiSource Data	*Qualified HU*	*351*	*708*	*610*	*390*	*911*		92	3062
Santa Maria	5		*REiSource Data*	*Qualified HU*	*0*	*1*	*2*	*4*	*6*		1	14
Shell Beach*	5		*REiSource Data*	*Qualified HU*	*2*	*34*	*19*	*13*	*30*		5	103
***Blue font indicates numbers taken from US Census. Estimates are for SFOO homes based on the												
fraction of SFOO in Total Housing Units in 2000, according to the US Census.												
*** Shell Beach is a Census Designated Place in Pismo Beach.**											Total	*12584*

Table A-2. Climate Zone 5 housing units by jurisdiction and decade.

Appendix B. Effectiveness of Individual Improvements on Homes by Decade and Climate Zone

Effectiveness of Measures in pre1940s Homes, Climate Zone 4

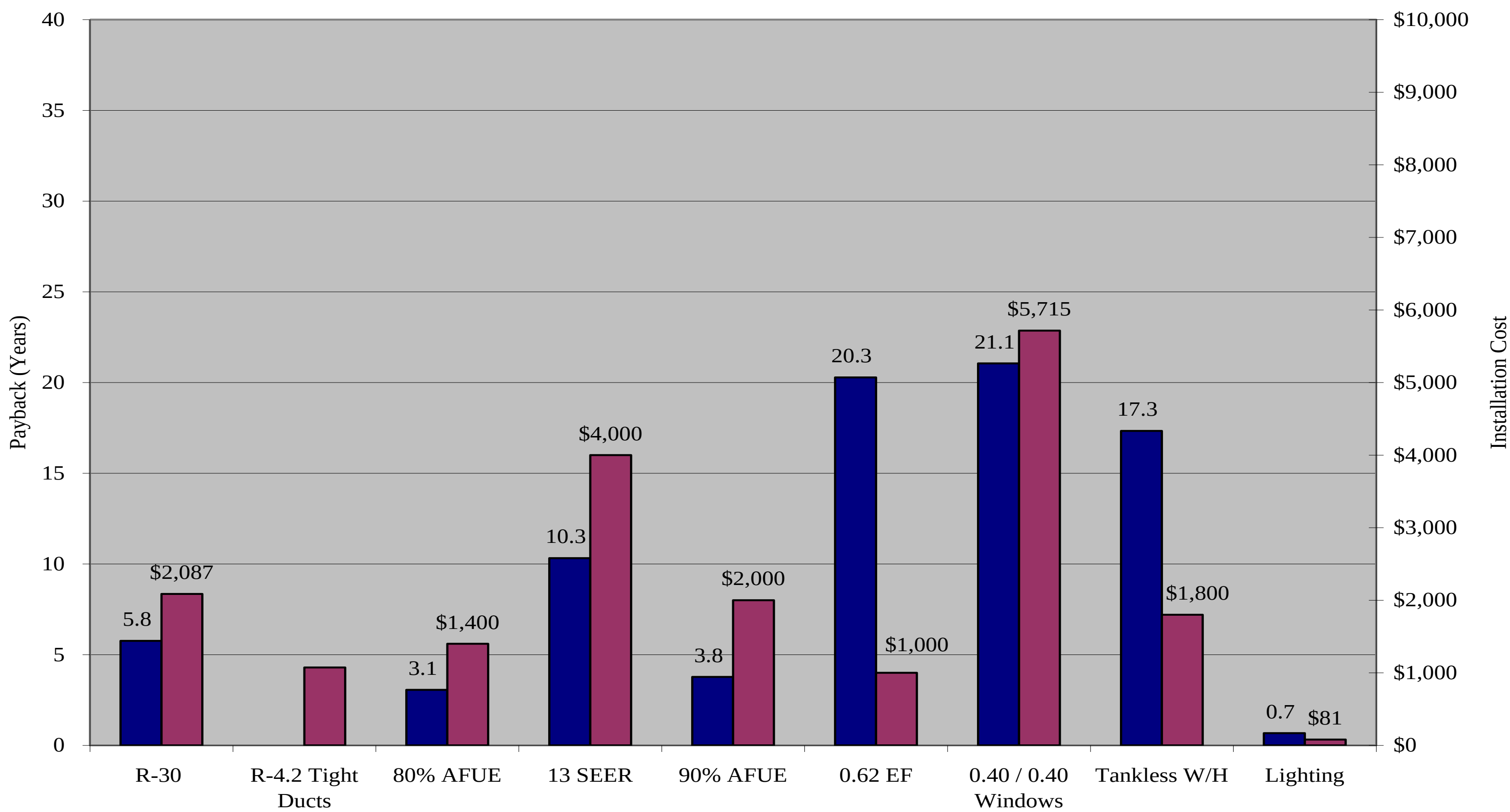

Figure B-1. Effectiveness of modeled energy efficiency upgrades on homes built prior to the 1940s in Climate Zone 4. Blue bars indicate payback period in years, purple bars show cost for improvements.

Of note in Figure 1 is the long payback periods for water heaters (.62 and Tankless) and windows. Window replacement is generally regarded as having one of the longest payback periods, but nonetheless a very popular upgrade for aesthetic and property value improvement. As was previously discussed, the models assume that homes built before 1970 do not contain ducted air heating and cooling. Therefore Figure 1 shows no payback period for insulating and sealing of ducts as there is no duct system present in the modeled homes.

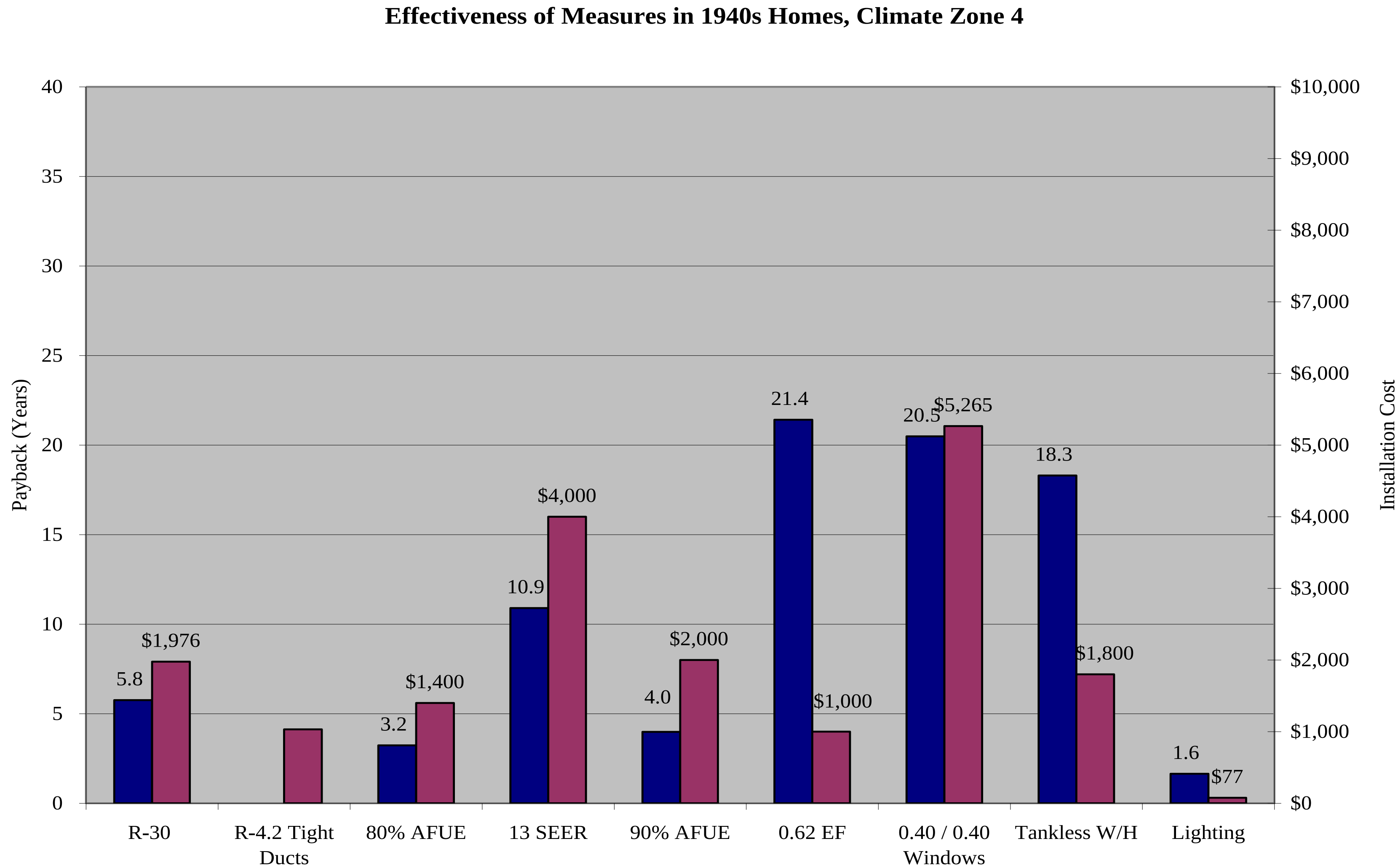

Figure B-2. Effectiveness of modeled energy efficiency upgrades on homes built during the 1940s in Climate Zone 4. Blue bars indicate payback period in years, purple bars show cost for improvements.

The graphs for homes built in the 1940s are very similar to those of homes built prior to 1940. The slight differences reflect the minor upgrades in attic space insulation and increases in the assumed window area and conditioned floor area by decade.

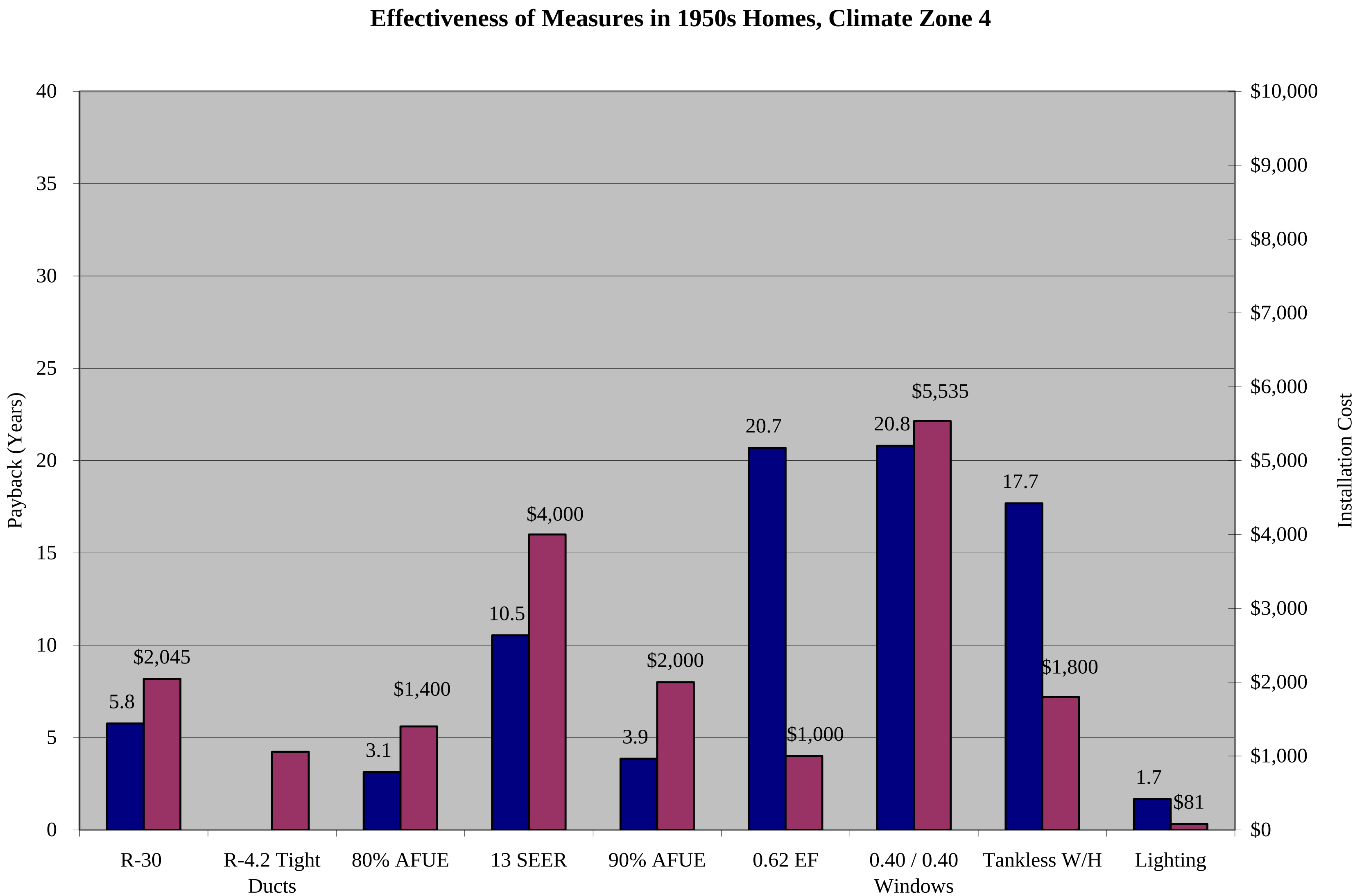

Figure B-3. Effectiveness of modeled energy efficiency upgrades on homes built during the 1950s in Climate Zone 4. Blue bars indicate payback period in years, purple bars show cost for improvements

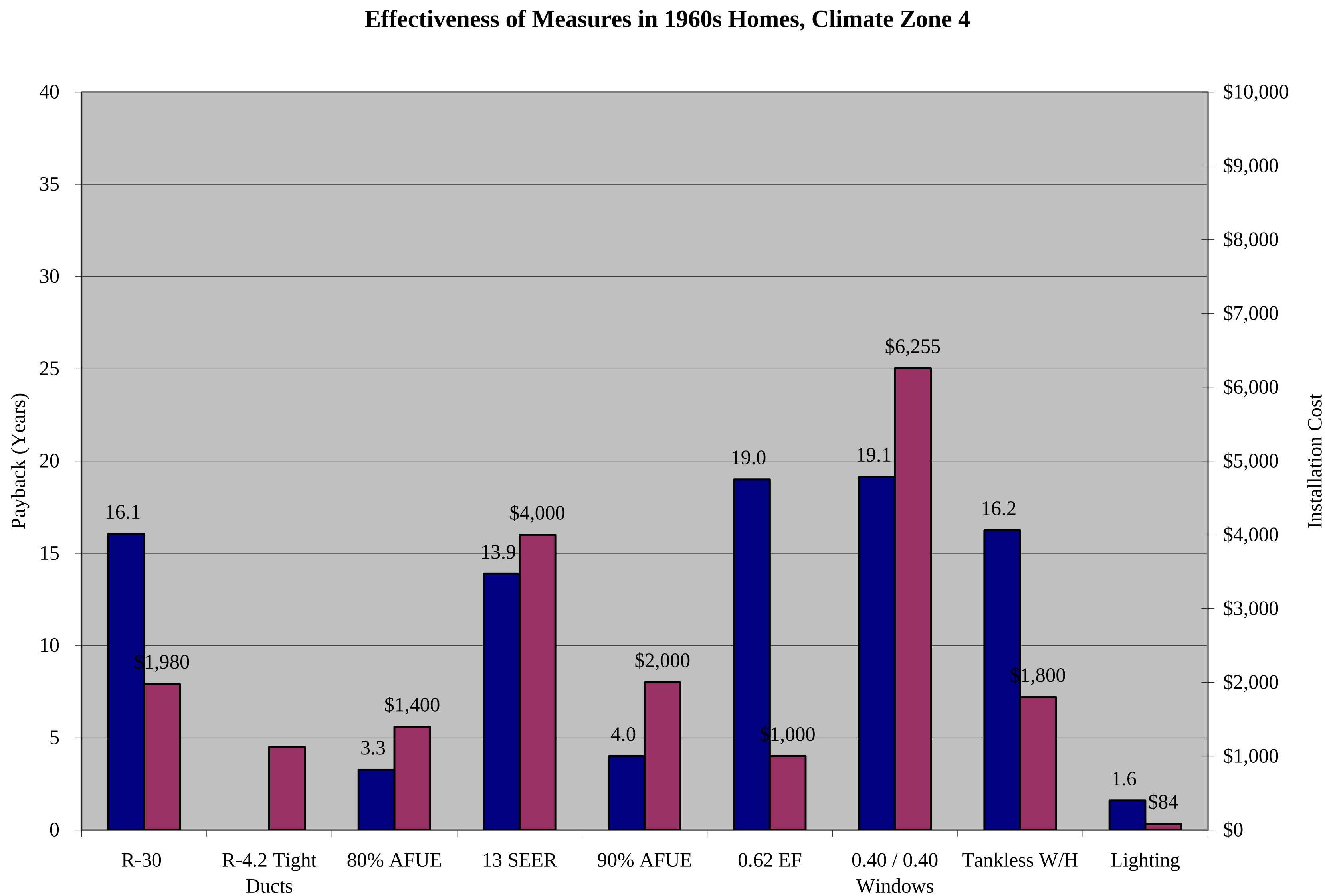

Figure B-4. Effectiveness of modeled energy efficiency upgrades on homes built during the 1960s in Climate Zone 4. Blue bars indicate payback period in years, purple bars show cost for improvements.

Effectiveness of Measures in 1970s Homes, Climate Zone 4

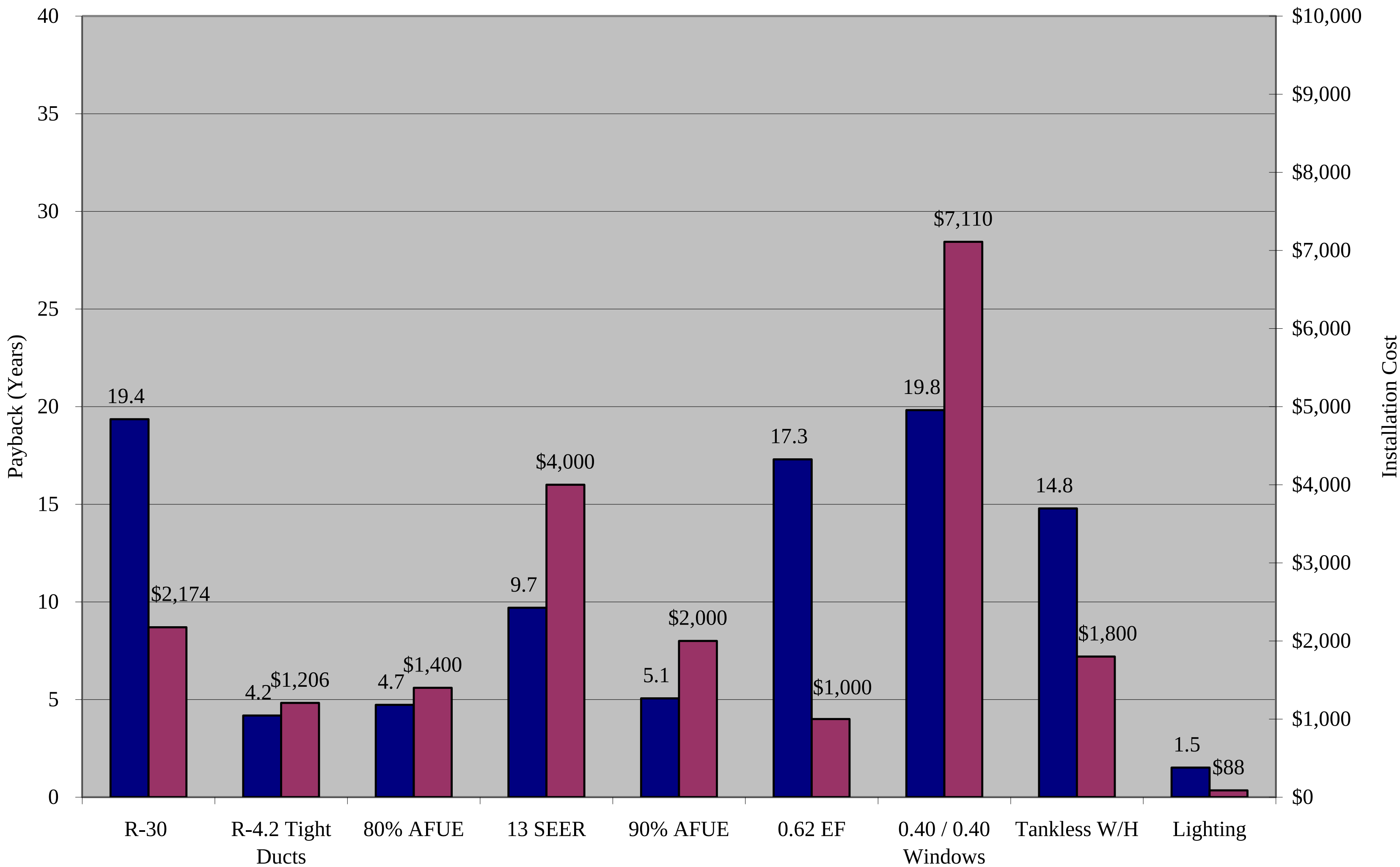

Figure B-5. Effectiveness of modeled energy efficiency upgrades on homes built during the 1970s in Climate Zone 4. Blue bars indicate payback period in years, purple bars show cost for improvements

Effectiveness of Measures in 1980s Homes, Climate Zone 4

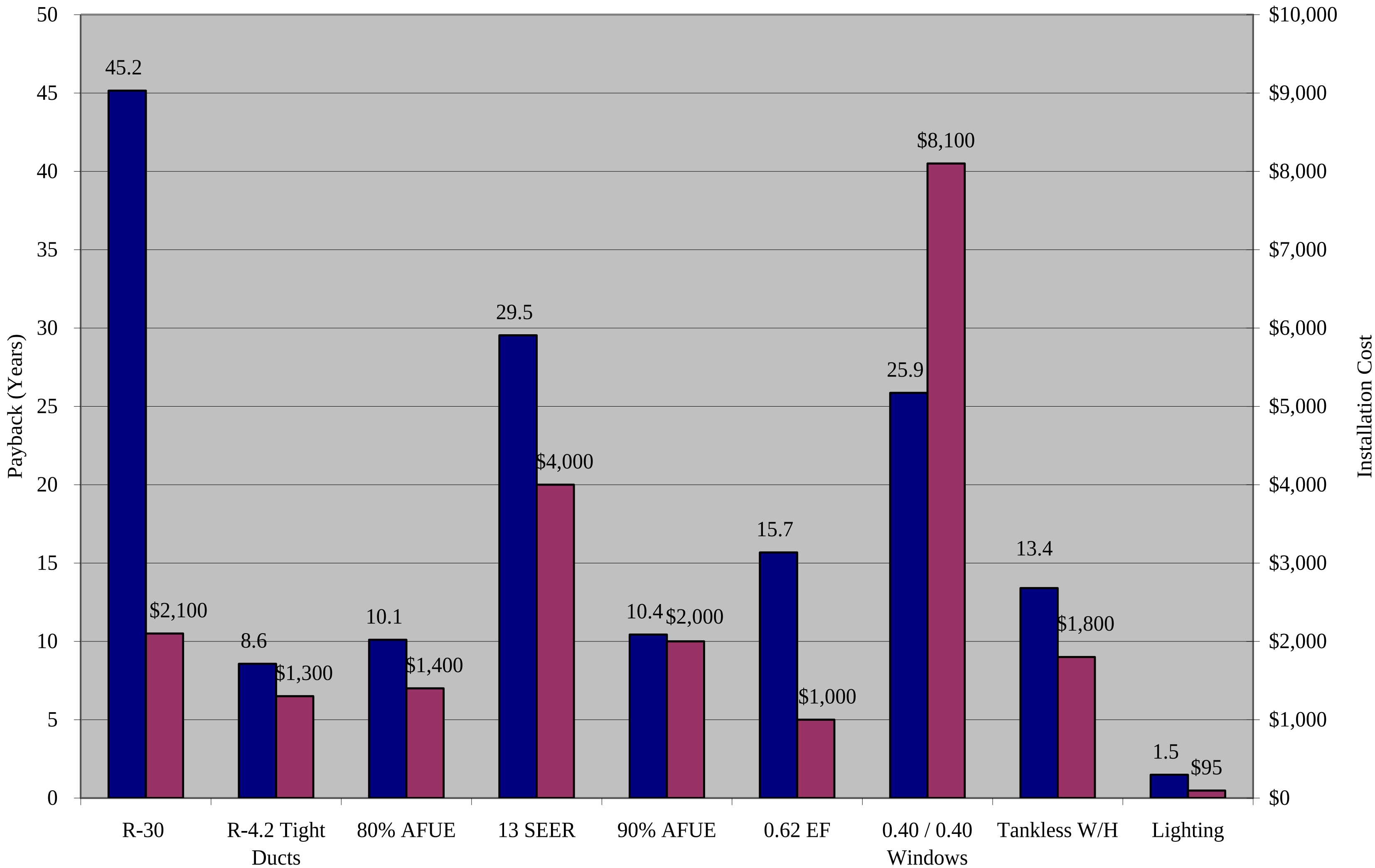

Figure B-6. Effectiveness of modeled energy efficiency upgrades on homes built during the 1980s in Climate Zone 4. Blue bars indicate payback period in years, purple bars show cost for improvements

Climate Zone 5

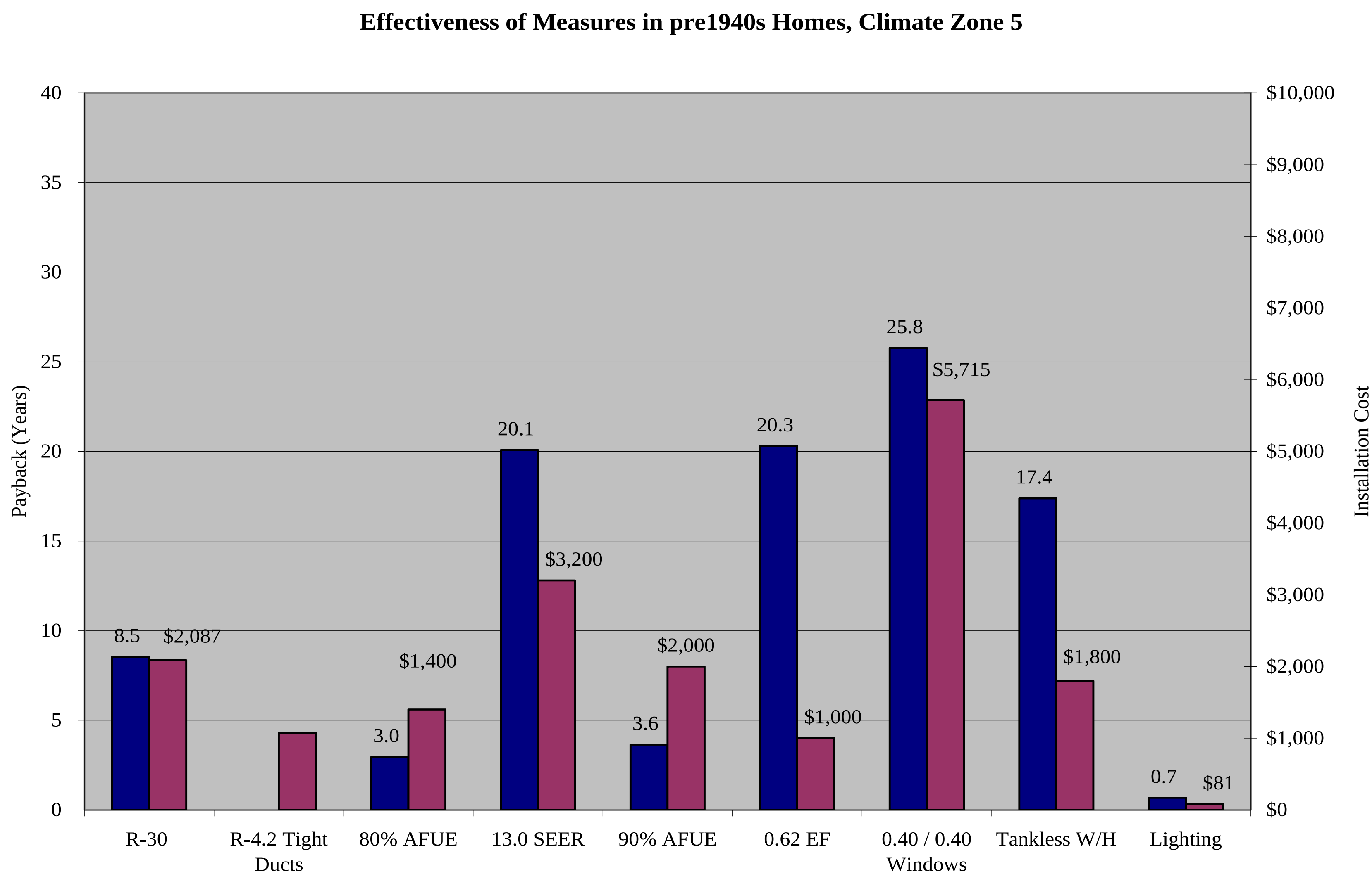

Figure B-7. Effectiveness of modeled energy efficiency upgrades on homes in Climate Zone 5 built prior to the 1940s. Blue bars indicate payback period in years, purple bars show cost for improvements

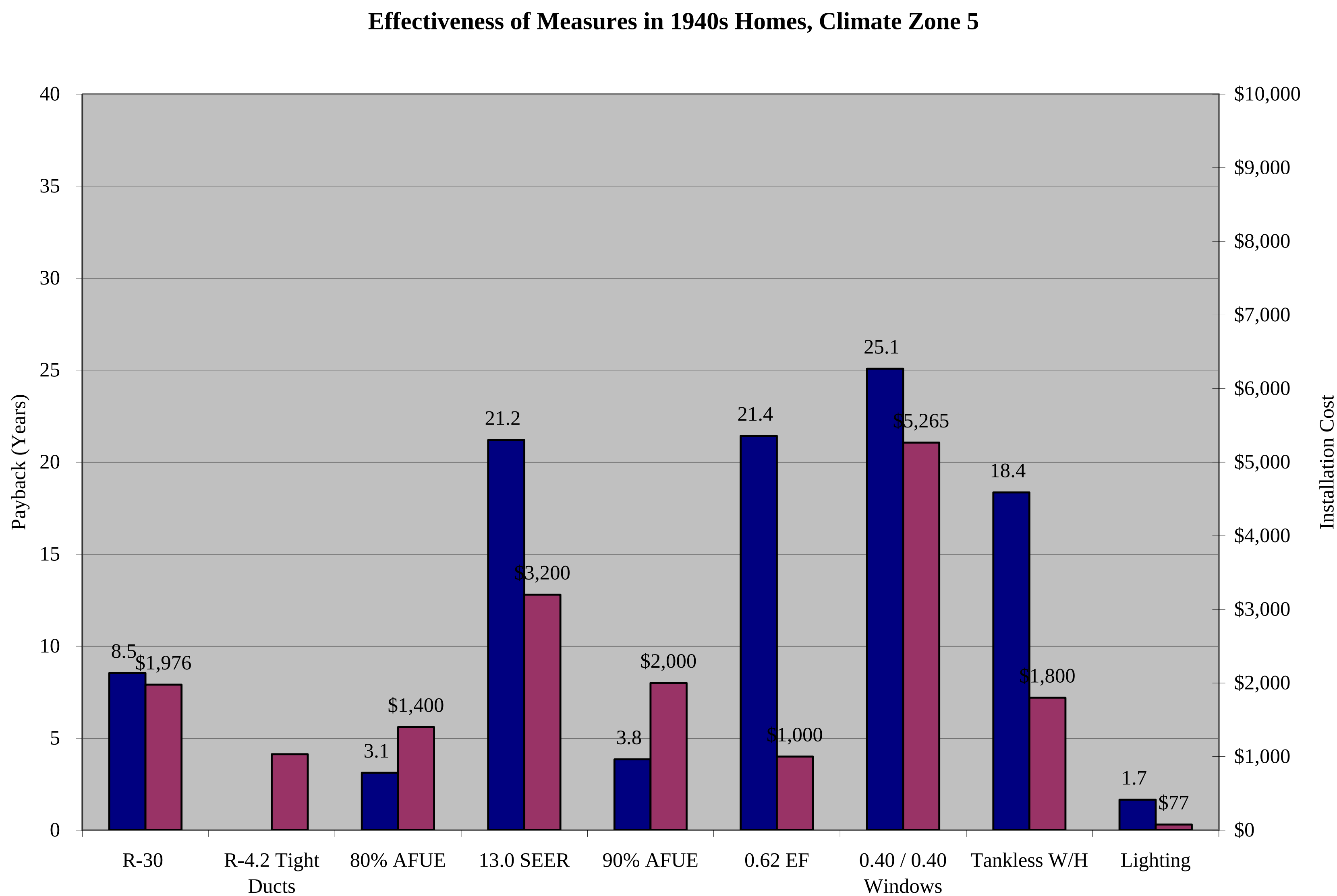

Figure B-8. Effectiveness of modeled energy efficiency upgrades on homes in Climate Zone 5 built during the 1940s. Blue bars indicate payback period in years, purple bars show cost for improvements.

Effectiveness of Measures in 1950s Homes, Climate Zone 5

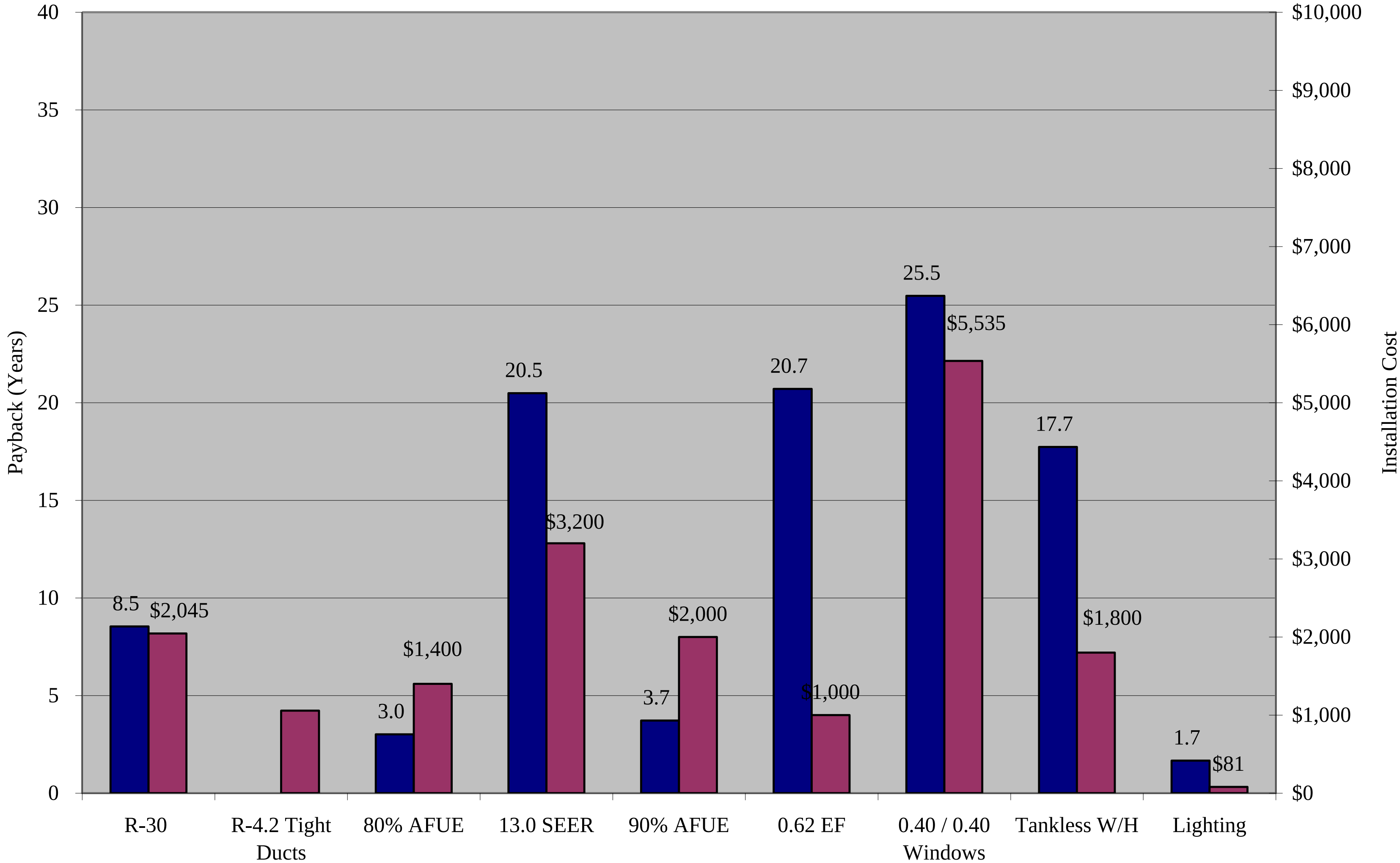

Figure B-9. Effectiveness of modeled energy efficiency upgrades on homes in Climate Zone 5 built during the 1950s. Blue bars indicate payback period in years, purple bars show cost for improvements

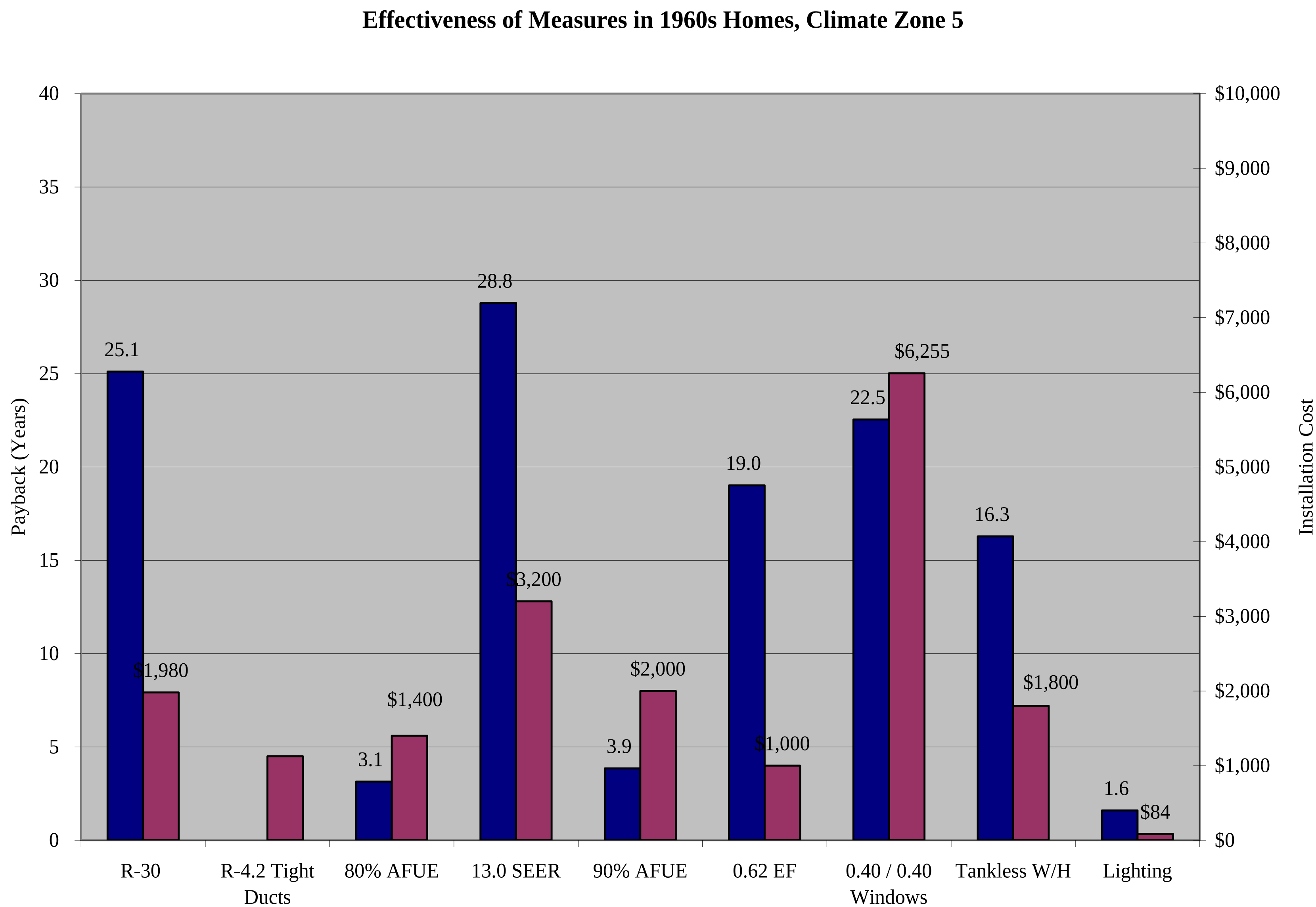

Figure B-10. Effectiveness of modeled energy efficiency upgrades on homes in Climate Zone 5 built during the 1960s. Blue bars indicate payback period in years, purple bars show cost for improvements.

Effectiveness of Measures in 1970s Homes, Climate Zone 5

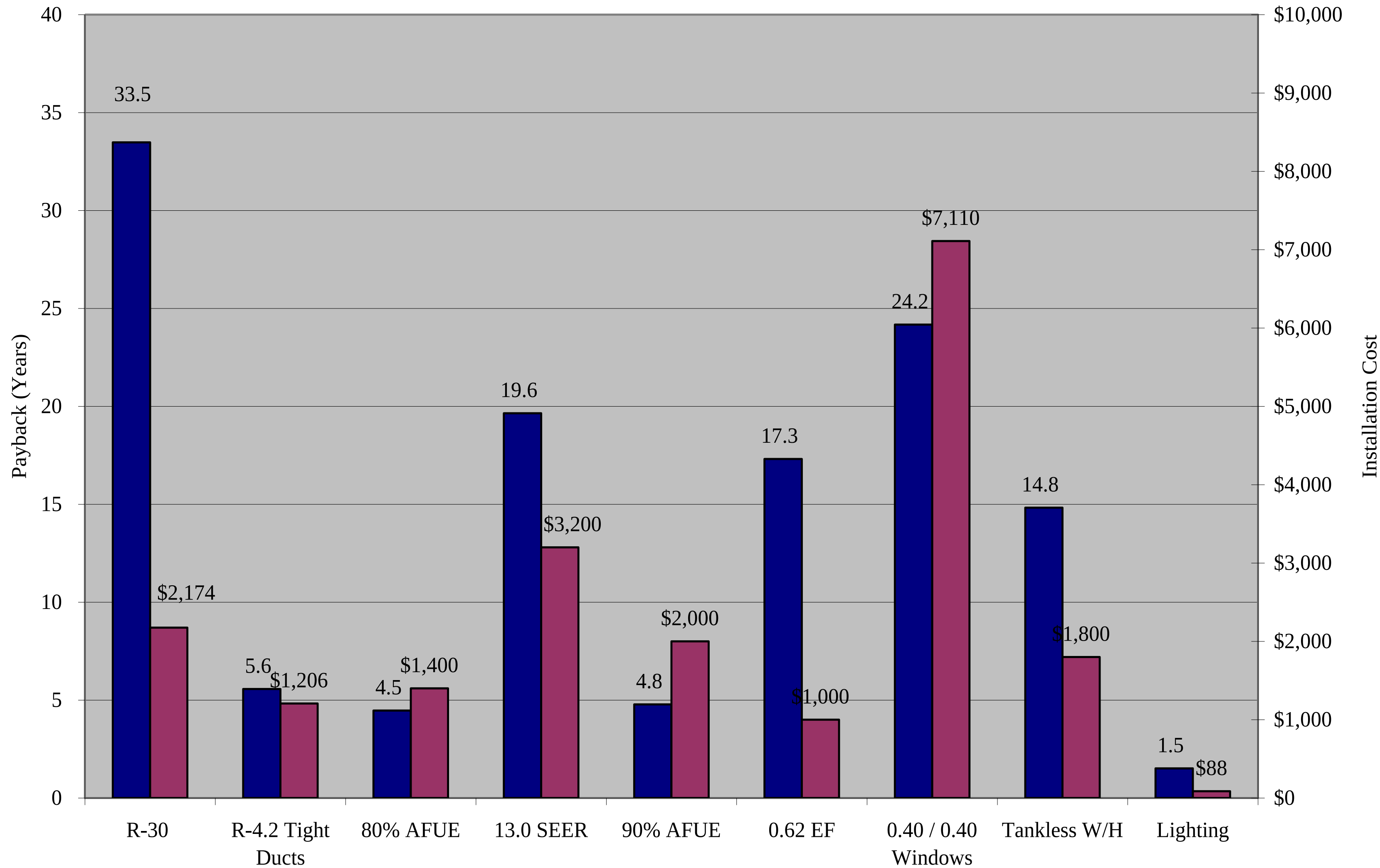

Figure B-11. Effectiveness of modeled energy efficiency upgrades on homes in Climate Zone 5 built during the 1970s. Blue bars indicate payback period in years, purple bars show cost for improvements.

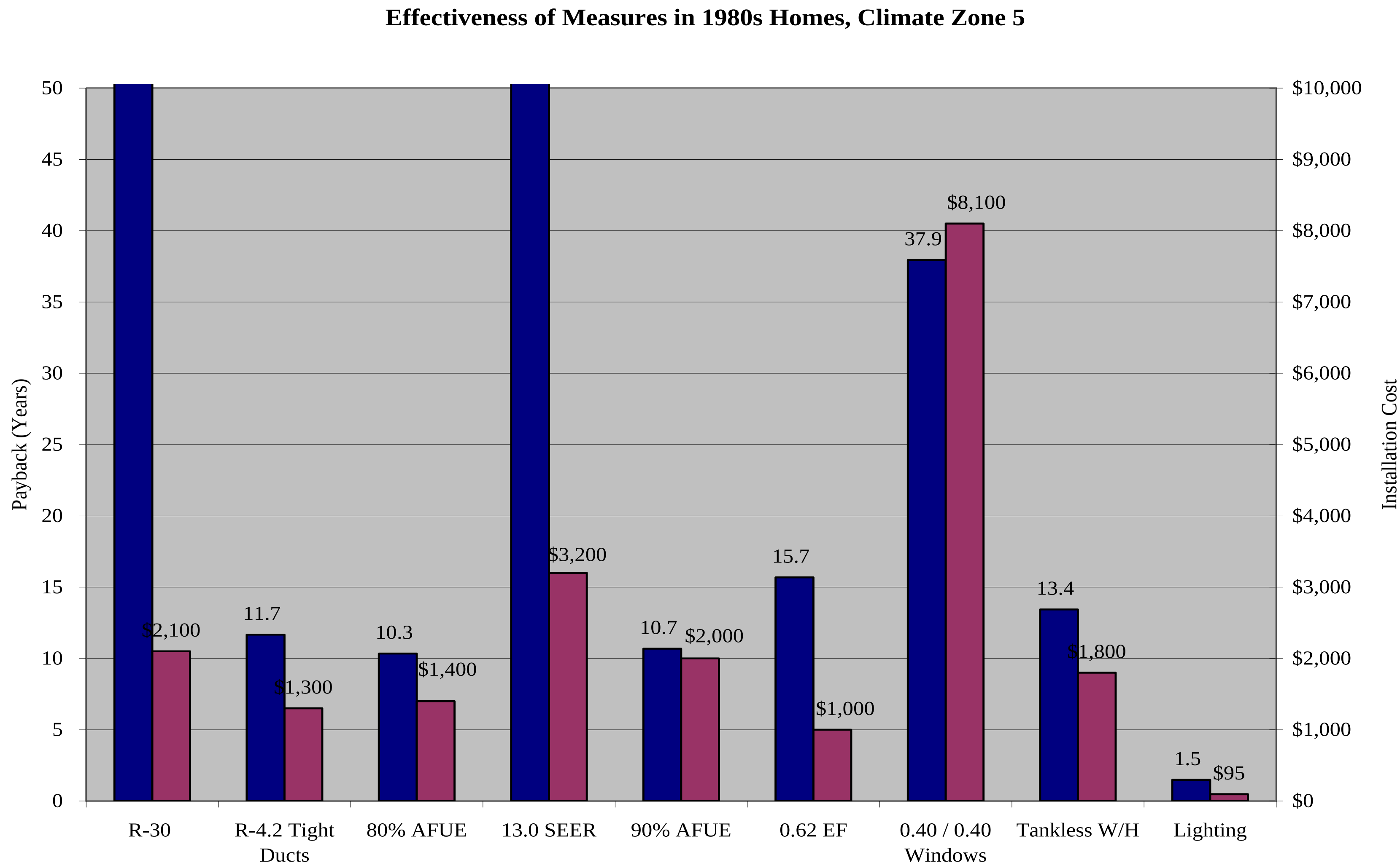

Figure B-12. Effectiveness of modeled energy efficiency upgrades on homes in Climate Zone 5 built during the 1980s. Blue bars indicate payback period in years, purple bars show cost for improvements

Note: The base model assumes R-19 attic insulation and a 7.1 SEER A/C unit in homes built in the 1980s, which renders the payback period for increased attic insulation (R-30) and improved A/C efficiency (SEER 13) to be greater than 50 years.

Appendix C: Payback and Utility Bill Savings Graphs for Three Packages of Energy Improvements
Climate Zone 4

Decadal Expected Payback and Annual Savings Resulting from Package 1 Retrofit Improvements

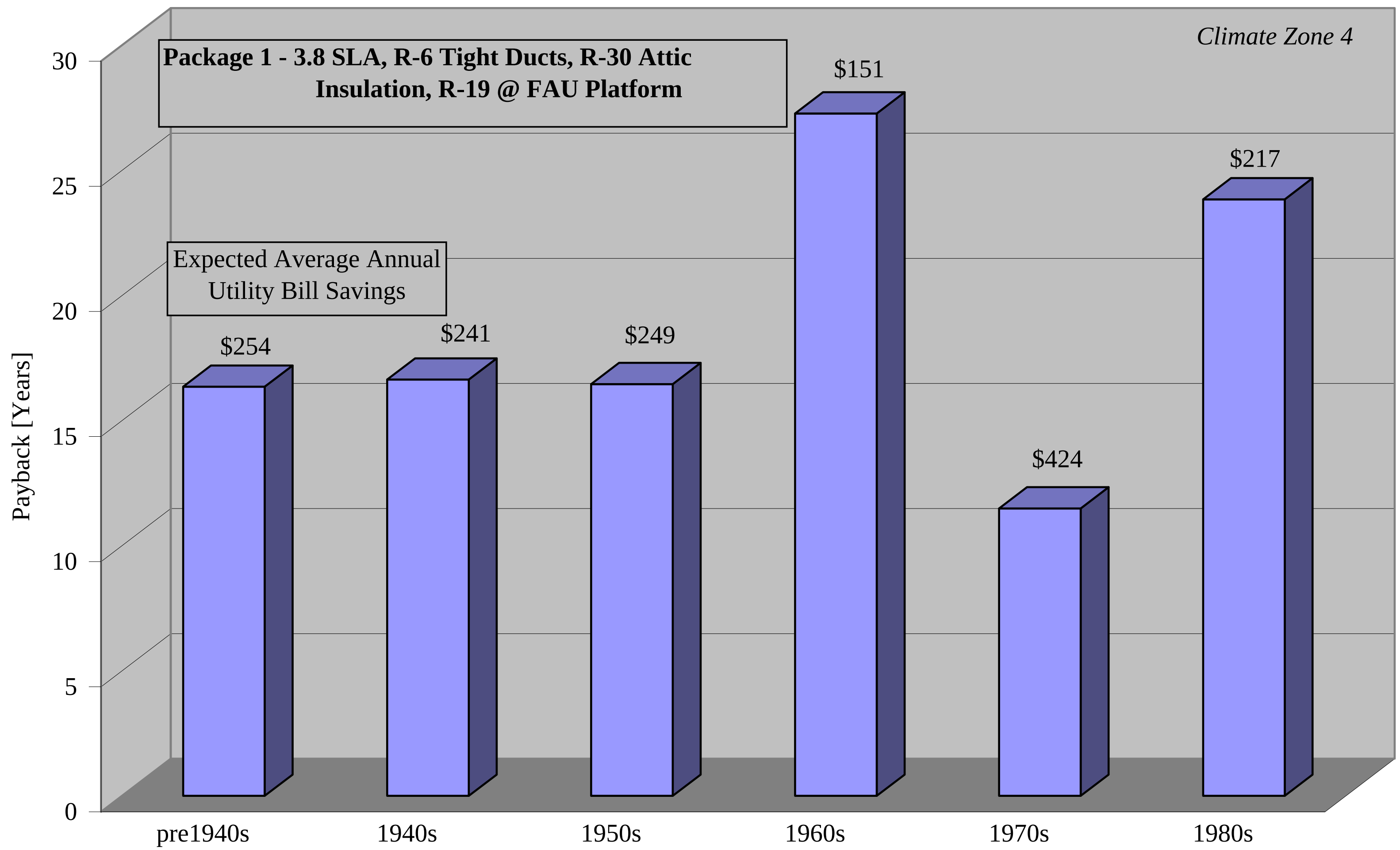

Figure C-1. Improvement Package 1 calculated payback in years and annual savings.

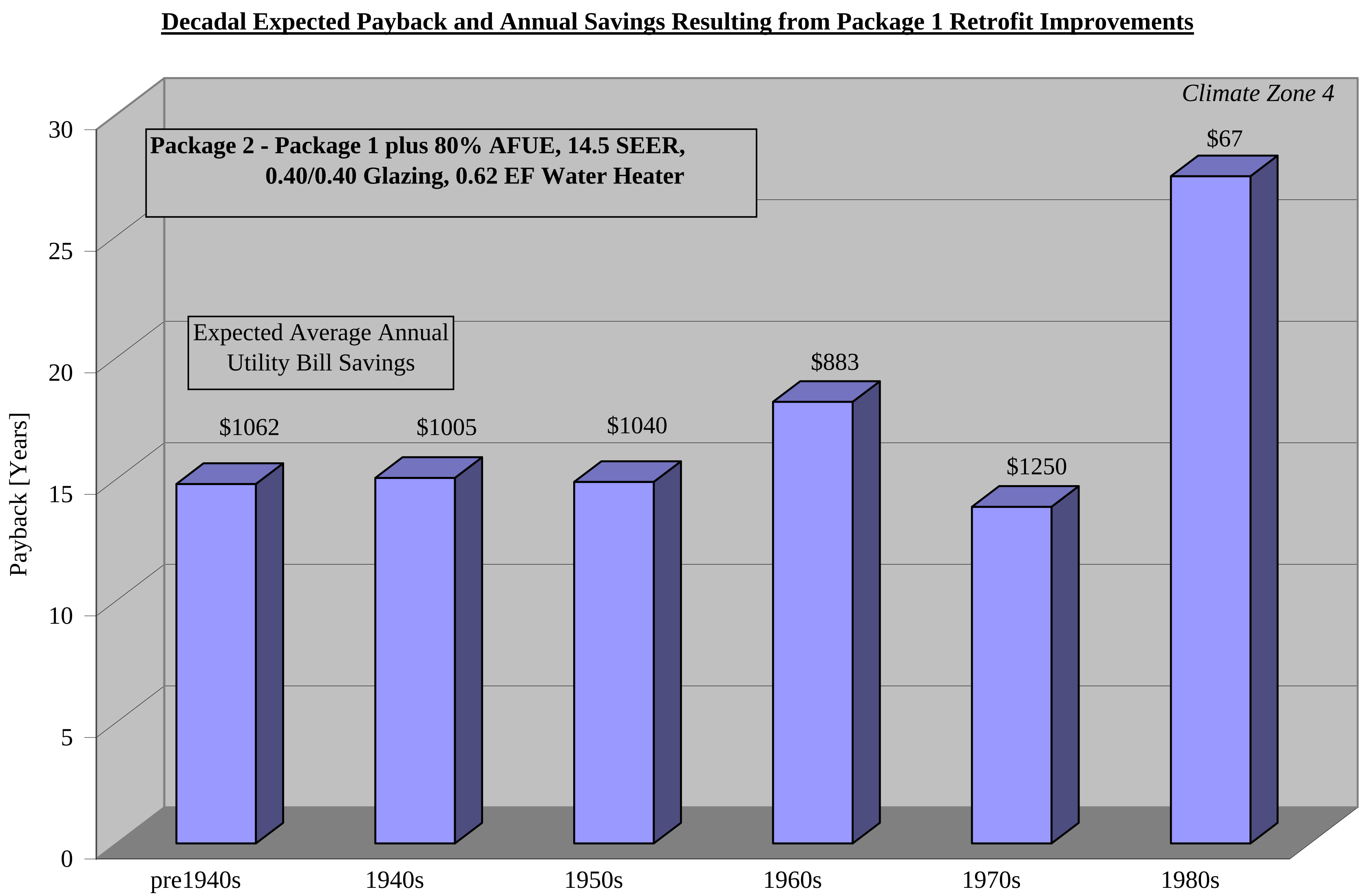

Figure C-2. Improvement Package 2 calculated payback in years and annual savings.

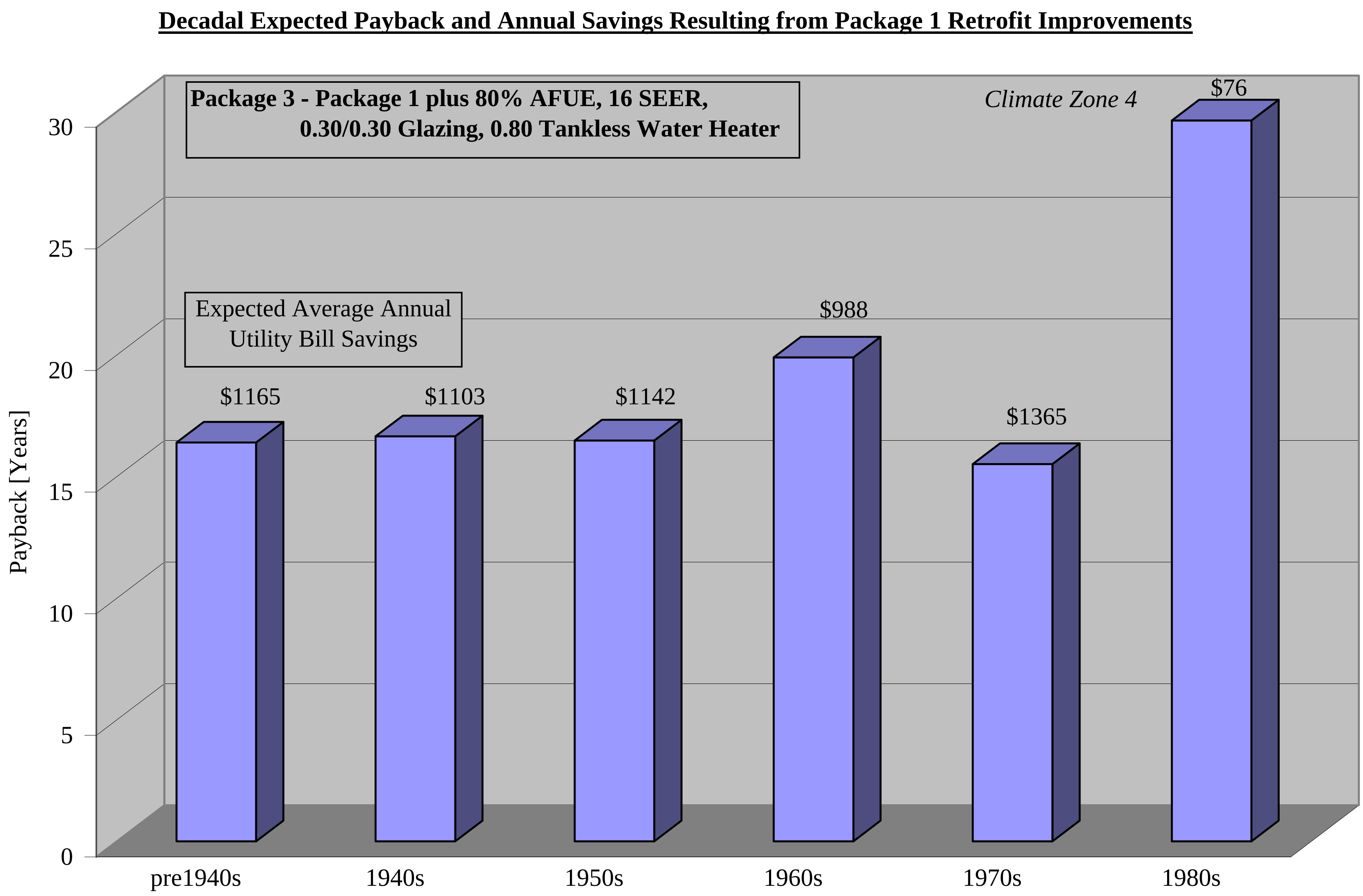

Figure C-3. Improvement Package 3 calculated payback in years and annual savings.

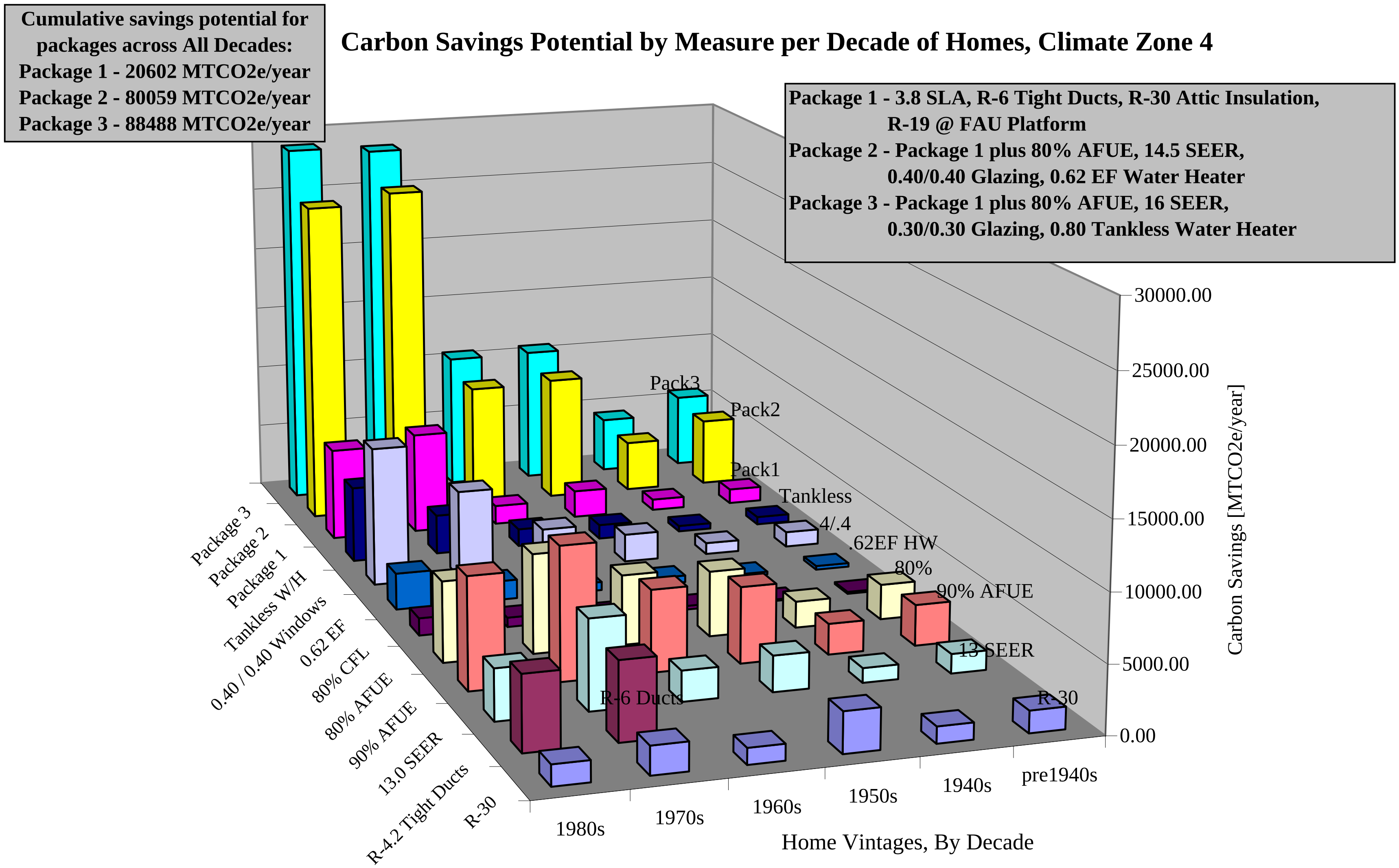

Figure C-4. The carbon-saving potential of individual and three packages of improvements.

Climate Zone 5

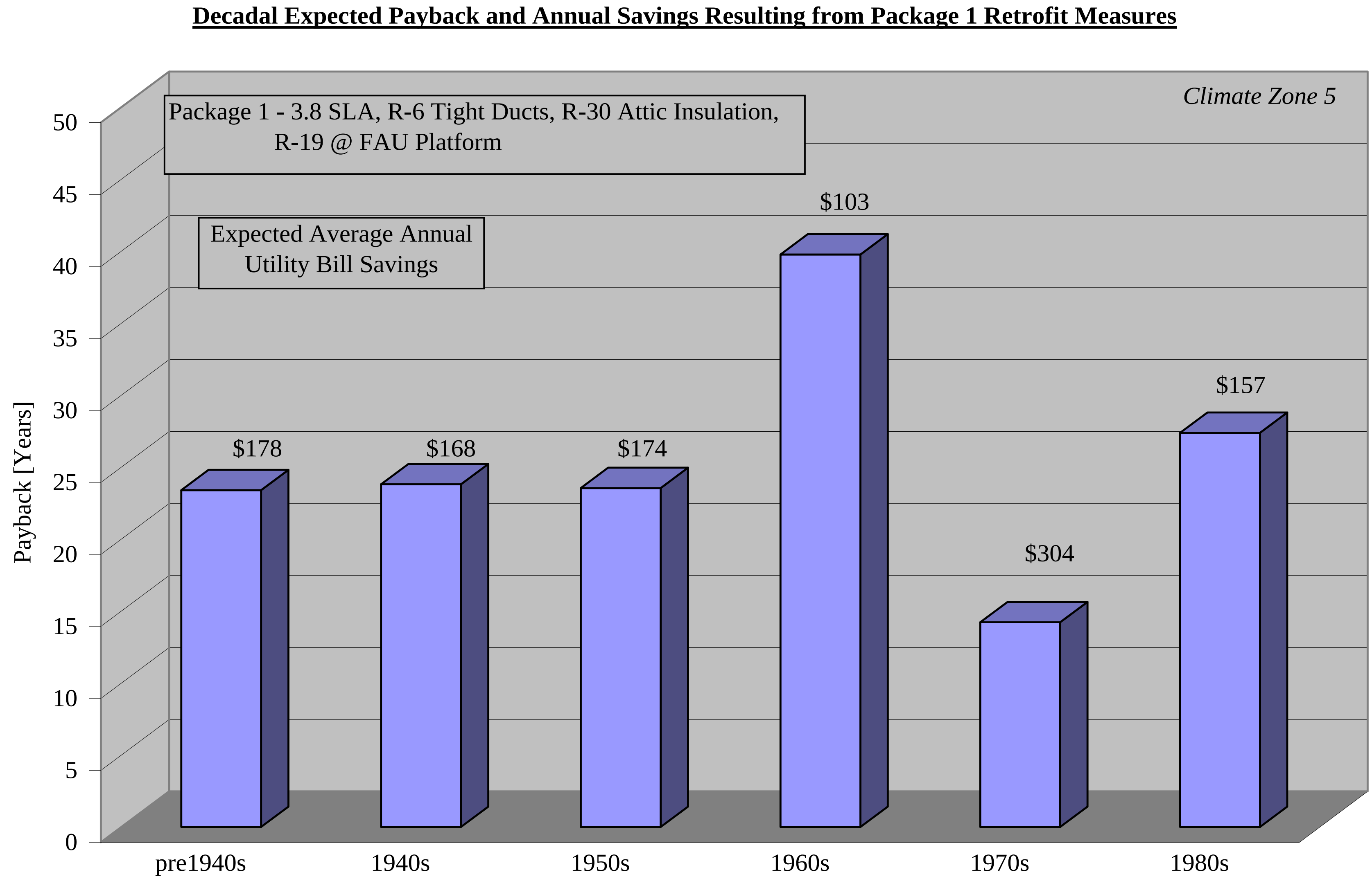

Figure C-5. Improvement Package 1 calculated payback in years and annual savings.

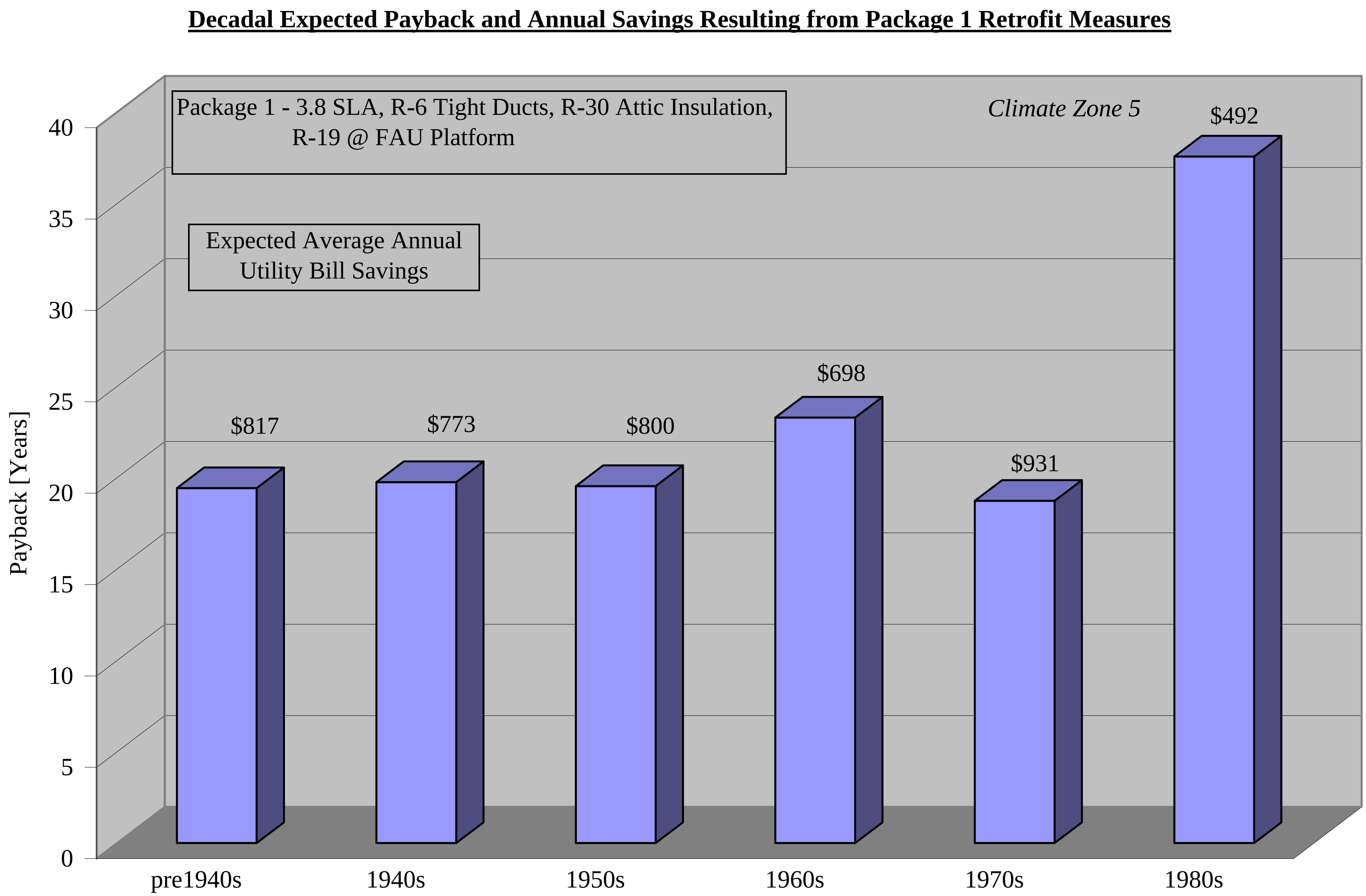

Figure C-6. Improvement Package 2 calculated payback in years and annual savings.

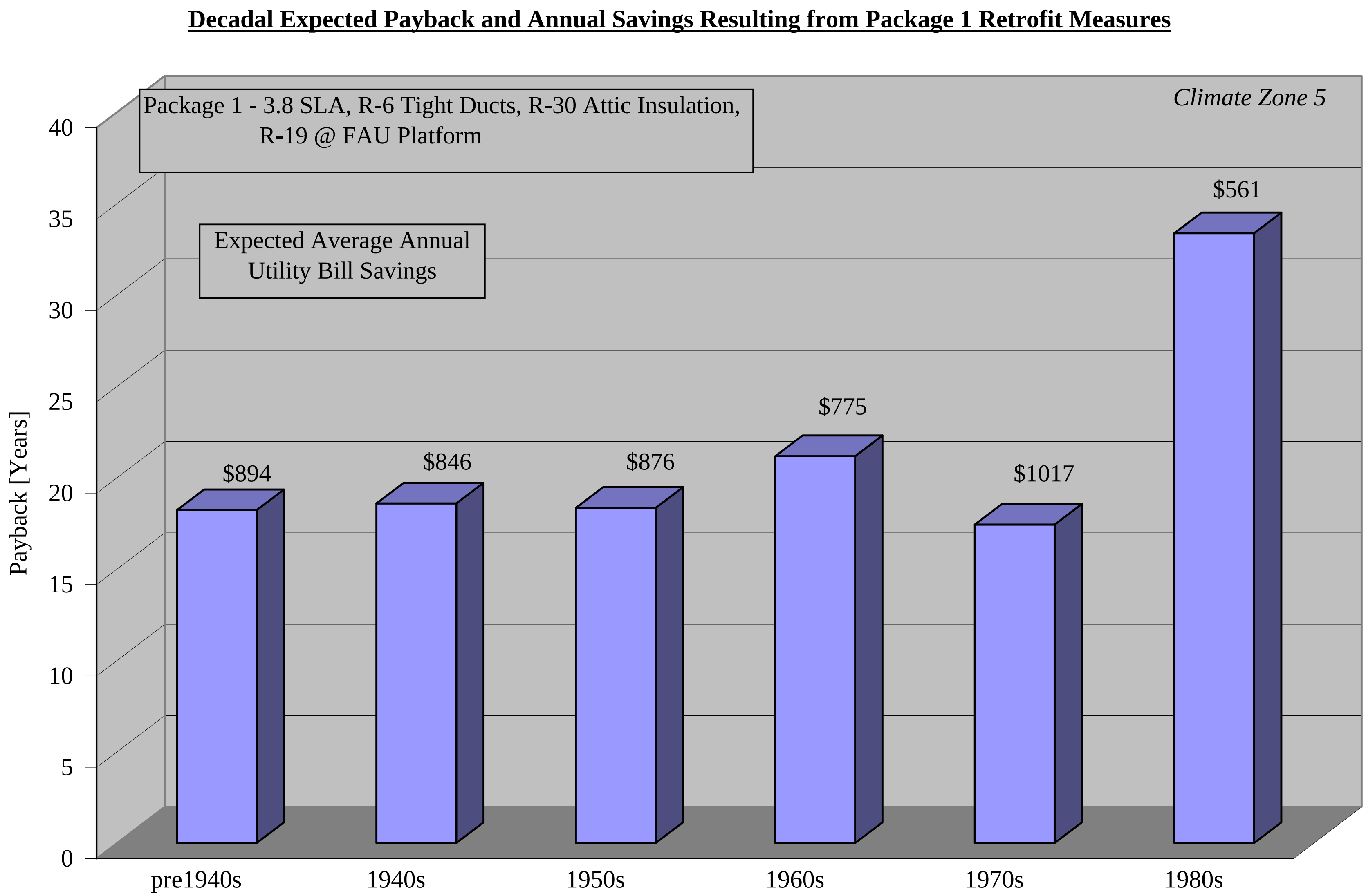

Figure C-7. Improvement Package 3 calculated payback in years and annual savings.

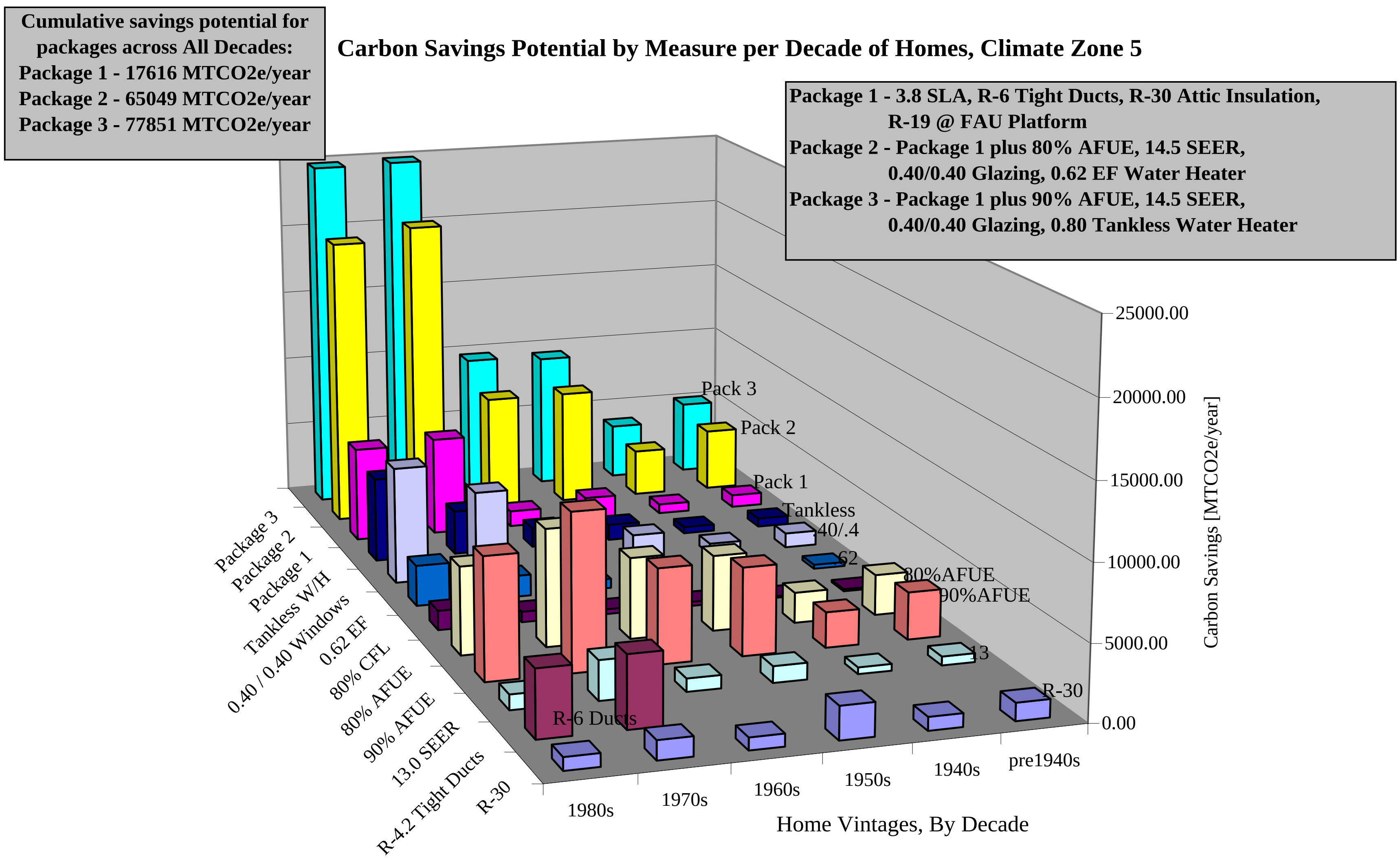

Figure C-8. The carbon-saving potential of individual and three packages of improvements.