

Estimated Cumulative Energy Savings From Packages of Retrofits for Thirteen Different Building Types

This appendix illustrates the effect of forming three packages of retrofits for each of the 13 building types for which retrofit options were presented in appendix A. One package contains a set of nonoverlapping retrofits of low capital cost; a second package includes a set of retrofits of moderate capital cost compared to savings; and a third package contains retrofits of high capital cost compared to savings.

For each building type there is a graph that shows cumulative energy savings as low, moderate, and high capital cost retrofit packages are added to that building. The cost per million Btu of each package is shown on the vertical axis of each graph. Because of interactive effects the cost per annual million Btu saved may fall outside the capital cost thresholds established by OTA for individual retrofits even though all the individual retrofits in the package would fall within the threshold if installed separately. This happens occasionally for the low capital cost package, more frequently for the moderate cost package, and very frequently for the high cost package.

For example, when combined into a package the low capital cost retrofits to a clad wall commercial building with an air system will cost \$26 per annual million Btu saved ("fuel-adjusted"*) even though

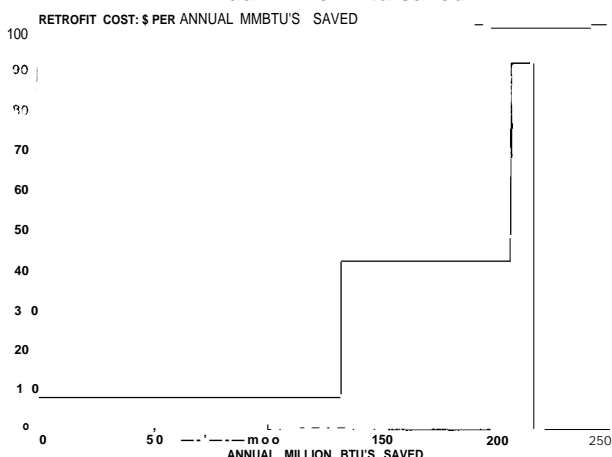
each of the retrofits in the package will cost no more than \$14 per annual million Btu saved if done individually. For the rest of the building types, however, the cost per annual million Btu of the low cost retrofit package lies within the low capital cost threshold.

Similarly, for several of the commercial buildings the cost per annual million Btu saved of the moderate cost package is somewhat higher than the moderate capital cost threshold of \$49 per annual million Btu saved even though individual retrofits in the package cost less than that. Several of the high capital cost retrofit packages cost substantially more than the high capital cost threshold. The rest cost a little more. These results indicate that high capital cost retrofits would not be cost effective if done after all low capital cost and all moderate capital cost retrofits had been installed.

For convenience the list of retrofits included in each retrofit package is given at the right of each graph. There are a few differences between these lists and those shown in appendix A. In most cases this is because some interactive effects among retrofits were anticipated in assigning individual retrofits to retrofit packages.

*See explanation of "fuel-adjusted" in introduction to appendix A.

Figure B-1.—Small Frame House: Air System*
V: Retrofit cost—\$/million Btu saved
H: Annual million Btu saved



● Base annual energy use = 575 million Btu "fuel-adjusted."

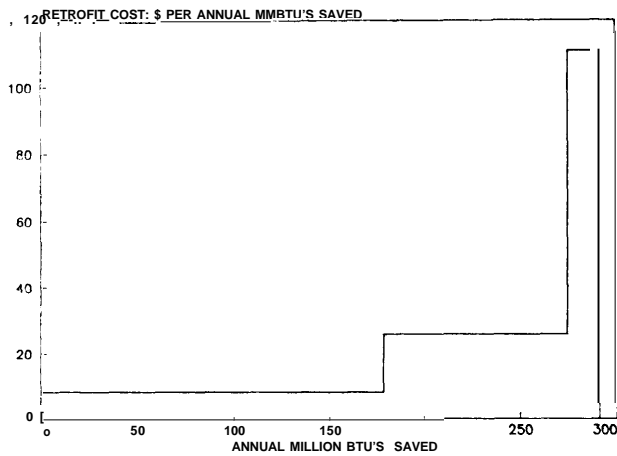
Retrofits included in Low, Moderate, and High Cost Packages for Analysis of Cumulative Savings

Small Frame House With an Air System

Low*	Moderate•	High •
Wall insulation	Roof insulation	Window insulation
Weatherstripping	Storm windows	
Thermostats	Vent damper	
2-speed fan motor	Insulate ducts	
Flow controls	DHW vent damper	
Insulate DHW storage		

*Capital cost compared to savings.

Figure B-2.—Small Frame House: Water System*



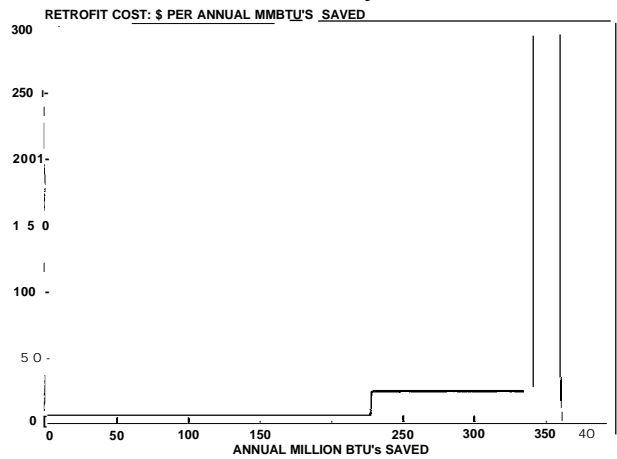
● Base annual energy use = 628 million Btu "fuel-adjusted."

Retrofits Included in Low, Moderate, and High Cost Packages for Analysis of Cumulative savings

Small Frame House With a Water System

<i>Low*</i>	<i>Moderate•</i>	<i>High •</i>
Roof insulation	Storm windows	Window insulation
Wall insulation	Vent damper	Replace burner
Weatherstripping	Modular aquastat	
Thermostats	Replace room AC	
Flow controls	DHW vent damper	
Insulate DHW storage		

Figure B-3.-Small Frame House: Decentralized System*



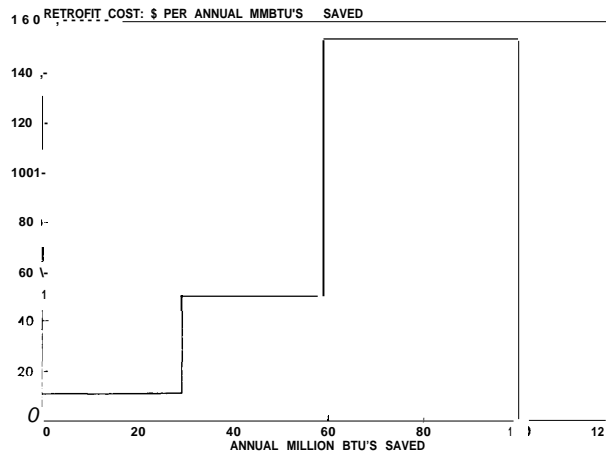
● Base annual energy use = 705 million Btu "fuel-adjusted."

Small Frame House With a Decentralized System

<i>Low*</i>	<i>Moderate•</i>	<i>High •</i>
Roof insulation	Storm windows	Electric heat pump
Wall insulation	Window insulation	
Weatherstripping	Replace room AC	
Flow controls		
Insulate storage		

● Capital cost compared to savings.

Figure B-4.—Small Masonry Rowhouse: Air System*



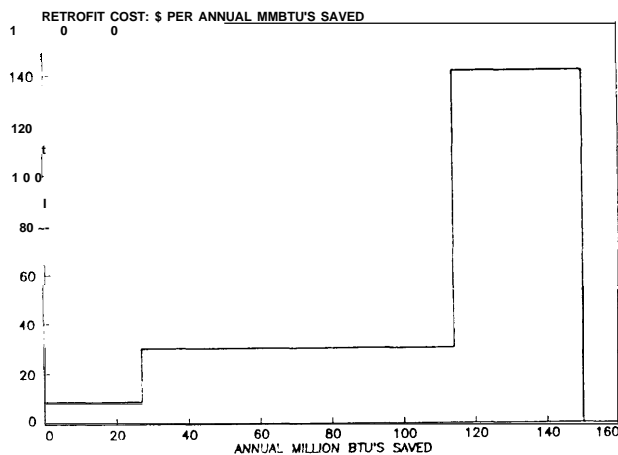
● Base annual energy use = 404 million Btu "fuel-adjusted."

Retrofits Included in Low, Moderate, and High Cost Packages for Analysis of Cumulative Savings

Small Masonry Rowhouse With an Air System

Low*	Moderate•	High•
Weatherstripping	Roof insulation	Wall insulation
Thermostats	Storm windows	Window insulation
2-speed fan motor	Vent damper	Insulate ducts
Flow controls	DHW vent damper	
Insulate storage		

Figure B-5.—Small Masonry Rowhouse: Water System*



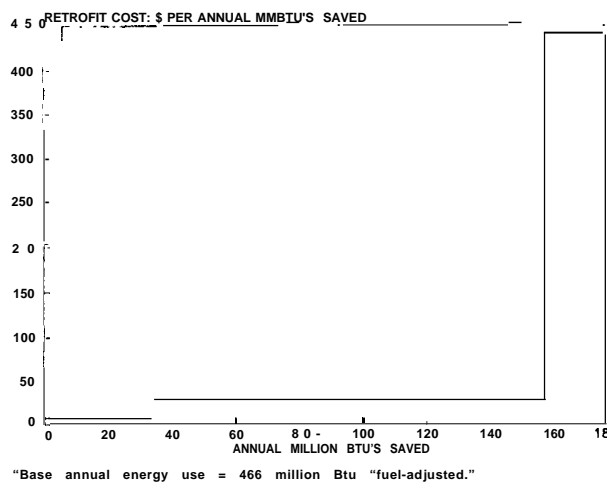
*Base annual energy use = 436 million Btu "fuel-adjusted."

Small Masonry Rowhouse With a Water System

Low*	Moderate"	High•
Weatherstripping	Roof insulation	Wall insulation
Thermostats	Storm windows	Window insulation
Flow controls	Vent damper	
Insulate storage	Modular aquastat	
	Replace room AC	
	DHW vent damper	

● Capital cost compared to savings.

Figure B-6.—Small Masonry Rowhouse: Decentralized System*

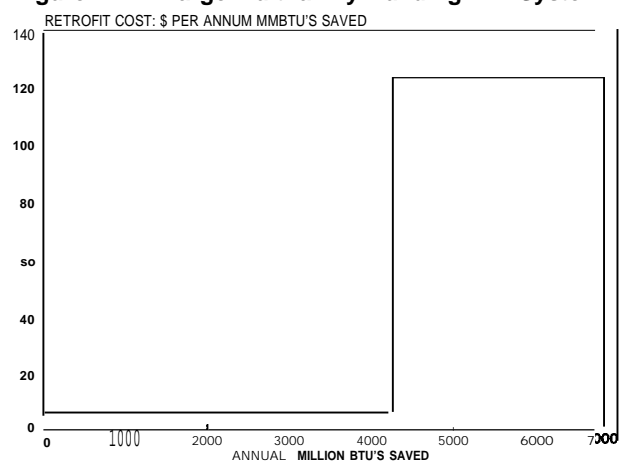


Retrofits Included in Low, Moderate, and High Cost Packages for Analysis of Cumulative Savings

Small Masonry Rowhouse With a Decentralized System

Low	Moderate	High
Weatherstripping	Roof insulation	Wall insulation
Thermostats	Storm windows	Electric heat pump
Flow controls	Window Insulation	
Insulate storage	Replace room AC	
	DHW heat pump	

Figure B-7.—Large Multifamily Building: Air System*

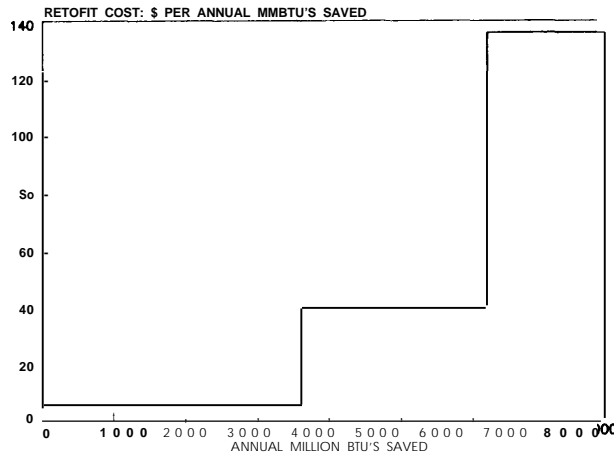


Large Multifamily Building With an Air System

Low*	Moderate	High
Roof spray	Window Insulation	Roof insulation
Vent damper	Water-cooled condenser	Wall Insulation
Thermostats	Insulate ducts	Weatherstripping
Enthalpy control		
Vary CHW temp		
2-speed fan motor		
Flow controls		
DHW vent damper		
Hybrid lamps		

*Capital cost compared to savings.

**Figure B-8.—Large Multifamily Building:
Water System***



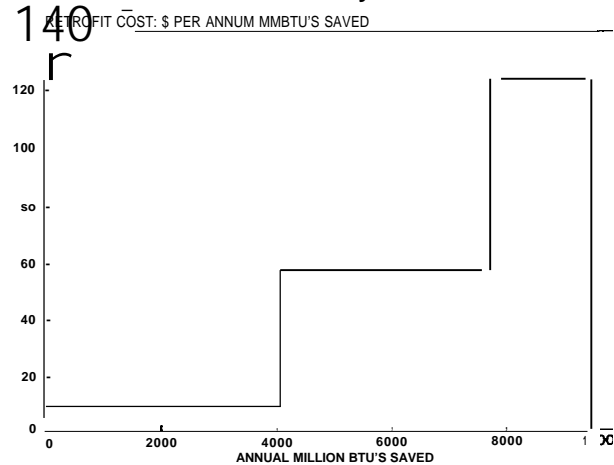
*Base annual energy use = 13,950 million Btu "fuel-adjusted."

Retrofits included in Low, Moderate, and High Cost Packages for Analysis of Cumulative Savings

Large Multifamily Building With a Water System

Low*	Moderate•	High •
Roof spray	Roof insulation	Wall insulation
Vent damper	Weatherstripping	Boiler turbolator
Modular aquastat	Window insulation	
Thermostats	Replace burner	
Flow controls	Replace room AC	
DHW vent damper		

**Figure B-9.—Large Multifamily Building:
Decentralized System***



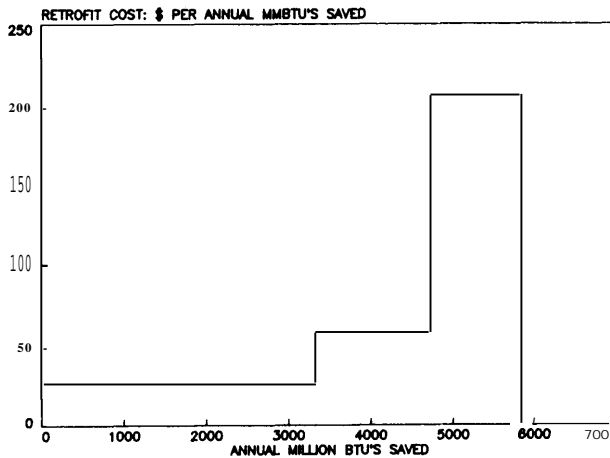
● Base annual energy use = 14,923 million Btu "fuel-adjusted."

Large Multifamily Building With a Decentralized System

Low*	Moderate	High •
Roof spray	Roof insulation	Wall insulation
Thermostats	Weatherstripping	
Flow controls	Window insulation	
Insulate storage	Electric heat pump	
DHW heat pump	Replace room AC	
Hybrid lamps		

"Capital cost compared to savings."

**Figure B-10.—Large Commercial Building:
Air System***



*Base annual energy use = 10,545 million Btu "fuel-adjusted."

Retrofits Included in Low, Moderate, and High Cost Packages for Analysis of Cumulative Savings

Large Commercial Building With an Air System

*Low**

Roof spray
Vent damper
Thermostats
Enthalpy control
Vary CHW temp
Reduce ventilation
2-speed fan motor
Flow controls
Insulate storage
DHW vent damper
Task lighting
High-efficiency fluorescent

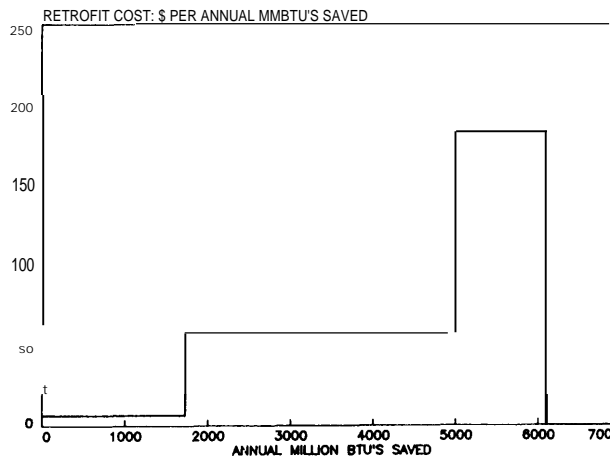
Moderate

Weatherstripping
Shading devices
Replace burner
Insulate ducts

High

Roof insulation
Wall insulation
Window insulation
Water-cooled condenser

**Figure B-11.—Large Commercial Building:
Water System***



● Base annual energy use = 10,579 million Btu "fuel-adjusted."

Large Commercial Building With a Water System

*Low**

Roof spray
Vent damper
Modular aquastat
Thermostats
Flow controls
Insulate storage
DHW vent damper
High-efficiency fluorescent

Moderate

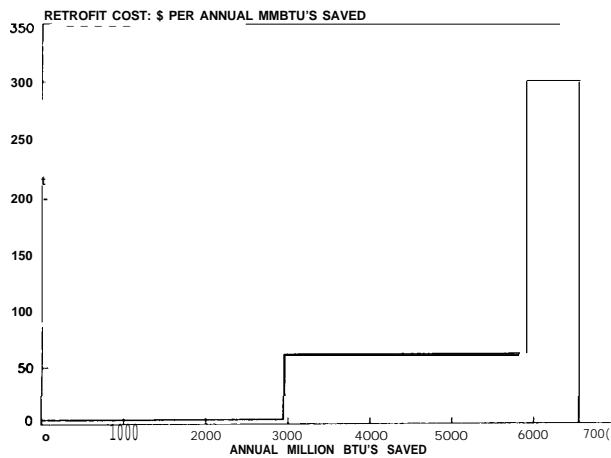
Weatherstripping
Shading devices
Replace burner
Replace room AC
Task lighting

High

Roof insulation
Wall insulation
Window insulation

● Capital cost compared to savings.

**Figure B-12.—Large Commercial Building:
Decentralized System***



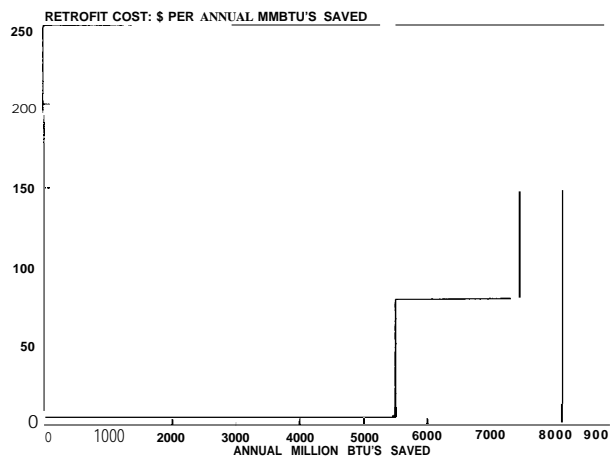
*Base annual energy use = 10,882 million Btu "fuel-adj. justed."

Retrofits Included in Low, Moderate, and High Cost Packages for Analysis of Cumulative Savings

Large Commercial Building With a Decentralized System

Low*	Moderate •	High •
Shading devices	Roof insulation	Wall insulation
Roof spray	Weatherstripping	
Thermostats	Window insulation	
Flow controls	Replace room AC	
Insulate storage	Task lighting	
High-efficiency fluorescent		

**Figure B-13.—Large Commercial Building:
Reheat System***



*Base annual energy use = 13,705 million Btu "fuel-adjusted."

Large Commercial Building With a Complex Reheat System

Low*	Moderate •	High"
Roof spray	Weatherstripping	Roof insulation
Replace burner	Shading devices	Window insulation
Vent damper	Boiler turbotator	Water-cooled condenser
Thermostats	Insulate ducts	
Reheat to VAV	Insulate storage	
Flow controls	Task lighting	
DHW vent damper		
High-efficiency fluorescent		

● Capital cost compared to savings.