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ENERGY CONSIDERATIONS IN REAL ESTATE APPRAISING

April 1980

MASTER

Prepared for:

U.S. Department of Energy

Assistant Secretary for Conservation and Solar
Under Contract No. EM-78-G-01-5223

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Master

ENERGY CONSIDERATIONS IN REAL-ESTATE APPRAISING

April 1980

Prepared by:

Society of Real Estate Appraisers
645 North Michigan Avenue
Chicago, Illinois 60601
Contract No. EM-78-G01-5223

Prepared for:

U.S. Department of Energy
Assistant Secretary for Conservation and Solar
Washington, D.C. 20585

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AGENDA: DAY ONE

I. INTRODUCTION	9:00 - 9:30 a.m.
II. ENERGY EFFICIENCY IN SINGLE-FAMILY RESIDENCES	9:30 - 12:00 Noon
A. How a House Uses Energy	
B. Collecting Energy Cost Information	
C. Identifying "Special Energy-Efficient Items"	
D. Collecting Energy Information	
III. RESIDENTIAL APPRAISAL APPLICATIONS	1:30 - 5:00 p.m.
A. Using Energy Information in Appraisal	
B. Single-Family Case Study	

AGENDA: DAY TWO

IV. ENERGY EFFICIENCY IN MULTI-FAMILY RESIDENCES

9:00 - 10:45 a.m.

- A. How a Multi-Family Property Uses Energy
- B. Collecting Energy Cost Information
- C. Identifying "Special Energy-Efficient Items"
- D. Collecting Energy Information

III. MULTI-FAMILY APPRAISAL APPLICATIONS

- A. Using Energy Information in Appraisal

11:00 - 12:00 Noon

- B. Life-Cycle Costing

- C. Multi-Family Case Study

1:30 - 5:00 p.m.

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PREFACE

"Energy Considerations in Real Estate Appraising" was developed during 1978 with the help of a grant from the Department of Energy. After several meetings involving energy experts and real estate appraisers, a program emerged that seemed both technically sound and of practical value to the appraiser.

Three pilot seminars were conducted in early 1979, and several modifications have been introduced since then to give greater emphasis to practical applications and to attempt to simplify the technical presentations. As energy considerations become a more generally recognized aspect of the appraisal process, this seminar will be modified further to incorporate new methods and ideas.

This ground-breaking seminar offers appraisers the technical information required to understand "energy efficiency" in residential and commercial buildings and various methods to measure and compare energy demand and use in such buildings. The financial analysis necessary to calculate the profitability of investment in energy efficiency is illustrated through two case studies.

The prime mover in the development of "Energy Considerations in Real Estate Appraising" was Alan N. Sayford, SREA, MAI, of Jacksonville, Florida, who coordinated the contributions of other authors and developed valuable methods of applying the traditional "approaches" to the valuation of energy-conserving techniques.

Edgar W. Carl, SREA, of Utica, New York, assisted in the development of the original seminar materials and has been chiefly responsible for revisions in the seminar format and content. James E. Summers of Kansas City, Missouri, an Associate Member of the Society of Real Estate Appraisers, assisted in preparing the case studies and in coordinating certain written materials associated with the seminar.

The technical materials on energy use and energy efficiency in buildings were prepared by or adapted from the work of John A. Murphy of Pataskala, Ohio; Lawrence G. Spielvogel, PE, of Wyncote, Pennsylvania; and Richard B. Hayter, Ph.D., John Twenty, and Lee McQueen, all of Topeka, Kansas. Written materials used extensively in preparation of this course include The Realtor's(R) Guide to Residential Energy Efficiency (1980) and the Energy Cost Reduction Guide for Apartment Managers (1975).

The Society has enjoyed the strong support and valuable advice of the Department of Energy throughout the development and early presentation of the seminar, particularly review by DOE from Peter Back and Linda Schuck. In addition, Brian O'Regan from the Lawrence Berkeley Laboratory added valuable technical assistance in the creation of the Appraisers' Energy Form.

The origin of the "Energy Seminar" can be traced to Dan L. Swango, Ph.D., SREA, MAI, Chairman of the Seminars Subcommittee of the International Education Committee. Mr. Swango proposed the seminar outline that eventually led to the request for funding from the Department of Energy. Judy Kirkendall, Associate Director of Education, provided staff support and coordination throughout the development of the seminar. Frank Faulkner, Director of Education, served as program director for the DOE grant.

Most importantly, the "Energy Seminar" is another sign of the Society's commitment to meet the evolving and expanding educational needs of today's appraiser. In order to ensure the continuing relevance of the seminar and related written materials, the Society invites the comments and recommendations of attendees regarding further refinements that might be appropriate.

INTRODUCTION

I.

1. Purpose and Scope

Purposes of the "Energy Considerations in Real Estate Appraising" seminar include the following:

1. To provide the appraiser an opportunity to learn how to identify and analyze the actual physical consumption of energy as well as the energy-saving improvements in properties under appraisal and in comparable sale and lease properties;
2. To help the appraiser in developing methods to keep meaningful records on the energy consumption of subject and comparable properties so as to observe in an orderly way the behavior of buyers, sellers, tenants, landlords, borrowers, and lenders with respect to energy efficiency; and
3. To assist the appraiser in learning to measure the relative sensitivities of the various segments of the market to energy considerations as indicated by differences in sale prices and rentals.

Appraisers, of course, must realize that sensitivities to energy considerations will vary generally from region to region and from locale to locale, as well as individually among buyers, sellers, lenders, and others who make an impact upon the market. The responsibility of the appraiser, as always, is to maintain a level of understanding at least as sophisticated as that reflected in the market and, ideally, to stay substantially ahead of the market in terms of the skills necessary for recognizing and measuring the effects that energy efficiency may have upon property value.

To achieve the goals stated above, the seminar employs two case studies, one for a single-family residence and one for a multi-family building, both in Topeka, Kansas. The case studies are for illustrative purposes only; in applying the lessons of the seminar to their own daily work, students should be careful to develop information that is pertinent to their subject properties and subject areas and not rely on any of the particulars laid out in the cases.

Most of this morning's session, labeled "Section II" in the course outline, will focus on identifying (1) energy cost information and (2) the "special energy efficient items" that may curtail the loss of energy units and dollars. Sources of information that may help the appraiser better to measure and understand utility costs associated with such items will also be discussed.

In moving this afternoon into Section III, "Residential Appraisal Applications," slides and other exhibits will be used to show how the typical inspection of the subject property might be expanded to include examination of all

property components that may save energy. Following the inspection, some time will be devoted to measuring the dollar effects of the various energy-efficient items. At this point, students will be challenged to complete the single-family appraisal form included among the study materials. All adjustments have been made already, except those for "Special Energy Efficient Items." Students will be able to examine information concerning comparable sales and to develop market data adjustments.

Tomorrow morning's session, labeled "Section IV" in the course outline, builds upon today's work. Because the designers of the seminar believe that the most demanding kind of investment-property appraisal involves apartment buildings, the entire second day will focus on this type of appraisal. Students will realize that many of the lessons of the seminar can be readily applied to valuation of other classes of investment real estate.

Section V - "Multi-Family Appraisal Applications" includes a discussion of life-cycle costing--essentially a form of discounted cash-flow analysis--to ascertain investment feasibility.

The instructors and the authors of the course material join the Society of Real Estate Appraisers in suggesting that, after the end of the seminar, students return home and make an effort to apply the lessons of the seminar to an appraisal project in progress at the present time or, if they prefer, to their own residence. This will help students understand how to integrate the lessons of the seminar with the environment and architecture typical of their own market area.

2. Energy Awareness

Until recently, the costs of heating, cooling, washing, cooking, and so on were relatively low when expressed as a percentage of family income or household/property maintenance expenses. Over the past decade or so, however, costs of fuel have increased remarkably and, in some instances, there have been genuine concerns about the availability of fuel at any price.

Because of increasing expenses and because some properties are more energy efficient than others, the market has, in at least a crude, general way, become more accustomed to considering the relative energy efficiency of properties available for sale, rent, or lease. Appraisers, like the market in general, have become aware that in many areas and for many classes of properties, there is an increment of additional value allocable to properties that are comparatively economical with respect to energy consumption.

Higher interest rates and rising utility costs have combined to make the cost of owning and occupying a property higher than many would have thought possible just a few years ago. For this reason, energy awareness has reached the point where the Federal Home Loan Mortgage Corp. (FHLMC) has stated that, in examining the income ratios necessary for qualifying home buyers:*

*Underwriting Guidelines: Home Mortgages, Federal Home Loan Mortgage Corporation, revised July 1979, page 14.

Consideration must be given to the energy efficiency of the property, especially energy efficient items which will reduce the energy costs of the property, thus permitting a greater portion of the borrower's income to be applied to housing expenses.

Accordingly, it is likely that FHLMC and others active in the lending industry, both in primary and secondary markets, will be examining much more closely the energy efficiency of properties in making and insuring loans. To satisfy any new underwriting requirement, the appraiser must sharpen his/her competence with respect to analysis and measurement of value increments, if any, resulting from comparative energy efficiency.

This phenomenon has not been limited to single-family residential markets. Just as rising interest rates have led to much more creative methods of financing purchases of investment properties, so have prudent and resourceful property owners begun increasingly to install energy-efficient items in order to increase net operating income. This will be illustrated in the multi-family case study.

In the final analysis, markets for all classes of properties can be expected to become increasingly aware of the value of energy savings. The appraiser's skills must meet or exceed the awareness of the general market if he/she is to continue to be able to value properties competently.

3. Understanding Guidelines and Forms

Because the initial focus of the seminar is on single-family residential appraisal, it is appropriate to examine the current standard "Residential Appraisal Report" form, known as FHLMC Form 70/FNMA Form 1004, most recently revised in July 1979.

At the end of this section is a copy of a residential appraisal form. Those portions relating to energy considerations are labeled A through E, representing the following categories or headings:

- A - "Window (Type)," where the appraiser is asked to check boxes labeled Storm Sash, Screens, or Combination.
- B - "Insulation," with boxes to indicate no insulation or insulation in the floors, ceilings, roofs, and/or walls of the subject property. Insulation is relatively easy to check, necessitating only a slightly longer allowance for inspection time.
- C - "Insulation - adequacy," where the appraiser is asked to judge whether the adequacy of insulation is good, average, fair, or poor in comparison to that typically found in the subject market.
- D - "Special Features (including energy efficient items)." This is the first area on the appraisal form where all energy efficient items can and should be listed together. If space does not allow a full listing, attachments may be appropriate. A fuller discussion of possible energy-efficient items appears in Section II.C.

E - Because there is no space on the appraisal form for specifically noting the average annual energy cost per square foot for the subject property, the authors of the course material recommend that this item be listed just below Item D. This has been done in the single-family case study.

Also, the valuation section of the residential appraisal form includes spaces for the notation of energy features. Portions relating to energy considerations are labeled F and G, representing the following:

F - "Special Energy Efficient Items." This is the only space on the form providing for treatment of such items in the Cost Approach. Because of the limited space allowance, attached sheets may again be necessary, or reference may be made to the adjustment grid provided for Market Data Analysis of the property. All energy-related items listed at point D must be considered at point F.

G - "Special Energy Efficient Items." This is the portion of the Market Data Analysis section that corresponds with item F. Again, all items listed elsewhere on the form must be considered.

As indicated above, there may be a variety of energy efficient items that are more or less commonly found in some markets. The description below has been excerpted from Underwriting Guidelines: Home Mortgages.*

Energy Efficient Items. FHLMC defines an energy efficient property as one which uses cost effective design, materials, equipment, and site orientation in providing conservation of non-renewable fuels. Implicit in this definition are proper design and installation of materials and equipment consistent with climatic conditions in the area.

Items contributing to the energy efficiency of a property include but are not limited to:

(1) insulation with adequate R-values installed in ceilings, exterior walls, roofs, around hot water heaters, under floors covering unheated areas, and surrounding ducts and pipes in unconditioned areas.

(2) caulking and weatherstripping;

(3) double or triple pane windows;

(4) window shading or landscaping for solar control;

(5) storm fittings;

(6) automatic setback thermostat;

*Federal Home Loan Mortgage Corp., revised July 1979, pp. 7 and 8.

(7) heating, cooling, lighting systems and appliances designed specifically to be energy efficient;

(8) solar systems for water heating, space heating and cooling;

(9) wood fired heating systems; and

(10) building designs which minimize energy use, such as, smaller window area and earth sheltering.

The underwriter should note any energy efficient items entered under "Special Features." Increasing energy costs should be of concern to borrowers and lenders alike. FHLMC shares this concern and promotes energy efficient items in the appraisal process. Because of the differences in climate throughout the country and the differences in utility costs, the nature of these items and their contribution to value will vary. The appraiser should have listed any special energy efficient items in the "Interior Finish and Equipment" section of the appraisal report and have shown the cost of such items in the "Cost Approach" section and the amount of their contribution to value in the "Market Data Analysis" section. In the "Property Rating" section, the appraiser should also have indicated the "Adequacy of Insulation." Recognition of the contribution of these items to market value is encouraged since any increase in principal and interest payments resulting from these items being included in the financing may be offset or exceeded by the savings in energy costs.

Figure 11. Residential Appraisal Report

Borrower		Census Tract		Map Reference																																																																		
Property Address																																																																						
City		County		State																																																																		
City		County		State																																																																		
City		County		State																																																																		
Legal Description																																																																						
Sale Price \$		Date of Sale		Loan Term yrs																																																																		
Actual Real Estate Taxes \$		(yr) Loan charges to be paid by seller \$		Other sales concessions																																																																		
Lender/Client		Address		Appraiser																																																																		
Occupant		Appraiser		Instructions to Appraiser																																																																		
<p>NEIGHBORHOOD</p> <p>Location ☐ Urban ☐ Suburban ☐ Rural</p> <p>Built Up ☐ Over 75% ☐ 25% to 75% ☐ Under 25%</p> <p>Growth Rate ☐ Fully Dev. ☐ Rapid ☐ Steady ☐ Slow</p> <p>Property Values ☐ Increasing ☐ Stable ☐ Declining</p> <p>Demand/Supply ☐ Shortage ☐ In Balance ☐ Over Supply</p> <p>Marketing Time ☐ Under 3 Mos. ☐ 4-6 Mos. ☐ Over 6 Mos.</p> <p>Present Land Use ☐ % 1 Family ☐ % 2-4 Family ☐ % Apts. ☐ % Condo ☐ % Commercial</p> <p>☐ % Industrial ☐ % Vacant ☐ %</p> <p>Change in Present Land Use ☐ Not Likely ☐ Likely (*) ☐ Taking Place (*)</p> <p>(*) From _____ To _____</p> <p>Predominant Occupancy ☐ Owner ☐ Tenant ☐ % Vacant</p> <p>Single Family Price Range \$ _____ to \$ _____ Predominant Value \$ _____</p> <p>Single Family Age _____ yrs to _____ yrs Predominant Age _____ yrs</p> <p>Note: FHLMC/FNMA do not consider the racial composition of the neighborhood to be a relevant factor and it must not be considered in the appraisal.</p> <p>Comments including those factors, favorable or unfavorable, affecting marketability (e.g. public parks, schools, view, noise)</p>																																																																						
<p>SITE</p> <p>Dimensions _____ Sq. Ft. or Acres ☐ Corner Lot</p> <p>Zoning classification _____ Present improvements ☐ do ☐ do not conform to zoning regulations</p> <p>Highest and best use: ☐ Present use ☐ Other (specify) _____</p> <p>Etc. ☐ Public ☐ Other (Describe) _____</p> <p>Gas ☐ _____</p> <p>Water ☐ _____</p> <p>San/Sewer ☐ _____</p> <p>☐ Underground Elect. & Tel. ☐ Sidewalk ☐ Street Lights</p> <p>Comments (favorable or unfavorable including any apparent adverse easements, encroachments or other adverse conditions)</p>																																																																						
<p>IMPROVEMENTS</p> <p>☐ Existing ☐ Proposed ☐ Under Constr. No. Units _____ Type (det, duplex, semi-det, etc.) Design (rambler, split level, etc.) Exterior Walls _____</p> <p>Yrs. Age: Actual _____ Effective _____ to _____ No. Stories _____</p> <p>Roof Material _____ Gutters & Downspouts ☐ None Window (Type): ☐ Storm Sash ☐ Screens ☐ Combination ☐ Insulation ☐ None ☐ Floor</p> <p>☐ Manufactured Housing ☐ % Basement ☐ Floor Drain ☐ Finished Ceiling</p> <p>Foundation Walls ☐ Outside Entrance ☐ Sump Pump ☐ Finished Walls</p> <p>☐ Concrete Floor ☐ % Finished ☐ Finished Floor</p> <p>☐ Slab on Grade ☐ Crawl Space Evidence of: ☐ Dampness ☐ Termites ☐ Settlement</p> <p>Comments _____</p>																																																																						
<p>ROOM LIST</p> <table border="1"> <thead> <tr> <th>Room List</th> <th>Foyer</th> <th>Living</th> <th>Dining</th> <th>Kitchen</th> <th>Den</th> <th>Family Rm.</th> <th>Rec. Rm.</th> <th>Bedrooms</th> <th>No. Baths</th> <th>Laundry</th> <th>Other</th> </tr> </thead> <tbody> <tr> <td>Basement</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>1st Level</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>2nd Level</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>						Room List	Foyer	Living	Dining	Kitchen	Den	Family Rm.	Rec. Rm.	Bedrooms	No. Baths	Laundry	Other	Basement												1st Level												2nd Level																												
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<p>INTERIOR FINISH & EQUIPMENT</p> <p>Finished area above grade contains a total of _____ rooms _____ bedrooms _____ baths. Gross Living Area _____ sq. ft. Bsmt Area _____ sq. ft.</p> <p>Kitchen Equipment: ☐ Refrigerator ☐ Range/Oven ☐ Dishwasher ☐ Fan/Hood ☐ Compactor ☐ Washer ☐ Dryer</p> <p>HEAT: Type _____ Fuel _____ Cond. _____ AIR COND: ☐ Central ☐ Other ☐ Adequate ☐ Inadequate</p> <p>Floors ☐ Hardwood ☐ Carpet Over ☐ _____</p> <p>Walls ☐ Drywall ☐ Plaster ☐ _____</p> <p>Finish ☐ Good ☐ Average ☐ Fair ☐ Poor</p> <p>Bath Floor ☐ Ceramic ☐ _____</p> <p>Bath Wainsc. ☐ Ceramic ☐ _____</p> <p>Special Features (including energy efficient items) _____</p> <p>ATTIC: ☐ Yes ☐ No ☐ Stairway ☐ Drop-stair ☐ Scuttle ☐ Floored ☐ Finished (Describe) _____</p> <p>CAR STORAGE: ☐ Garage ☐ Built-in ☐ Attached ☐ Detached ☐ Car Port</p> <p>No. Cars _____ Adequate ☐ Inadequate ☐ Condition _____</p> <p>FIREPLACES, PATIOS, POOL, FENCES, etc. (describe) _____</p> <p>COMMENTS (including functional or physical inadequacies, repairs needed, modernization, etc.) _____</p>																																																																						
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Compatibility to Neighborhood	☐	☐	☐	☐																																																																		
Overall Livability	☐	☐	☐	☐																																																																		
Appeal and Marketability	☐	☐	☐	☐																																																																		
Yrs Est Remaining Economic Life _____ to _____ Explain if less than Loan Term																																																																						

Figure 11. (Continued)

Purpose of Appraisal is to estimate Market Value as defined in Certification & Statement of Limiting Conditions (FHLMC Form 439/FNMA Form 1004B). If submitted for FNMA, the appraiser must attach (1) sketch or map showing location of subject, street names, distance from nearest intersection, and any detrimental conditions and (2) exterior building sketch of improvements showing dimensions.

Measurements	No. Stories	Sq. Ft.	ESTIMATED REPRODUCTION COST - NEW - OF IMPROVEMENTS:	
☒ ☒ ☒	☒ ☒ ☒	☒ ☒ ☒	Dwelling	Sq. Ft. @ \$ = \$
☒ ☒ ☒	☒ ☒ ☒	☒ ☒ ☒	Extras	Sq. Ft. @ \$ = \$
☒ ☒ ☒	☒ ☒ ☒	☒ ☒ ☒	Special Energy Efficient Items	
☒ ☒ ☒	☒ ☒ ☒	☒ ☒ ☒	Porches, Patios, etc.	
☒ ☒ ☒	☒ ☒ ☒	☒ ☒ ☒	Garage/Car Port	Sq. Ft. @ \$ = \$
☒ ☒ ☒	☒ ☒ ☒	☒ ☒ ☒	Site Improvements (driveway, landscaping, etc.)	
Total Gross Living Area (List in Market Data Analysis below)			Total Estimated Cost New	
Comment on functional and economic obsolescence:			Less Physical	
			Depreciation \$	\$ = \$
			Depreciated value of improvements	\$ = \$
			ESTIMATED LAND VALUE	\$ = \$
			(If leasehold, show only leasehold value)	
			INDICATED VALUE BY COST APPROACH	\$ = \$

The undersigned has recited three recent sales of properties most similar and proximate to subject and has considered these in the market analysis. The description includes a dollar adjustment, reflecting market reaction to those items of significant variation between the subject and comparable properties. If a significant item in the comparable property is superior to, or more favorable than, the subject property, a minus (-) adjustment is made, thus reducing the indicated value of subject; if a significant item in the comparable is inferior to, or less favorable than, the subject property, a plus (+) adjustment is made, thus increasing the indicated value of the subject.

ITEM	Subject Property	COMPARABLE NO. 1	COMPARABLE NO. 2	COMPARABLE NO. 3
Address				
Proximity to Subj.				
Sales Price	\$	\$	\$	\$
Price/Living area	\$	\$	\$	\$
Date Source				
Date of Sale and Time Adjustment	DESCRIPTION	DESCRIPTION	DESCRIPTION	DESCRIPTION
Location				
Site/View				
Design and Appeal				
Quality of Const.				
Age				
Condition				
Living Area Room Count and Total	Total B-rms Baths	Total B-rms Baths	Total B-rms Baths	Total B-rms Baths
Gross Living Area	Sq.Ft.	Sq.Ft.	Sq.Ft.	Sq.Ft.
Basement & Bmt. Finished Rooms				
Functional Utility				
Air Conditioning				
Garage/Car Port				
Porch, Patio, Pools, etc.				
Special Energy Efficient Items				
Other (e.g. fireplaces, kitchen equip., remodeling)				
Sales or Financing Concessions				
Net Adj. (Total)	☐ Plus; ☐ Minus \$	☐ Plus; ☐ Minus \$	☐ Plus; ☐ Minus \$	☐ Plus; ☐ Minus \$
Indicated Value of Subject	\$	\$	\$	\$

Comments on Market Data

INDICATED VALUE BY MARKET DATA APPROACH \$ = \$

INDICATED VALUE BY INCOME APPROACH (If applicable) Economic Market Rent \$ /Mo. x Gross Rent Multiplier = \$

This appraisal is made ☐ "as is" ☐ subject to the repairs, alterations, or conditions listed below ☐ completion per plans and specifications.

Comments and Conditions of Appraisal:

Final Reconciliation:

Construction Warranty ☐ Yes ☐ No Name of Warranty Program Warranty Coverage Expires

This appraisal is based upon the above requirements, the certification, contingent and limiting conditions, and Market Value definition that are stated in ☐ FHLMC Form 439 (Rev. 10/78)/FNMA Form 1004B (Rev. 10/78) filed with client 19 ☐ attached.

I ESTIMATE THE MARKET VALUE, AS DEFINED, OF SUBJECT PROPERTY AS OF 19 to be \$

Appraiser(s) Review Appraiser (If applicable) ☐ Did ☐ Did Not Physically Inspect Property

ENERGY EFFICIENCY IN SINGLE-FAMILY RESIDENCES

II.

In preparation for this afternoon's case study, the rest of the morning will be devoted to the following topics:

- A. How a house uses energy;
- B. Collecting energy cost information;
- C. Identifying special energy efficient items; and
- D. Obtaining energy information.

At the conclusion of this session, the student will have a clearer understanding of the ways in which residents of a house interact with their environment (i.e., the home and its component parts or systems). That will enable the appraiser to gather and weigh the various kinds of information that may affect property values. Finally, the notebook will demonstrate some of the ways in which such information may be translated into dollar measurements of value.

As is always the case with general seminars and workshops, the student may find that, for his/her particular market area, different or more specific measurements may be more appropriate than those illustrated in this seminar. The appraiser may wish to consult with other appraisers or with utility companies, lenders, brokers, and others familiar with the market area in order to develop more pertinent measurements of value.

Before beginning a discussion on the ways in which a house physically uses energy, it is important to remember that a residence uses energy not only because of its physical features and location, but also as a function of the judgment, tastes, and lifestyle of its occupants. The grid in Figure II.1 is a simple tool for helping the appraiser to understand the relationship between houses and their inhabitants.

The grid is useful in illustrating that, with regard to any particular residence, one of four conditions may exist. Although it is reasonable to assume a relationship between building features and energy costs, lifestyle and the general design and orientation of a property also will affect utility costs.

Quadrant No. 1 shows lower than average energy costs per square foot, and more energy-efficient features than average for the market area. This is an energy-efficient property. The borrower who lives in this house will effectively have a higher disposable income to cover mortgage payments than if he/she lived in an average property. In this case the lender, under the FHLMC guidelines, can increase the income ratio to recognize this fact.

Figure II.1. ENERGY CONSUMPTION (Units or dollars per square foot per year)

		ENERGY CONSUMPTION (units or dollars per sq. ft. per year)	
ENERGY FEATURES (cumulative effect)		<u>Lower than</u> <u>Norm for Market Area</u>	<u>Higher than</u> <u>Norm for Market Area</u>
	<u>Higher than Norm</u> <u>for Market Area</u>	1 (Energy efficient property)	2 (Energy use affected by lifestyle or general design)
	<u>Lower than Norm</u> <u>for Market Area</u>	3 (Energy use affected by lifestyle or general design)	4 (Property needs upgrading)

Quadrant 4, on the other hand, illustrates a property with higher than average energy costs and lower than average energy improvements. In this case, the borrower will have less disposable income available to cover mortgage payments, and the situation is likely to become worse as energy costs rise. The lender may want to encourage such a borrower to upgrade the property as a condition of the loan. Several lenders make a practice of adding the cost of the improvements to the mortgage as an inducement for upgrading.

In Quadrants No. 2 and 3, where the logical relationship between energy-efficient features and energy consumption is not evident, the appraiser may assume that the discrepancy results from the lifestyle of the occupants of the house or from design or installation characteristics. The Quadrant No. 2 family may have poor blood circulation, a greater preference for hot baths, or one or more young family members who may be oblivious to the desirability of turning off stereos, televisions, and unused lights. The effects of energy-efficient items can be reduced significantly by such a lifestyle.

Quadrant No. 3 family members may enjoy winter vacations in the South Seas and summer vacations in Canada, or, probably more likely, they prefer to wear tweeds and sweaters in the winter and lighter cotton clothes in the warmer months.

The point of the preceding discussion is that, whenever there is a significant deviation from the norm--i.e., from the vertical and horizontal lines shown on the model--factors not pertaining to real estate may be involved. Because they are not sociologists or psychologists, appraisers normally should assume a typical lifestyle and focus upon the logical relationship between energy features and consumption.

If the appraiser assumes a typical lifestyle for the residents of the subject property, he/she is free to examine the ways in which energy is physically consumed by the residence.

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II-4

A. How A House Uses Energy

The combined residential and commercial sector consumed approximately one third of the total energy used in the United States in the mid-1970s. More recently, this has increased to nearly 40 percent of the total U.S. consumption. It is not unrealistic to assume that the energy consumed by this sector could economically be reduced by more than 30 percent. To do so, however, it would be necessary to understand how energy use is distributed within the sector so that energy conservation programs can have the most significant effect.

Each building is unique, in terms both of structure and in site and susceptibility to climatic effects. Thus, it is not possible to formulate a general document to identify the specific conditions that might exist. It is possible, however, to identify general conditions that affect most buildings.

Three general elements influence energy usage:

- Non-Energized Systems, which do not consume energy directly, but do affect the amount of energy that active or energized systems must use to do their jobs. Examples include walls, windows, floors, doors, roofs, ceilings, landscaping, and site orientation.
- Energized Systems, which consume energy directly. Examples of energized systems include heating, cooling, humidification/dehumidification, water heating, lighting, food cooking, laundry (washing/drying), dishwashing, interior conveniences, and other appliances (typewriters, lamps, sewing machines, televisions, and the like).
- Human Systems, the people who have an impact on when and what quantity of energy is consumed. Examples include number of occupants, thermostat setting, period of occupancy, etc.

If each building had these three systems functioning as efficiently as possible, the minimum amount of energy would be expended. Difficult as this may seem, it should nonetheless be the long-range goal for every building.

Reducing heat gained and lost through windows, walls, and doors would reduce the heating and cooling costs of a building. Heating and cooling costs can also be reduced significantly by improving the operating efficiency of the heating and cooling systems.

In order to determine the efficiency with which a house uses energy, both energized and non-energized systems must be considered. These will be covered in section IIC.

1. Non-Energized Systems

General physical features bearing upon energy efficiency include the shape, conduction and infiltration, thermal mass of the building envelope, and the siting and orientation of the property.

The shape of a home is important in a variety of ways. Most significant is the difference between one- and two-story homes containing similar living areas. The two-story home generally is more efficient than the one-story residence because exterior square-foot exposure is less. The roof over two 750-square-foot stories is smaller and more efficient than the roof over a single 1,500-square-foot story, for example.

Conduction and infiltration are processes by which a structure gains and loses heat through the skin of the building. More specifically, conduction is the movement of heat through the building skin. Heat always moves from warm to cold, meaning that, in the summer, heat moves from the outside to the inside, while the reverse is true in the winter. Insulation can reduce conduction, thereby lowering energy bills.

Infiltration is the leakage of air. It depends upon the number, size, and location of cracks in the building skin. Wind intensity also may contribute to infiltration. Infiltration can be reduced by caulking, weatherstripping, and paying particular attention to air leaks up furnace and fireplace chimneys.

Thermal mass is the relative weight of the building's structural components, such as walls and roofs. An all masonry or a stone house would have a high thermal mass, while a wood-frame house would have a relatively low thermal mass. High thermal mass tends to level the effect of temperature extremes on heating and cooling loads. Depending upon the construction, however, the benefits of high thermal mass can vary considerably. Masonry and stone building materials in themselves are relatively poor insulators, and an uninsulated house built of these materials would not necessarily have low utility costs.

The siting orientation of a property on a lot can affect its energy use substantially. Good designs make use of structural elements or landscaping to take advantage of the sun's heat during cool seasons and to protect the house from the sun's heat in hot seasons.

2. Energized Systems

Systems within the home that directly consume energy--such as heating, air conditioning, domestic water heating, lighting, and appliances--are considered energized systems.

Heating and air conditioning system energy requirements are in direct response to the effect of the non-energized systems. Their purpose is to maintain a comfortable environment for the occupants. Homes with identical non-energized systems can vary considerably in energy requirements because of the difference in efficiency of the energized systems. For example, a gravity type furnace may have a seasonal efficiency of 57 percent (43 percent of the energy into the furnace is lost--primarily up the flue). A new energy-efficient gas furnace

may have a seasonal efficiency of 80 percent. Thus, the cost to heat the home with the energy-efficient furnace would be 23 percentage points less than that with the gravity furnace, yet the non-energized systems would contribute equally to the energy requirements of the house.

Other items contribute to the energy requirements of energized systems. These include such things as the degree to which the systems are oversized, the level of system maintenance, and the method by which the systems are used, such as the drying cycle on a dishwasher.

3. Human Systems

The human element in energy usage is extremely important. As suggested by the energy-efficiency matrix at the introduction to Section II, two identical houses could have vastly different utility costs only because of the behavior of the occupants. Appraisers must assume, however, that future occupants will behave in a typical manner; and, therefore, behavior, preferences, and number of occupants will not be considered in this energy analysis.

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B. Collecting Energy Cost Information

Energy costs are important because they are, obviously, the most pertinent measure of energy use as it relates to property value. One inherent problem with energy-cost data, however, is that they incorporate the effects of lifestyle, with which the appraiser should not be concerned. With proper attention to the possibly distorting effects of personal and family behavior, the appraiser can, in most cases, make a well-reasoned assessment of the ways in which energy costs can have an impact upon value.

As is the case throughout the appraisal process, the appraiser should collect sufficient data to allow for meaningful comparison of his/her subject property to other properties in the market. The greatest possible volume of energy data (e.g., utility and fuel bills) should be accumulated in an orderly manner. Copies of utility bills may be obtained from the current owners or from the companies providing service to the property. Such information then should be reduced to a common unit of comparison, which typically would be the square-foot basis in single-family residences.

Figure II.2. Collecting Energy Cost Information

Return postage guaranteed to:
THE KANSAS POWER AND LIGHT COMPANY
 BOX 889 TOPEKA KS 66601

MAR 28

5

YOUR ACCOUNT NUMBER	FUEL COST ADJUSTMENT INCLUDED	LOCAL REVENUE CHARGE INCLUDED	STATE SALES TAX INCLUDED	SERVICE TO MO & DAY & YEAR
64005200	257	273		011680
TYPE OF SERVICE	PRESENT METER READING	BILLING CAPACITY	KWH OR MCF USED	NET AMOUNT
ELECTRIC	48413	18	2179	8025

PLEASE RETURN THIS STUB WITH PAYMENT.

ROBERT P PUBLIC
 1515 W 10TH
 TOPEKA KS 66699

THIS AMOUNT DUE AFTER	AMOUNT NOW DUE
\$81.85 FEB 15	\$80.25

51201 640 05200

8185 FEB 15 8025

However, the appraiser can ascertain only the energy consumption of the subject property when lived in by current or previous occupants. Accumulation and

analysis of such information does not necessarily allow for reliable projection of future energy use by the subject property if lived in by anyone else.

A calculation of total energy usage for a one-year period would resemble Table II.1.

Table II.1. EXAMPLE OF ENERGY USAGE FOR ONE-YEAR PERIOD

<u>Month</u>	<u>Gas</u>	<u>Electricity</u>
Jan.	\$163.92	\$ 33.05
Feb.	120.35	26.12
Mar.	96.45	21.30
Apr.	26.17	27.15
May	19.53	23.42
June	23.41	21.70
July	22.11	29.30
Aug.	27.32	31.75
Sept.	50.45	26.25
Oct.	75.00	24.43
Nov.	120.60	21.15
Dec.	<u>137.00</u>	<u>26.43</u>
Total	\$882.31	\$312.05

Total energy cost is computed as follows:

$$\$882.31 + \$312.05 = \$1,194.36.$$

Assuming square footage of 1,560 (conditioned space only; unheated garages, basements, and the like should be excluded from the calculations), this is equivalent to about 77¢ per square foot per year:

$$\frac{\$1,194.36}{1,560 \text{ square feet}} = \$0.766 \text{ per square foot.}$$

If the appraiser could determine from comparable data that similar residences (i.e., same number of stories, same type of construction materials) typically have energy costs of \$1.10 per square foot, then he/she might be able to judge that the subject's energy savings could be transferred in whole or in part to the value of the subject, and an adjustment should be made accordingly.

Energy Measurement

It is useful to understand the units that are used when talking about energy. Table II.2 shows the typical energy used in conjunction with buildings. Table II.3 shows energy conversion factors.

Table II.2. ENERGY UNITS

Btu	British Thermal Unit
Kwh	Kilowatt Hour - Electricity 3,413 Btu/Kwh
CF	Cubic Foot - Gas 1,000 to 1,030 Btu/CF
Therm	Gas - 100,000 Btu/Therm
Gallon	Oil - 130,000 to 150,000 Btu/Gallon
Pounds	Steam - 1,000 Btu/Pound

Table II.3. ENERGY CONVERSION FACTORS

<u>To Convert</u>	<u>Into</u>	<u>Multiply by</u>
Barrels, oil	gallons	42.0
Cubic feet, natural gas	therms	0.01
Cubic feet, natural gas	Btu's	1,020
MCF natural gas	Btu's	1,000,000
Therms, natural gas	cubic ft.	100
Therms, natural gas	Btu's	100,000
Gallons, No. 2 fuel oil	Btu's	138,000*
Gallons, No. 4 fuel oil	Btu's	145,000*
Gallons, No. 5 fuel oil	Btu's	148,000*
Gallons, No. 6 fuel oil	Btu's	150,000*
Gallons, Kerosene	Btu's	135,000*
Gallons, Gasoline	Btu's	125,000*
Gallons, diesel oil	Btu's	138,700*
Kilowatt-hours (electricity)	Btu's	3,413
Steam, saturated (lbs.)	Btu's	970

*These are average values. Exact Btu content varies with type and source.

The most common unit is the Btu--the British thermal unit. Scientifically speaking, it is the amount of heat necessary to raise the temperature of one pound of water one degree Fahrenheit. A simple approximation that is commonly used is the amount of heat that is obtained by the burning of one match. All forms of energy can be measured in terms of Btu's. Since buildings consume large quantities of energy, thousands and millions of Btu's per square foot or per apartment are used frequently to describe the energy performance of a building.

The basic unit of electric energy is the kilowatt hour (1,000 watt-hours). Each kilowatt hour contains 3,413 Btu's.

Natural gas is usually sold in multiples of cubic feet, each of which contains 1,000 to 1,030 Btu's. Gas is also sold by the Mcf, or 1,000 cubic feet. Some utilities sell gas by the Therm, which is defined to have 100,000 Btu's. The cost of natural gas is usually expressed in cents per Therm or dollars per Mcf.

Fuel oil is usually sold by the gallon. A gallon of fuel oil contains from 130,000 to 150,000 Btu's, depending on the grade. The Btu content of fuel oil also varies from truck load to truck load. Typically, the residential or light weight fuel oils have heating values in the range of 130,000 to 140,000 Btu's per gallon.

For those buildings that purchase steam from a utility company, the quantity of steam is usually expressed in pounds or M pounds, which is 1,000 pounds. There are approximately 1,000 Btu's per pound, although, depending upon the pressure and temperature, the heat content of the steam purchased for buildings can range from a low of 800 to a high of 1,200 Btu's per pound or more.

Occasionally, it is advantageous to look at the energy cost per million Btu's for various types of energy. Table II.4 shows the conversion process necessary to compare energy source costs. For convenience, the comparison is based on the cost per million Btu's. Assumptions are made as to initial energy cost and combustion efficiencies.

Table II.4. RELATIVE COSTS OF DIFFERENT FUELS

Example 1: Natural Gas

One Cubic Foot of Natural Gas = 1,000 Btu
One Hundred Cubic Feet (CCF) = 100,000 Btu
One Thousand Cubic Feet (MCF) = 1,000,000 Btu
or 1×10^6 Btu
One Therm of Natural Gas = 100,000 Btu

Assuming that natural gas sells for \$2.00/MCF and the gas furnace is 60 percent efficient (40 percent of the energy input is lost up the flue), the cost of the useful heat produced is as follows:

$$\frac{(\$2.00/\text{MCF}) (1,000,000 \text{ Btu})}{(1,000,000 \text{ Btu/MCF}) (0.6)} = \$3.33/\text{million Btu}$$

Example 2: Oil

Assuming (a) that one gallon of #2 oil contains 141,000 Btu/gallon, (b) that the cost of one gallon of #2 oil equals \$0.95, and (c) that the furnace is 60 percent efficient, the cost of the useful heat produced is as follows:

$$\frac{(\$0.95/\text{gallon}) (1,000,000 \text{ Btu})}{(0.6) (141,000 \text{ Btu/gallon})} = \$11.23/\text{million Btu}$$

Example 3: Electricity

1 Kwh = 3,413 Btu

Assuming that the cost of one Kwh is 4.17¢, and that the electric furnace is 100 percent efficient, having no flue, the cost of useful heat produced is as follows (remember that 1 Kwh = 3,413 Btu's):

$$\frac{(4.17\text{¢}/\text{MCF}) (1,000,000 \text{ Btu})}{(3,413 \text{ Btu/Kwh}) (100\text{¢}/\$)} = \$12.22/\text{million Btu}$$

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II-14

C. Identifying "Special Energy-Efficient Items"

The Federal Home Loan Mortgage Corporation defines an energy-efficient property as:

. . . one which uses cost effective design, materials, equipment, and site orientation in providing conservation of non-renewable fuels. Implicit in this definition are proper design and installation of materials and equipment consistent with climatic conditions in the area.

Energy-efficient items recognized by FHLMC include, but are not limited to the items listed on pages I-3 and I-4 of Section I of this notebook. Each of these is discussed more fully in this portion of the seminar.

1. Insulation

Insulation is material installed in a structure to reduce heat flow, thereby also reducing annual fuel consumption and allowing smaller and less expensive mechanical systems than would be necessary otherwise.

The standard measure of the efficiency of insulation is R-value. R-value is an index for comparing the resistance quality of various insulation forms. Higher R-value means better resistance to the conduction of heat.

Insulation comes in five basic forms:

- Blankets, which are made of glass fiber or mineral wool and come in thicknesses of one to 10 inches and lengths of 16 to 64 feet. They can be installed by the homeowner or a contractor.
- Batts, which are also made of glass fiber or mineral wool, are precut into four- or eight-foot lengths for easy handling. They also can be installed by either homeowner or contractor.
- Rigid Boards, which are made of polystyrene, polyurethane, isocyanurate, and glass fiber. They are used primarily in basement walls, as sheathing in exterior walls under construction, and on top of roof decks. Since they are combustible, it is normally required that they be covered with a fireproof material. They generally are installed by a contractor.
- Loose fill (blown or poured in), which is made of mineral wool, glass fiber, cellulose fiber, vermiculite, or perlite. It can be poured into places that do not have regularly spaced rafters or joists. Special equipment can blow these materials into hard-to-reach places. This usually is installed by a contractor.

- Foam Insulation, which is made up of resin, hardener, and air. The material is made at the home by mixing these ingredients and injecting them into the walls of the house. The most common foam insulation used in houses is urea formaldehyde (UF). Because UF foam can break down chemically at high temperatures, it should not be used in attics and cathedral ceilings, which can be very warm. Special care also must be taken in installation, as an exact proportion of chemicals is necessary in order to ensure proper curing and avoid excessive shrinkage. Foam insulation cannot be installed without specialized equipment and trained personnel.

For more information on types of insulation, see Table II.6.

How is Insulation Measured?

R-value is the measure of the thermal resistance value of insulation, and the table given with each insulation feature shows what R-value is suggested for your climate zone. Different kinds of insulation materials have different R-values per inch of thickness. Table II.5 indicates the R-value per inch of various types of insulation. Here are some hints to identify the various types of insulation seen most often. They are all made of fine, short (1/2" or less) fibers:

- Glass fiber - white, yellowish, or pink fibers; the fibers are shiny because they are made of glass;
- Rock wool - also called 'mineral wool;' white or grayish dull fibers; can resemble compacted cotton wool; and
- Cellulose - grayish fibers, often with bits of color; it resembles (and is) finely chopped newspaper.

Table II.5. THICKNESS OF INSULATION PER R-VALUE (In inches)

	<u>Batts or Blankets</u>		<u>Loose Fill (Poured in)</u>		
	Glass Fiber	Rock Wool	Glass Fiber	Rock Wool	Cellulosic Fiber
R-11	3.5-4	3	5	4	3
R-13	4	4.5	6	4.5	3.5
R-19	6-6.5	5.5	8-9	6-7	5
R-22	6.5	6	10	7-8	6
R-26	8	8.5	12	9	7-7.5
R-30	9.5-10.5	9	12-13	10-11	8
R-33	11	10	15	11-12	9
R-38	12-13	10.5	17-18	13-14	10-11

To determine the climate zone for a particular area, see Table II.7, which provides zip codes and corresponding climate zones. The table and the recommended levels of "special energy efficient items" used in this workbook were developed for the Residential Conservation Service (RCS) program by the Department of Energy in 1979.

Venting is an important consideration in the use of attic insulation. Since summer temperatures in attics can reach 135°, lack of ventilation can add a considerable burden to the house's cooling system. During winter months, condensation could form in the upper walls and ceiling near the attic. This could well damage wood, insulation, paint, and plaster. A recommended ratio for venting is one square foot of venting for each 150 square feet of attic floor area. If there are vapor barriers, there should be one square foot of venting area for every 300 square feet of attic floor area. Attic fans are not required with proper venting.

The standard FHLMC/FNMA appraisal form for single-family residences provides boxes for the appraiser to mark to show no insulation or insulation in the floor, ceiling, roofs, and/or walls of the subject property (see Item B on Page I-7 of Section I of this notebook).

Floor Insulation

Floor insulation saves energy by reducing heat loss through the floor to unconditioned spaces below. This feature is perhaps most important in houses heated with electric resistance heating or in homes whose heating plant is not located in the basement. Floor insulation is visible if the basement or garage has an unfinished ceiling. It normally is placed between the floor joists, with the vapor-barrier side up. Wire braces spaced several inches apart often hold the insulation in place.

How Much Floor Insulation is Enough?

Region	1	2	3	4	5	6	7	8
Oil, Gas	NR	11	NR	11	11	11	11	19
Electric Resistance Heat	NR	11	11	19	19	19	19	19

Crawl Space Insulation

Related to floor insulation is crawl space insulation, which slows down the exchange of heat between outside and inside. Crawl spaces can be insulated cost effectively if they are easily accessible. Only a flashlight is necessary to determine if a crawl space is insulated.

Crawl spaces may be protected by installing insulation on the interior of the foundation wall or immediately beneath the floor. If the foundation wall is to be insulated, the band space, or perimeter joists, should be insulated as well as the wall itself. Any pipes in the crawl space also should be insulated. In

Table II.6. INSULATION MATERIALS

Batts/Blankets

Preformed glass fiber or rock wool with or without vapor barrier backing.

Fire resistant, moisture resistant, easy to handle for do-it-yourself installation, least expensive. Fiberglass may cause skin irritation.

Unfinished attic floor; rafters; underside of floors; between studs.

Foamed in Place

Plastic installed as a foam under pressure. Hardens to form insulation.

1. Urethane
2. Ureaformaldehyde
3. Polystyrene

1. Has highest R-value. If ignited, burns explosively and emits toxic fumes. Should be covered with 1/2" gypsum wallboard to assure fire safety.
 2. Fire resistant, high R-value, first choice of many experts. Requires installation by reliable experienced contractor (as all foams do). May shrink or cause odor problems if improperly mixed or cured, and is light sensitive.
 3. Lacks fire resistance as does urethane and has lower R-value than urethane.

Finished frame walls; floors; ceilings.

Ureaformaldehyde can be used as a masonry or block insulation in place of pealite, vermiculite, or styrene beads. Foams should not be used in hot, humid climates.

Rigid Board

1. Extruded polystyrene bead
2. Extruded polystyrene
3. Urethane
4. Glass fiber

All have high R-values for relatively small thickness. 1,2,3. Are not fire resistant, require installation by contractor with 1/2" gypsum board to insure fire safety.
 2. Is its own vapor barrier.
 3. Is its own vapor barrier, however, when in contact with water, it should have a skin to prevent degrading.
 1,4. Require addition of vapor barrier.

Basement walls; new construction frame walls; commonly used as an outer sheathing between siding and studs.

Loose Fill
(Poured-in)

1. Glass fiber
2. Rock wool
3. Treated cellulosic fiber

All easy to install; require vapor barrier bought and applied separately. Vapor barrier may be impossible to install in existing walls.
 1,2. Fire resistant, moisture resistant.
 3. Check label to make sure material meets federal specifications for fire, and moisture resistance and R-value.

Unfinished attic floor; uninsulated existing walls.

Table II.6. INSULATION MATERIALS (cont'd)

Loose Fill
(Blown in)

1. Glass fiber	All require vapor barrier bought separately; all require space to be filled completely. Vapor barrier may be impossible to install in existing walls.	Unfinished attic floor; finished attic floor; finished frame walls; underside of floors.
2. Rock wool		
3. Treated cellulosic fiber	1,2. Fire resistant, moisture resistant. 3. Fills up spaces most consistently. When blown into closed spaces, has slightly higher R-value; check label for fire and moisture resistance and R-value. Chemicals added to cellulose may reduce its thermal resistance; a potential for corroding pipes exists if too many sulfate chemicals are added.	

the case of slab structures situated on grade, only the outer two feet of the perimeter of the slab need be insulated.

How Much Crawl Space Insulation is Enough?

Region	1	2	3	4	5	6	7	8
Oil, Gas	NR	11	11	11	11	19	19	19
Electric Resistance Heat	NR	11	19	19	19	19	19	19

Sill Area Insulation

In many homes, the biggest source of air leakage or infiltration is at the sill area, where wood meets the foundation. Caulking reduces the leakage by covering up pathways for air flow. In new construction, a sill sealer (a semi-rigid fibrous insulation) may be placed between the foundation and the sill to reduce infiltration. In addition, the band space above the sill plate should be insulated to reduce conductive heat loss. This is a heat-loss area that is relatively easy to cure. The presence of sill-area insulation can be determined by examination of the tops of the basement walls. If present, well-fitted blanket insulation will be evident.

Table II.7. Zip Codes and Climate Zones

If Your Zip Code Begins With These 3 Numbers	Your Climate Zone Is	084 5	178 6	264 6	360 2	457 5	559 8	665 6	773 2	890 2
		085 6	179 6	265 6	361 2	458 6	560 8	666 6	774 2	891 2
		086 6	180 6	266 5	362 3	460 6	561 8	667 4	775 2	893 8
		087 6	181 6	267 6	363 2	461 6	562 8	668 5	776 2	894 7
		088 6	182 7	268 5	364 2	462 6	563 8	669 6	777 2	895 7
		089 6	183 6	269 5	365 2	463 7	564 8	670 5	778 2	897 7
		090 6	184 7	270 4	366 2	464 7	565 8	671 5	779 2	898 8
		100 6	185 7	271 4	367 2	465 7	566 8	672 5	780 1	900 2
		103 5	186 7	272 4	368 2	466 7	567 8	673 4	781 2	902 2
		104 5	187 7	273 4	369 2	467 7	570 8	674 5	782 2	903 2
		105 6	188 7	274 4	370 4	468 7	571 8	675 5	783 1	904 2
		106 6	189 7	275 3	371 4	469 6	572 8	676 6	784 2	905 2
010	7	107 5	190 6	276 3	372 4	470 5	573 8	677 6	785 1	906 2
011	7	108 6	191 5	277 3	373 3	471 5	574 8	678 6	786 2	907 2
012	8	109 6	193 5	278 3	374 3	472 6	575 8	679 5	787 2	908 2
013	7	110 5	194 5	279 3	376 5	473 6	576 8	680 7	788 2	910 2
014	7	111 5	195 6	280 3	377 4	474 5	577 8	681 7	790 4	911 2
015	7	112 5	196 6	281 3	378 4	475 5	580 8	683 7	791 4	912 2
016	7	113 5	197 5	282 3	379 4	476 4	581 8	684 7	792 3	913 2
017	7	114 5	198 5	283 3	380 3	477 4	582 8	685 7	793 4	914 2
018	6	115 5	199 5	284 2	381 3	478 6	583 8	686 7	794 4	915 2
019	6	116 5	200 4	285 3	382 4	479 6	584 8	687 8	795 3	916 2
020	6	117 5	202 4	286 3	383 3	480 7	585 8	688 7	796 3	917 2
021	6	118 5	203 4	287 4	384 3	481 7	586 8	689 6	797 3	918 2
022	6	119 5	204 4	288 4	385 4	482 7	587 8	690 6	798 3	920 2
023	6	120 7	205 4	289 4	386 3	484 8	588 8	691 7	799 3	921 2
024	6	121 7	206 4	290 2	387 3	485 8	590 8	692 8	800 7	922 2
025	6	122 7	207 4	291 2	388 3	486 8	591 8	693 7	801 7	923 2
026	6	123 8	208 4	292 2	389 3	487 8	592 8	700 2	802 7	924 2
027	6	124 7	209 4	293 3	390 2	488 7	593 8	701 2	803 6	925 3
028	7	125 6	210 5	294 2	391 2	489 7	594 8	703 2	804 8	926 2
029	7	126 6	211 5	295 3	392 2	490 7	595 8	704 2	805 8	927 2
030	7	127 7	212 5	296 3	393 2	491 7	596 8	705 2	806 7	928 2
031	7	128 8	214 4	297 3	394 2	492 7	597 8	706 2	807 7	930 2
032	8	129 8	215 6	298 2	395 2	493 8	598 8	707 2	808 7	931 2
033	8	130 7	216 4	299 2	396 2	494 8	599 8	708 2	809 7	932 2
034	8	131 7	217 5	300 3	397 3	495 8	600 8	710 2	810 6	933 2
035	8	132 7	218 4	301 3	400 4	496 8	601 7	711 2	811 8	934 2
036	8	133 7	219 5	302 3	401 4	497 8	602 7	712 2	812 8	935 2
037	8	134 7	220 5	303 3	402 4	498 8	603 7	713 2	813 8	936 3
038	8	135 7	221 5	304 2	403 5	499 8	604 7	714 2	814 8	937 3
040	8	136 8	222 5	305 3	404 5	500 7	605 7	716 3	815 6	939 2
041	8	137 8	223 5	306 3	405 5	501 7	606 7	717 3	816 8	940 3
042	8	138 8	224 4	307 3	406 4	502 7	609 6	718 3	820 8	941 3
043	8	139 8	225 4	308 2	407 4	503 7	610 7	719 3	822 7	943 3
044	8	140 7	226 5	309 2	408 4	504 8	611 7	720 3	823 8	944 3
045	7	141 7	227 5	310 2	409 4	505 7	612 7	721 3	824 8	945 3
046	7	142 7	228 5	312 2	410 5	506 8	613 6	722 3	825 8	946 3
047	8	143 8	229 4	313 2	411 5	507 8	614 7	723 3	826 8	947 3
048	7	144 7	230 4	314 2	412 5	508 7	615 7	724 4	827 8	948 3
049	8	145 7	231 4	315 2	413 4	510 8	616 7	725 3	828 8	949 3
050	8	146 7	232 4	316 2	414 4	511 8	617 6	726 4	829 8	950 2
051	8	147 7	233 3	317 2	415 5	512 8	618 6	727 4	830 8	951 2
052	8	148 7	234 3	318 2	416 5	513 8	619 6	728 3	831 8	952 3
053	8	149 7	235 3	319 2	417 4	514 7	620 5	729 3	832 7	953 3
054	8	150 6	236 3	320 2	418 4	515 7	622 5	730 4	833 8	954 3
056	8	151 6	237 3	322 2	419 4	516 6	623 6	731 4	834 8	955 5
057	8	152 6	238 4	323 2	420 4	520 8	624 5	734 3	835 6	956 3
058	8	153 6	239 4	324 2	421 4	521 8	625 6	735 3	836 6	957 3
060	7	154 6	240 4	325 2	422 4	522 7	626 6	736 4	837 6	958 3
061	7	155 7	241 4	326 1	423 4	523 7	627 6	737 4	838 7	959 2
062	7	156 6	242 5	327 1	424 4	524 7	628 5	738 4	840 6	960 4
063	6	157 6	243 4	328 1	425 4	525 7	629 4	739 5	841 6	961 7
064	7	158 8	244 4	329 1	426 4	526 7	630 5	740 4	843 6	970 5
065	7	159 6	245 4	330 1	427 4	527 7	631 5	741 4	844 6	971 5
066	6	160 6	246 6	331 1	430 6	528 7	633 5	743 4	845 6	972 5
067	7	161 6	247 6	333 1	431 6	530 8	634 6	744 4	846 8	973 5
068	6	162 6	248 6	334 1	432 6	531 8	635 6	745 3	847 7	974 5
069	6	163 7	249 6	335 1	433 6	532 8	636 5	746 4	850 2	975 5
070	6	164 7	250 4	336 1	434 7	534 7	637 4	747 3	852 2	976 7
071	6	165 7	251 4	337 1	435 7	535 8	638 4	748 3	853 2	977 7
072	6	166 7	252 4	338 1	436 7	537 8	639 4	749 3	855 3	978 6
073	6	167 7	253 4	339 1	437 6	538 8	640 5	750 2	856 2	979 6
074	6	168 7	254 4	350 3	438 6	539 8	641 5	751 2	857 2	980 4
075	6	169 7	255 4	351 3	439 6	540 8	644 6	752 2	859 6	981 4
076	6	170 6	256 4	352 3	440 7	541 8	645 6	754 2	860 8	982 6
077	6	171 6	257 4	353 3	441 7	542 8	646 5	755 2	863 5	983 5
078	7	172 6	258 6	354 3	442 7	543 8	647 5	756 2	864 3	984 5
079	6	173 6	259 6	355 3	443 7	544 8	648 4	757 2	865 6	985 6
080	5	174 6	260 6	356 3	444 7	545 8	650 5	758 2	870 4	986 7
081	5	175 6	261 5	357 3	445 7	546 8	651 5	759 2	871 4	988 7
082	5	176 6	262 6	358 3	446 7	547 8	652 6	760 2	873 6	989 6
083	5	177 6	263 6	359 3	447 7	548 8	653 5	761 2	874 6	990 7
					448 6	549 8	654 5	762 3	875 7	991 7
					449 6	550 8	655 5	763 3	877 7	992 7
					450 6	551 8	656 5	764 2	878 6	993 6
					451 6	552 8	657 5	765 2	879 4	994 6
					452 6	553 8	658 5	766 2	880 4	995 8
					453 6	554 8	660 5	767 2	881 4	996 8
					454 6	556 8	661 5	768 2	882 3	997 8
					455 6	557 8	662 5	769 2	883 5	998 8
					456 6	558 8	664 6	770 2	884 4	999 8

How Much Sill Area Insulation is Enough?

Region	1	2	3	4	5	6	7	8
Amount of Insulation R-	11	11	11	11	11	19	19	19

If any sill-area insulation exists, no more should be added.

Attic Insulation

Attic and ceiling insulation saves energy by slowing down the flow of heat through a house's uppermost ceiling. This reduces heat loss in the winter and heat gain in the summer, which will reduce both heating and cooling costs.

Because hot air rises and because the roof is a large surface area exposed to wind, snow, and sun, the roof is a major source of heat loss and gain. Attic insulation usually is easy to install and generally pays for itself very quickly. In addition, attic insulation often allows the top floor to be used in all seasons.

Attics may be classified as unfinished and unfloored; unfinished, but floored; and finished. The unfinished, unfloored attic is easiest to check for insulation. Either blankets or loose-fill insulation is generally installed on the floor of the attic. A flashlight may be necessary when inspecting between the joists to see if any insulation is present.

In the unfinished but floored attic, insulation may be located either under the floor boards, in the form of blankets or loose-fill insulation, or in the rafter spaces, where insulation typically will be either of blanket or batt. In the finished attic or cathedral ceiling, it may be difficult to determine whether any insulation exists unless there are hatches to permit access and inspection.

How Much Attic Insulation is Enough?

Region	1	2	3	4	5	6	7	8
Oil, Gas	19	19	22	30	30	30	30	38
Electric Resistance Heat	19	22	30	30	30	30	38	38

Wall Insulation

Wall insulation reduces the effects of conduction and infiltration. An insulated wall has a higher R-value than an uninsulated one, resulting in higher efficiency and lower heating and cooling expenses.

Electrical switches, outlets, baseboards, ceiling mouldings, and window and door trim are leaky areas in the walls. Since it would not be practical to plug these leaks completely, installation of wall insulation can help by blocking the pathway of the air after it enters the house. Ease of installation and local climate determine whether wall insulation is a practical weatherization option.

Wall insulation is difficult to see in an existing home. A hole might permit easy inspection of the insulation, but likely would represent a glaring source of heat loss. It may be possible to assess the existence of wall insulation by removing an electrical outlet cover on an exterior wall and looking into the wall cavity with the aid of a flashlight. Sometimes the wall cavity can be viewed from the attic or the basement. The appraiser should be careful that he/she is not looking at a remodeled portion of the home. Secondly, the appraiser should be aware that insulation in one wall does not guarantee the presence of insulation in all walls.

Most wall insulation is glass fiber, loose fill, or foam.

How Much Wall Insulation is Enough?

Wall insulation is recommended in every climate zone, except zone 1.

Hot Water Tank Insulation

Other forms of insulation may be beneficial as well. For example, hot water tanks tend to lose heat by conduction and convection. If the tank is warm to the touch, it probably needs insulation. Insulating jackets are simple and inexpensive to install. This feature is recommended in all climate zones.

Pipe and Duct Insulation

In heating and central air conditioning systems, conditioned air or water travels from the heating or cooling source through metal ducts or pipes to registers or radiators in the living space. Insulation wrapped around the ducts and pipes slows down the conduction and saves energy. Insulating ducts and pipes that run through unconditioned spaces is an important, cost-effective way to save energy; when such pipes and ducts run through living spaces, insulation generally is not necessary, as any heat that escapes will contribute to the space-heating needs of the house.

Unconditioned spaces where ducts and pipes should be inspected for insulation include basements, crawl spaces, garages, and attics. Pipe insulation generally is of elastomeric rubber--a black, foam-rubber-like substance--or rigid glass fiber, which is a white, yellow, or pink fibrous substance usually fitted with a vinyl or paper jacket. Duct insulation usually is a vinyl or foil-backed glass fiber blanket wrapped around the ducting system. The backing is a vapor barrier and should be faced toward the living area.

How Much Duct Insulation is Enough?

Region	1	2	3	4	5	6	7	8
Duct Insulation R-	7	7	7	7	13	13	13	13

Heating-pipe insulation is recommended in all regions.

2. Caulking and Weatherstripping

Caulking and weatherstripping work by reducing infiltration. The more airtight a building, the less frequently its heating or cooling system will have to turn on to adjust incoming outdoor air to room temperature. Outdoor air seeps in easily through gaps around windows, doors, electrical outlets and switches, and through fireplaces. This unintentional ventilation can account for up to 50 percent of the heat loss of an unweatherized building.

Weatherstripping is especially important in older homes or in those with ill-fitting windows and doors. Caulking and weatherstripping are low-cost, simple, do-it-yourself measures with typically short payback periods.

The appraiser should look for caulking between window and door frames and siding, between chimney and siding, and at the sill area, where the foundation meets the walls of the house. In fact, caulking should be visible between any two different building materials. All doors and windows to unheated parts of the house and to the outdoors should be fitted with weatherstripping. Weatherstripping may be found at door jambs and window channels and may be made of metal, felt, plastic foam, rubber, or vinyl.

The amount of outdoor air leaking into a house can be significantly affected by vertical passages through hollow walls, laundry chutes, along cracks up chimneys, and through attic scuttles. These passages have been labeled "attic bypasses," and should be controlled wherever possible. Stuffing noncombustible insulation in cracks along chimneys, and weatherstripping attic scuttles are two ways of reducing the effect.

How Much Caulking and Weatherstripping is Enough?

Any crack or gap between conditioned inside air and either outside or unheated spaces (i.e., attics, basements, or garages) should be filled. In addition to cracks around windows and doors, any penetrations through the exterior wall should be treated. These measures are recommended in all climate zones.

For more information on caulking and weatherstripping, see Table II.8.

Table II.8. CAULKING AND WEATHERSTRIPPING MATERIALS

<u>Type</u>	<u>Comments</u>	<u>Application</u>
<u>Caulking Compounds</u>		
1. Oil or resin base	1. Lowest cost, least durable; replacement time approximately 2 years.	At stationary joints; exterior window and door frames; whenever different materials or parts of building meet.
2. Latex, butyl, polyvinyl base	2. Medium priced, more durable; look for guarantees on time of durability..	
3. Elastomeric base: silicones, polysulfides, polyurethanes	3. Most expensive, most durable. Recommended by some experts as the best buy.	
	Note: Lease base caulk is not recommended because it is toxic.	
<u>Weatherstripping</u>		
1. Felt or foam strip	1. Inexpensive, easy to install, not very durable.	At moving joints; perimeter of exterior doors; inside of window sashes.
2. Rolled vinyl; with or without metal backing -	2. Medium priced, easy to install, durable, visible when installed.	
3. Thin spring metal	3. More expensive, somewhat difficult to install. Very durable, invisible when installed.	
4. Interlocking metal channels	4. Most expensive, difficult to install, durable, excellent weather seal.	

3. Double or Triple Pane Windows

Well-oriented and unobstructed windows admit the sun's heat and light directly into the structure. Windows, however, are also a major source of heat loss; a single pane conducts 10 to 20 times as much heat as a well-insulated wall. A second layer of glazing, whether of glass or plastic, placed over a window creates a dead air space between the two panes and doubles the ability of the window to resist heat flow.

In addition to reducing conductive losses, extra glazing helps to reduce infiltrative losses. Since materials conduct heat rapidly when the temperature gradient is large, additional layers of glass or plastic are important whenever there is a large difference between inside and outside temperature. Two panes are better than one, and three panes may be cost-effective in some climate zones.

The easiest type of multiple glazing to recognize is a primary window fitted with an aluminum or wood storm window. Multiple glazing can be observed either

from inside or outside of the house. In colder areas and in newer construction, thermal-pane windows are becoming common. Examination of the spot where the glass meets the frame will reveal if more than one layer is present.

How Many Glazing Layers are Enough?

Region	1	2	3	4	5	6	7	8
Oil, Gas	1	1	1	2	2	2	2	3
Electric Resistance Heat	1	2	2	2	3	3	3	3

All double-hung or sliding windows should have a locking device. This not only improves the security of the home, but tends to prevent the windows from slipping, thus affording protection from small, infiltrative cracks at the top of the window sill.

4. Window Shading or Landscaping for Solar Control

As noted previously, shading and orientation, or placement on the lot, can maximize the benefits of exposure to the sun. Deciduous trees provide shade in summer and, when they lose their leaves, permit the sun to warm the house in the winter. Overhangs and other architectural devices can be designed to block the high summer sun, but allow maximum exposure during cooler months.

How Much Shading is Enough?

While shading and landscaping for environmental control are desirable in all climate zones, the proper amount of each depends on such factors as number and orientation of windows, latitude, lot shape, and the like.

5. Storm Fittings (Doors)

Storm doors save energy by reducing infiltration and conduction. Although they do not save significant amounts of energy relative to their cost, they may be cost effective when placed over ill-fitting, flimsy, or all-glass doors, or when installed in houses exposed to long and severe winters. Weatherstripping an existing door costs much less than purchasing a new storm door, and usually saves as much or more energy. Non-energy advantages of storm doors include increased security and allowance for a screen door during the summertime.

Are Storm Doors Recommended?

Region	1	2	3	4	5	6	7	8
Oil, Gas	N	N	N	N	N	N	N	Y
Electric Heat Pump	N	N	N	N	N	Y	Y	Y
Electric Resistance Heat	N	N	N	N	Y	Y	Y	Y

6. Automatic Setback Thermostat

A clock thermostat saves energy by automatically lowering the thermostat setting when the occupants of the house are sleeping or away. A 10° setback for eight hours can save 10 percent of an occupant's fuel bill (see Table II.9). Two eight-hour setbacks in a day will save nearly double this amount. If a house has central air conditioning, a clock thermostat also can be set to increase the temperature setting during specific hours of the day in the summer and achieve summer savings as well.

Savings depend upon the setting chosen by the inhabitants, local climate, and the physical characteristics of the house. Cooling savings average about three percent of the cooling bill for each degree of permanent change in setting.

7. Heating, Cooling, Lighting Systems and Appliances

Heating systems are of two basic types--those that heat air and those that heat water or produce steam. While the term furnace can refer to either type of system, only hot water and steam systems have boilers. For purposes of this section, reference to furnace modifications and furnace efficiencies includes both types of systems.

Hot-air systems are those in which hot air travels through ducts to registers where it gives off heat into the living area of the house. In boiler systems, hot water or steam travels through pipes to radiators, convectors, or pipes located in the ceiling or floor. The water or steam then emits heat to the living space. A heat pump is a combination heating and cooling system. It will be discussed later in this section.

Furnaces and Boilers

Combustion space heating units such as boilers and forced air furnaces vary in their heating efficiencies (energy leaving the device for space heating versus energy entering the units). The efficiency is a function of the design of the heating unit, the capacity of the unit relative to the requirements of the structure, the maintenance of the unit, and the energy-saving features with which the unit is equipped.

Table II.9. PERCENT OF HOME HEATING ENERGY SAVED (In percent)

City	Night setback only (8 hours)		Dual setback (8 hours every night plus 8 each weekday)	
	5°F	10°F	5°F	10°F
Atlanta	11%	15%	17%	24%
Boston	7	11	13	19
Buffalo	6	10	11	17
Chicago	7	11	12	18
Cincinnati	8	12	14	21
Cleveland	7	10	12	18
Dallas	11	15	17	24
Denver	7	11	13	19
Des Moines	7	11	12	17
Detroit	7	11	12	18
Kansas City	8	12	14	20
Los Angeles	12	16	19	26
Louisville	9	13	15	21
Milwaukee	6	10	10	16
Minneapolis	5	9	9	15
New York	8	12	14	20
Omaha	7	11	11	17
Philadelphia	8	12	14	21
Pittsburgh	7	11	13	19
Portland, OR	9	13	15	21
St. Louis	8	12	14	20
Salt Lake City	7	11	12	18
San Francisco	10	14	16	23
Seattle	8	12	14	21
Washington, DC	9	13	15	22

Note: (1) Effect in masonry buildings will be less.

(2) If a home is heated with a heat pump, these savings will be reduced.

The basic design of the device varies between manufacturers and thus so does the combustion efficiency. The sizing of the unit is particularly important. A unit with a heating capacity vastly greater than the needs of the structure will generally have increased flue losses, thus reducing the heating efficiency. A heating unit may initially have an efficiency of 70 to 80 percent. Because of lack of maintenance (burners and jets cleaned, air/fuel mixtures adjusted), however, the operating efficiency may drop to 50 percent (50 percent of the energy input is thus lost up the flue).

With the exception of the energy-saving features, the relative effect of these other variables on energy efficiency will be difficult for the appraiser to assess. Generally speaking, the newer the heating unit, the higher the efficiency.

Below is a description and assessment of energy-saving features now available on newer or retrofitted combustion heating units.

Although there are a great many possible modifications for increasing the efficiency of a furnace, four of the most common and effective modifications are the following:

- Flame Retention Oil Burner. This usually is a small device located at the bottom of the furnace on the side opposite the chimney. As a result of new technology, such devices have increased combustion efficiencies of furnaces from the mid-70 to the mid-80 percent range. By extracting more usable heat from the fuel, the newer flame retention burners can use 10 to 15 percent less fuel.
- Vent Damper, also known as an automatic flue or a stack damper. This is a small device that reduces heat loss up the exhaust stack (chimney) during furnace off-time if the furnace is in a heated space. Vent dampers can be recognized by looking at the flue pipe between the flue's exit from the furnace and its entry into the chimney. The only visible part is a box mounted on the side of the flue pipe with wires running out of it. On the average, a vent damper could save about the same amount as a flame retention burner.
- Electric or Mechanical Ignition (for gas furnaces). Also called an intermittent ignition device, this gives off the spark that is necessary to start combustion. A continuous pilot is no longer needed, thus permitting savings on the small amount of gas that is normally consumed in keeping the pilot burning. The electric ignition is found only on recent gas furnaces or on older units that have been refitted. Usually, it is a small (4" x 4" x 4") box identified with a data plate mounted near the gas burner. An additional characteristic is a pair of wires running to the pilot light; the appraiser should be careful, however, not to confuse these wires with those associated with the metal-encased thermocouple unit, which is in all pilots.
- Modulating Aquastat. Even though a boiler usually maintains a constant water temperature of 140° to 180°, 365 days each year, such high temperatures are necessary to heat the house and its domestic hot water (with a tankless system) only on the coldest days of the winter. When the temperature outside is 50°, the boiler water may need to be only at about 100° to keep the house warm. A modulating aquastat is a sensing device generally located at or near the top of the boiler and connected into the aquastat, which in turn is mounted on the main supply pipe. The aquastat works by monitoring the outside temperature and adjusting the boiler temperature accordingly. Aquastats usually are identified by data plates. Similar devices are available for forced-air units also.

How Much of These Features is Enough?

These four modifications are recommended in all climate zones where they are applicable.

Heat Pump

A heat pump is an electric unit that serves as a combination heating and cooling system. It extracts heat from one location and transfers it to another. During the winter, a heat pump extracts heat from outdoor air and pumps the heat inside. It can do this because even cold air retains heat; air at 0°F contains 82 percent of the heat that 100°F air contains. During the summer, it operates like an air conditioner in that it pumps heat from inside the house to the outside.

An agent called a refrigerant circulates through the system. When it is liquid form and has been expanded to a low pressure, the refrigerant is cooler than air and absorbs heat. When vaporized and compressed, the refrigerant is warmer than air and releases heat.

A heat pump saves energy by delivering more energy than it uses. Heat pumps are most effective in moderate or warm climates and when replacing both electric resistance heat and air conditioning. If the system's source of heat is air rather than water or some other medium, its efficiency decreases as the outside temperature decreases.

The appraiser should locate the furnace or mechanical room of the house and look for a duct system. If ducts are visible and there is no exhaust flue, the system may be either a heat pump or an electric furnace. Because of the similar appearances of the two systems, reference to a data plate may be necessary.

Should a Heat Pump be Installed?

A properly-sized heat pump will supply all of the heating and cooling needs of the house. A heat pump is recommended only in climate zones 1 through 5, and only when the heat pump also will serve as an air conditioner. The expected life of a heat pump is much less than that of a furnace.

Air Conditioners

As is the case with combustion heating devices, the efficiency of the air conditioning equipment (cooling capacity versus power to operate the unit) also varies. Sizing and maintenance affect the efficiency, but innovative designs are significantly improving the efficiency of new units on the market.

Two terms are generally used to describe the efficiency of an air conditioning system. The "Coefficient of Performance" (COP) is the cooling capacity (in watts) versus the power input to the compressor (in watts). The "Energy Efficiency Ratio" (EER) is the cooling capacity in Btu/hr versus the power input to the compressor as well as other equipment, such as the condenser fan. Whereas older units typically had EER's of 6.5, newer units can be purchased with EER's of 10 or more (a 54 percent decrease in power requirements for the same cooling).

Recently a third rating term has been suggested which is the "Seasonal Energy Efficiency Ratio" (SEER). SEER takes into account the effect of seasonal operating conditions rather than a single prescribed condition for testing.

Unfortunately, with the exception of packaged unit air conditioners (window units), it is difficult to label the EER of a system because it is a function of components that make up the system. These vary from structure to structure. Again, the appraiser can assume that the newer the unit, the higher the EER. Some states are specifying minimum EER's allowed on units sold in the state.

Hot Water Systems

Most houses have separate water heaters fueled by gas, oil, electricity, or solar energy. The system usually has a storage tank sized to provide hot water for the needs of the occupants of the house. Some houses, however, do not have separate water heaters. In this case, cold water passes through a pipe that passes through the boiler water and picks up heat. This is called a tankless hot water system.

Because, on average, domestic water heating consumes 12 percent of the energy used by the home, methods for reducing its energy requirements can be effective in reducing energy costs.

Many times water heaters are maintained at excessive temperatures. Not only are they energy wasteful, but the hot water could be dangerous. Homes equipped with dishwashers may require water temperatures as high as 140°F, but experimentation may prove that lower temperatures would prove satisfactory. Without dishwashers, tank temperatures should be set between 105°F and 110°F.

If the storage tank of a water heater is warm to the touch, adding an insulation jacket would be appropriate. Insulation kits normally cost less than \$20.00, and are quite effective in reducing energy loss from the tank.

Domestic hot water requirements can also be reduced by installing low cost aerators or flow restrictors in lavatory and shower spigots. In addition, flow-reducing showerheads are available. By reducing the water requirements, the energy for heating that water will be reduced.

There are three general types of flow controlling devices: faucet aerators, retrofitted flow controllers, and flow-reducing showerheads. Faucet aerators screw on the end of a faucet and produce a bubbly stream of water. Flow controllers are inserted between the existing faucet head or showerhead. The device, which resembles a washer or nozzle, is invisible after installation.

Flow-reducing showerheads replace existing ones and can be recognized by brand name or by the fine, hard spray of water they produce.

Appliances

Recent legislation requires the labeling of the energy efficiency of appliances. Such information about the energy requirements of a particular appliance compared to the norm may soon appear on appliances. An example of the label is shown in Figure II.3. The appraiser should be aware of any labeling presently found on appliances such as the "energy saver" switch found in "frost free" refrigerators. In addition, Federal Standards are being developed to increase the energy efficiency of appliances.

Lighting

The efficiency of lighting systems (light output versus power input) is a function of both the type of light source (incandescent versus fluorescent) and the lighting fixture and lens. Previously, fluorescent lighting was not used extensively in residential applications because of poor color rendition. New fluorescent systems have overcome this problem, and should be used wherever practical. Not only is the efficiency of fluorescent lighting significantly better than incandescent, but new fluorescent tubes are available that are more efficient than their predecessors.

8. Solar Systems for Water Heating, Space Heating, and Cooling

In many areas in North America, the total solar energy striking the roof of a building during the year is more than enough to supply the hot water and space heating and cooling needs of the building--if only it all could be collected and used. At present, there are two practical approaches for putting part of this solar radiation to work:

- Passive solar systems, in which the building itself is designed to trap and retain solar heat when it is desired and to reject it when it is not desired.
- Active solar systems, in which special equipment for collecting solar energy is added to the building.

In either case, on sunny days, more heat than is needed can be collected. The extra heat may be transferred to storage in rock or water for use at night and during cloudy weather. Most solar energy systems include an auxiliary heating system that uses conventional fuel and takes over when the stored solar heat is exhausted. A building using an active solar system also needs a delivery system to move heat from the collection area to the place of consumption or to storage. Controls to regulate the flow of heat also are necessary.

Figure II.3. Example of Appliance Energy Efficiency Label

Refrigerator-Freezer Capacity: 23 Cubic Feet	(Name of Corporation) Model(s) AH503, AH504, AH507 Type of Defrost: Full Automatic
---	--

ENERGYGUIDE

Estimates on the scale are based on a national average electric rate of 4.97¢ per kilowatt hour.

Only models with 22.5 to 24.4 cubic feet are compared in the scale.

Model with lowest energy cost
\$68

\$91

THIS ▼ MODEL

Model with highest energy cost
\$132

Estimated yearly energy cost

Your cost will vary depending on your local energy rate and how you use the product. This energy cost is based on U.S. Government standard tests.

How much will this model cost you to run yearly?

Yearly cost	
Estimated yearly \$ cost shown below	
Cost per kilowatt hour	2¢ \$44
	4¢ \$88
	6¢ \$132
	8¢ \$176
	10¢ \$220
	12¢ \$264

Ask your salesperson or local utility for the energy rate (cost per kilowatt hour) in your area.

Important Removal of this label before consumer purchase is a violation of federal law (42 U.S.C. 6302)

(Part No. 371026)

Passive Solar System

In a passive solar energy system, there is no "controller" other than the building itself. Specifically, the design of the structure; its orientation, shape, and materials; and the size and location of windows perform the function of collecting solar energy.

In solar-heated passive houses, winter sun enters directly through sun-facing windows, where it not only heats the air but also raises the temperature of the walls, floors, and other components, which are made of materials capable of holding a great deal of heat. When the sun no longer shines and the room temperature drops below the temperature of the heat-storage components, heat will flow from these components back into the room. Undesired heat flow out of the building is inhibited by insulation and by covering the glass areas at night with insulated drapes or panels.

In the summertime, heat flow into a passive building is minimized, chiefly by insulating the building and shading the windows. Cooling occurs as hot air leaves the building and cooler air enters through well-placed vents. Especially effective are designs that use some form of nocturnal cooling, in which heat is encouraged to flow during the night from the warm structure to the cooler outdoor environment.

Active Solar Systems

In an active solar energy system, the role of the furnace is played by the collector. Radiant energy from the sun enters the collector, usually through glass or plastic glazing, and heats the absorber plate--a black metal surface that may be in direct contact with channels through which a fluid is moving or over which air is passed. The collector is designed so that as much heat as possible flows from the hot absorber plate into the moving fluid, which then carries the heat to where it is used.

Whether active or passive, the types of solar-heating systems in widest use today in homes are those used to heat domestic water supplies. Solar water heaters have been in existence since about 1905 and are now commonly used in Japan, Israel, and Australia. Ironically, thriving solar water heating industries in Florida and California went out of business in the 1930's and 1950's, when natural gas and electricity were relatively much cheaper as sources of heating energy. Solar water heaters have been enjoying increasing popularity more recently and are now available again commercially as totally installed systems, as prepackaged components, and as do-it-yourself kits.

Solar Water Heater

When properly designed for a specific climate and use-pattern, the solar water heater is an effective item, and its year-round use results in a relatively quick return on the investment in four to 10 years. A typical family of four may use more than 80 gallons of hot water daily, representing up to 25 percent of their total heating bill. As much as 80 percent of this requirement can be

met economically by solar heating. Although it is possible to heat water even when the weather is not perfect, an auxiliary water heater using conventional fuel usually is provided to ensure a continuous supply of hot water regardless of the weather. The combination of solar and conventional systems increases initial costs for water-heating equipment, but markedly reduces monthly heating bills as compared with non-solar systems.

The simplest and least expensive types of solar water heaters are those in which the household water is heated directly in the solar collector and circulated between collector and storage either by the thermosiphon effect (water circulation by natural convection currents that occur in any fluid when a temperature differential exists) or by force from a small pump.

A more expensive alternative is direct storage or integral solar water heaters, which combine collector and storage into one component. In this passive solar device, solar energy is absorbed directly by a blackened storage tank containing the water to be heated. The tank rests inside a glazed and insulated box. Shiny surfaces reflect increased sunlight onto the tank, and doors are closed at night to help keep the water warm. The system operates with city water pressure and thus requires no pumps. Although most often used as a preheater, such a system can provide 50 to 60 percent of the annual hot water needs of a household. The direct storage solar water heater is not yet commercially available, but has the potential of being cost-effective with low maintenance and high reliability.

In areas where freezing temperatures are common, a solar water heater with heat exchanger may be used. In this type of system, antifreeze solution is added to the water in the solar collectors, or a special heat-transfer fluid is substituted for the water. The heat-exchange fluid must be kept completely separate from the domestic water supply, as it is not suitable for human ingestion. This is accomplished by heating the domestic water indirectly by means of a heat exchanger.

The heat exchanger is a device found in every automobile and refrigerator. It is designed to maximize the flow of heat from a hot fluid to a cold one. There are two pathways through a heat exchanger, separated from each other by a metal wall. Numerous shapes and flow arrangements are possible. As the hot fluid from the solar collector moves through one pathway of a heat exchanger, heat flows across the metal separation into the cold household water that is moving through the other pathway. An alternate method for freeze protection is to have the collector drain automatically into a storage tank whenever freezing conditions exist. This avoids the necessity of a heat exchanger.

Solar water heaters save fossil fuel energy by substituting renewable energy. Solar water heaters can reduce costs by up to 80 percent in many areas. Solar water heating systems are identifiable by flat plate collectors--usually a series of rectangular pieces of black glass--on the roof or in the yard of a house with either solar hot water or solar heating. If the collector is readily accessible, the appraiser should examine couplings, seals, and hoses for leaks and cracks. If leaks or cracks can be found, the unit can usually be repaired at minimal cost.

Solar Space Heating

Heating and cooling by solar energy saves energy in the same way that solar water heating saves energy. In many parts of the country, solar heating and cooling can reduce annual fossil-fuel heating, and cooling costs by as much as 70 percent. Solar heating and cooling systems also are identifiable by flat plate collectors. In the case of a passive solar house, the appraiser should look for a limited window area facing north and maximum window area to the south. If unsure whether the house has active or passive solar features, the appraiser should ask the current homeowner about the extent to which solar energy is used in heating and cooling the home.

9 Wood Fired Heating Systems

Although woodstoves and fireplaces seldom replace conventional heating systems entirely, they can reduce fossil fuel consumption by heating parts of the house to a comfortable temperature. Homeowners can save energy by using woodburning devices if one or more of the zones in a zoned heating system can be turned off. It is important to be aware that, when used in conjunction with a conventional heating system, only airtight woodstoves and efficiently designed fireplaces produce more heat than they consume. In most instances, fireplaces result in a net loss of heat from the house because of drafts created by the fire's need for air.

An energy-efficient fireplace usually contains the following features:

- A tight, well-fitting damper;
- A shallow depth; and
- Glass doors and/or a circulating system.

The number of woodstoves that is desirable depends upon climate, size of the house, and availability of wood. Woodstoves usually are a supplemental, not a primary, source of heat.

10. Building Designs That Minimize Energy Use

Energy-conscious building design can decrease energy consumption greatly. As mentioned in the section on passive solar design, proper orientation, shading, and use of thermal mass in a structure can make maximum use of the sun's heat. Vegetation, overhangs, and insulation can reduce solar gain in hot climates. In addition, integrating the house into the earth ("earth sheltering" or "earth berming") can insulate it from temperature extremes.

Solar Design

The sun is a tremendous source of cheap energy but, since the sun is always hot, the most efficient use of the sun would include maximum exposure at cold

times and minimal exposure in warmer seasons. There are basically three ways in which to maximize the efficiency of the sun:

1. Shading, whether by vegetation, neighboring structures, or architectural devices, such as overhangs, awnings, and trellises. Because the position of the sun changes from season to season, overhangs can be designed to block the sun when it is in its high summer position, but let it in during winter months.
2. Orientation, or placement of the structure on the lot. For example, orientation so that the longer sides of a house are north and south results in exposure to more solar energy, which is a favored situation in cooler climates.
3. Careful placement of windows. Because no other portion of the outside of a house transfers as much energy per square foot, north-facing window space should be kept to a minimum in cooler climates. Conversely, south-facing window space can decrease heating demands in cooler climates, but increase cooling requirements in warmer climates.

Exposure

Exposure to wind and sun can have a great deal to do with the ways in which energy is saved or lost. Up to 50 percent of a home's energy costs may relate to air leakage. Sheltering by a hillside, by other houses, or by landscaping can protect the residence and reduce energy consumption. On the other hand, an air conditioned home in a warmer climate can benefit from being situated in a breezy location.

Earthsheltering

Earthsheltering, earth-integrated housing, earth berming, and underground housing are labels given to homes that take advantage of the thermal mass of earth. Earth is a relatively poor insulator, but the sheer mass of the material can be extremely beneficial in reducing energy costs.

A home constructed above grade is exposed to the extremes of the weather, and heat loss or gain through the walls responds to these extremes. Earth tends to reduce the extremes in temperature. The heat loss or gain is a function of the temperature of the earth in contact with the wall. Depending on the depth of the wall, the temperature of the earth may stay relatively constant, significantly reducing the heat transfer through the wall.

A second advantage of earth integration is reduction in infiltration. An earth-integrated home often will have only the south wall exposed (to take advantage of passive heating). With only one exposure, there is only one side vulnerable to infiltration.

There exists a variety of designs used in earth integration, varying in degrees of sheltering. These include homes that are completely underground with only entrances and ventilators exposed. Some will have central courts or atriums

either open or covered with skylights. Other homes will have exposed roofs and possibly the top of the sidewalls, which may have clerestory windows. As mentioned, entire walls may be exposed, or the home may be totally above grade with earth berms partially up the walls.

Because the energy requirement imposed by the non-energized systems is reduced, the total energy requirement will be reduced. Energy requirements are still a function of the efficiency of the energized systems and the lifestyle of the occupants.

11 Other Energy-Efficient Features

In addition to the foregoing "special energy efficient items," there are a great many features available as energy-saving components. While many of these may not yet be economically feasible as components in most residences, the changing economics of energy and advances in technology may make such devices practical in the short to intermediate future. The appraiser has an obligation to his/her clientele and to the profession to be aware of current innovations that may add some increment to the market value of the subject property.

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D. Collecting Energy Information

There are a variety of methods an appraiser may use to gather information on the energy usage of properties. Some of these are discussed and illustrated on the following pages.

When time and other considerations do not permit a complete energy-use survey of the subject property, the appraiser may have to make his/her own analysis of the property. This can be done with the aid of a form recently developed for this purpose by Lawrence Berkeley Laboratory of Berkeley, California. The applications of the form are demonstrated in the case study in Section III of this workbook.

As noted elsewhere, the appraisers should be conscientious in gathering all relevant information for retention in their files. Only by accumulating and analyzing energy-efficiency information can appraisers draw meaningful conclusions about the behavior of a local market with respect to energy usage.

The energy efficiency of a particular property may be evaluated by:

1. Energy audits, which may be prepared after inspection by a trained auditor or after submission of an audit questionnaire completed by the property owner and evaluated by utility company personnel or a computer program;
2. Engineering studies performed by qualified professionals; or
3. An appraiser using an energy efficiency checklist.

Although graduates of this seminar may be more qualified than the layman in evaluating the energy efficiency of properties, the appraiser always should ascertain whether a more qualified energy study exists. He/she also should learn which utility companies or other private firms provide energy audits and what forms those audits may take.

Examples of the output from energy audits and samples of checklists that appraisers can use to collect information are included at the end of this section.

1 Energy Audits

One method of classifying audits is by their level of sophistication. It has been proposed that audits be categorized "A," "B," and "C."

The "A" audit is conducted by a trained energy auditor. It is an in-depth investigation of the home or building, and generally offers the most effective

energy management program. There may be a fee to the home owner or building owner for the development of the class "A" audit.

One such auditing program is the Residential Conservation Service (RCS) Program, established under the National Energy Act in 1978. This is a utility-based program, through which trained energy auditors will be available to make an in-depth study of residential property. Audits will be available in late 1980.

The class "B" audit is a study performed by the homeowner. This usually entails completion of an energy survey. The survey is then submitted to an appropriate agency, such as a state energy office, and processed by use of a computer. The computer-generated recommendations are returned to the homeowner for voluntary implementation.

An example of a class "B" auditing form, and the resulting computer printout follows.

The class "C" energy audit is a study performed completely by the homeowner. A variety of publications are available to assist the homeowner with the study. An example is:

In the Bank ... Or Up the Chimney?
U.S. Government Printing Office
Washington, D.C. 20402
Cost: \$1.70
Date: 1978

ENERGY CONSERVATION ALTERNATIVES FOR THE HOME OF

RICHARD B. HAYTER
OF CURRENT RESIDENCE
834 HARRISON
TUPEKA, KS 66603

THE COSTS AND SAVINGS SHOWN BELOW ARE ESTIMATES. SAVINGS WILL VARY WITH COSTS OF FUEL AND SEVERITY OF THE WEATHER. COSTS WILL VARY WITH THE TYPE AND QUALITY OF MATERIALS AND THE CONSTRUCTION OF YOUR HOME.

ENERGY CONSERVING ACTION		ANNUAL DOLLAR SAVINGS CURRENT PRICES	VOLUME OF FUEL WINTER (CUFT) SUMMER (KWH)	COST ESTIMATES BASED ON...	ESTIMATED COSTS	YEARS TO RECOVER INVESTMENT	YIELD ON INVESTMENT PRESENT COSTS WITH INFLATION
INSTALL STORM WINDOWS OR REMAINING 4 WINDOWS	FROM: \$ 5 TO: \$ 16	4900	6000	DO-IT-YOURSELF \$ 50 TO \$ 105 CONTRACTOR \$ 70 TO \$ 120	10.2 11.8	7.5% 6.0%	11.3% 9.7%
INSTALL 3-4 INCHES (R-11) MOIST CEILING INSULATION	FROM: \$ 5 TO: \$ 6	1700	2100	50 MORE INSULATION WOULD SAVE ENERGY BUT WOULD NOT BE ECONOMICALLY JUSTIFIABLE AT THE PRESENT TIME			
INSTALL STORM DOORS OR REMAINING 2 DOORS	FROM: \$ 5 TO: \$ 10	3600	4500	20. STORM DOOR(S) WOULD SAVE ENERGY BUT WOULD NOT BE ECONOMICALLY JUSTIFIABLE AT THE PRESENT TIME			
DAYTIME WINTER THERMOSTAT SETTING IS CURRENTLY AT OR BELOW THE RECOMMENDED LEVEL.							
SET WINTER THERMOSTAT AT 60 DEGREES NIGHT	FROM: \$ 20 TO: \$ 25	12300	19200	THERMOSTAT ADJUSTMENT IS A RECOMMENDED, NO COST ACTION			
SET WINTER THERMOSTAT AT 55 DEGREES NIGHT	FROM: \$ 35 TO: \$ 45	21100	26100	THERMOSTAT ADJUSTMENT IS A RECOMMENDED, NO COST ACTION			

THE FOLLOWING INFORMATION IS A LISTING OF THE CHARACTERISTICS OF YOUR HOME TAKEN FROM YOUR QUESTIONNAIRE. THESE DATA WERE USED IN THE CALCULATION OF THE ABOVE ESTIMATES OF COSTS AND SAVINGS. AN ASTERISK (*) INDICATES THAT AN ASSUMED VALUE WAS USED, DUE TO AN INCOMPLETE QUESTIONNAIRE RESPONSE OR A POSSIBLE ERROR IN PROCESSING. IF THE INFORMATION PRESENTED BELOW DOES NOT APPEAR TO DESCRIBE YOUR HOME ACCURATELY YOU MAY WISH TO SUBMIT ANOTHER QUESTIONNAIRE.

GENERAL		ATTICS		DOORS	
BUILT: BETWEEN 1921 - 1945		ATTIC OR CRAWL SPACE UNDER ROOF: YES		NO. OF DOORS: 3	DOUBLE WOOD
STYLE: TWO-STORY		ATTIC HEATED: NO		3	WOODEN
HEATING FUEL: NATURAL GAS		PRESENT INSULATION: 2-4 INCHES		3	WID & GLASS
HEATING SYSTEM LAST SERVICED: WITHIN 6 MONTHS		PRESENT INSULATION: BATTING		3	DUTCH DOOR
WINTER THERMOSTAT: DAYTIME 65 - 68 DEG.		ATTIC VENTILATED: YES		3	SLIDING GLASS DOOR
EVENING 65 - 68 DEG.		ATTIC FAN: NO		3	DOOR WITH VESTIBULE
NIGHT 65 - 68 DEG.		PERMANENT FLOORING INSTALLED: NO			
LIVING AREA: 1601 TO 2000 SQ. FT.				NO. OF STORM DOORS: 2	
AIR CONDITIONED: YES - ELECTRIC CENTRAL				DOORS WITH AIR LEAKAGE: NONE	
SUMMER THERMOSTAT: DAYTIME ABOVE 78 DEG.		WINDOWS		DOORS WEATHERSTRIPPED/CAULKED: ALL	
NIGHT ABOVE 78 DEG.		NO. OF WINDOWS: 22	DOUBLE HUNG YES		
YEARLY FUEL COST: HEATING \$ 350 COOLING \$ 350		4	TILTING NO		
		0	CASEMENT		
		0	SLIDING PANE		
		0	PICTURE/BAY		
MAJOR APPLIANCES				OTHER ENERGY CONSUMERS	
COOKING STOVE: ELECTRICITY		STORM SASH OR DOUBLE GLAZING ON 22 WINDOWS		COLOR TV SET: YES	
OVEN: ELECTRICITY		WINDOWS RATTLE: NONE		OUTSIDE GAS LIGHT: NO	
WATER HEATER: NATURAL GAS		WINDOWS WITH AIR LEAKAGE: NONE		FROST FREE REFRIG.: NO	
CLOTHES DRYER: ELECTRICITY		WINDOWS WEATHERSTRIPPED/CAULKED: ALL		FROST FREE FREEZER: NO	

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A. Using Energy Information in Appraisal

Among topics discussed in preceding portions of Section II were how a house uses energy and identification and collection of energy data. Because the Income Approach (i.e., capitalization of net operating income) normally is not appropriate as a valuation approach in most single-family residential markets, the present section focuses on ways in which energy information may be used in the Cost and Market Sales Comparison Approaches. Using a gross rent multiplier in this instance simply repeats the Market Sales Comparison Approach in a slightly different way.

In using energy information in a single-family residential appraisal--and in other types of appraisal as well--the appraiser must not attribute to the market a greater degree of sophistication or sensitivity to energy matters than is made evident by the overall behavior of those active in the market.

1. The Cost Approach

The premise behind the Cost Approach to Value is that the value of a property is equal to the sum of depreciated replacement cost new and land value. Classical appraisal theory calls for the following steps:

1. Estimation of total current reproduction cost new, including energy-related equipment;
2. Subtraction of the dollar amount of all accrued depreciation in order to arrive at depreciated current reproduction cost new;
3. Addition of land value (estimated through market comparison) to arrive at overall property value.

Accrued depreciation falls into the following categories:

1. Physical deterioration, by which is meant the wearing-away of the improvement and its components as a result of time passage and the activities of natural elements;
2. Functional obsolescence, meaning the loss in value resulting from decreased capacity of the structure or its components to perform the function for which it was intended, in terms of current market standards as of the date of the appraisal; and
3. Locational obsolescence, which is a reduction in utility experienced by a structure as a result of negative environmental forces outside the boundaries of the property.

With respect to estimation of current reproduction costs new associated with energy-related property components, the SREA and the Department of Energy are now working with the various cost manual services to have pertinent information included in those publications. Until this has been accomplished, the best sources of cost information may be hardware or department store catalogs, manufacturers' brochures, or other similar material. Possibly the best source, if available, are actual costs incurred from market sources (contractors, owners, etc.).

The estimation of obsolescence affecting energy-related components poses a particular problem. Although such items tend to have shorter useful lives or economic lives than the structures housing them and are subject to physical deterioration and functional obsolescence, any meaningful valuation of an energy-efficient property should contemplate the likely future costs of replacing energy-related components as they become less appropriate for the subject property, whether by reason of physical deterioration or functional inadequacy.

In view of the recent rapid acceleration of the costs of acquiring and installing energy-conserving equipment, the appraiser may wish to exclude consideration of obsolescence affecting such items for as long as they remain physically serviceable and subject to repair. While this would not be technically correct from a theoretical standpoint, such treatment may reasonably approximate the behavior of the market. Before adopting this rationale, the appraiser should be confident that this is in fact the case.

Once the appraiser has settled upon a viewpoint that he/she considers to be relevant to actual market behavior, he/she may carry out the Cost Approach computations in accordance with the format provided by the FHLMC/FNMA form or whatever other appraisal reporting mode is to be used.

2. The Market Sales Comparison Approach

The assumption underlying the Market Data Approach is that, given typically informed and knowledgeable buyers and sellers in the marketplace, a typical buyer would be indifferent between exactly comparable properties. Any physical, functional, financing (economic), or locational differences between two properties may result in different value indications for the properties, although these may be offsetting. The relative importance of such differences tends to vary in different market areas and, indeed, from buyer to buyer.

The appraiser's problem addressed here, of course, is how to acquire and use energy information. As mentioned throughout the seminar, energy information may be available from a variety of sources, many of which already have been discussed. If a professional energy audit or engineering study exists, or if time permits the appraiser or property owner to secure such a study, the appraiser, of course, should take advantage of the opportunity to use the conclusions of such an audit or study.

In the more likely case that no such analysis is available, the appraiser may have to make his/her own energy analysis. In the case study in Section III, a form developed by Lawrence Berkeley Laboratory of Berkeley, California, will be employed. Because the "Energy Appraisal Form" had not been finalized when this

workbook was being prepared, students may be given two or three different versions. Comments and observations will be solicited for each of the various suggested forms by the seminar instructors.

Each form will allow the appraiser to calculate a rating that is proportionate to expected utility bills. Although the rating may not reflect actual fuel bills, it can be used to compare the subject property with any comparable property that has been rated by the same approach. It is important to remember that each form is specific for a particular climate zone. Students should refer to the zip code list to locate the climate zone for the subject property.

Specific energy-related features are listed on the left side of the form, categorized as to whether they pertain to heating, water heating, cooling, or other features. The bar extending to the right of each listed feature gives the consumption points* associated with different levels of each feature. The consumption for the property being analyzed is determined by selecting the position on the bar that corresponds to the amount or quality of that isolated feature. The points then are read from the scale across the top and entered in the column to the right.

Once each of the right-hand columns has been completed, all consumption points for each class of fuel are summed in the lower right-hand corner of the form. Each total figure then is divided by a factor that will convert all consumption points into common units of consumption. These "units of consumption" relate to quantities of energy used by utility services for billing purposes. The appraiser, perhaps, should be reminded that all conversion factors are zone-specific. Thus, using the zip code list is of critical importance.

Division by the conversion factors results in a figure representing fuel consumed in terms of energy units used for billing. These figures then are multiplied by the price of fuel for each unit, resulting in the total cost for each fuel. The dollar costs then are summed and divided by the square footage of the residence being analyzed.

Once this has been done, the appraiser may make meaningful comparison of the subject property with comparable sales for which he/she has similar information. The principal advantage of the form is that it allows the appraiser to value energy-related items on the basis of their cumulative effects (i.e., relative costs or savings), rather than by a unit-to-unit comparison of features present in some homes and absent in others. The principal disadvantage of the form is that it does not provide for any kind of "novelty value" associated with an unusual feature such as earthsheltering or solar heating and cooling.

In using the "Energy Appraisal Form" as an aid in valuing single-family residential properties, the appraiser would subtract the energy-consumption expenses of the comparable property from those of the subject. He/she then would capitalize the net difference in order to arrive at the dollar amount to add or subtract from the comparable sale price as the adjustment for "special energy efficient items." The gross rent multiplier found appropriate for

*Consumption points are based upon thousands of BTU's per square foot.

valuing the subject property is a reasonable factor to use in capitalizing the estimated energy cost differential for residential appraisal at least.

The capitalization rate might also be developed in a variety of ways, including a band of investment. One method might involve consideration of the projected fuel-inflation rate and the anticipated rate of general inflation. These and perhaps other methods will be discussed by your instructors as the single-family case study unfolds.

B. Single-Family Case Study

1. Property Description

Location

Topeka, Kansas (Average Cooling Degree Days = 1361, Average Heating Degree Days = 5243, Prevailing Wind from North. Zip Code prefix = 666).

Site

The structure is located on a slightly irregular corner lot measuring approximately 135 feet (frontal) by 100 feet. The lot has numerous deciduous trees along the north and east borders. No trees exist on the south and west sides of the lot, although numerous trees exist across the streets to the south and west, providing some late afternoon summer shade.

Structure

The two-story, wood-frame Colonial house was constructed in 1939. It contains approximately 1,873 square feet of living area (i.e., 840 square feet on each story, plus a first-floor den or sunroom containing 193 square feet) and has a full basement (840 square feet) and a large unfinished attic. The home has 1-1/2 baths, three bedrooms, a living room, a dining room, a kitchen, and the first-floor den.

Envelope

The walls are constructed of 1/2" wood lapped siding, 3/4" pine sheathing, 2"-by-4" hollow core (i.e., without insulation), lath and plaster. The attic has four-mil plastic vapor barriers covered with R19 fiberglass batt over two thirds of the attic and R38 over the other third (Average R = 25.3). The drop-stair to the attic is uninsulated.

All windows are double hung and are equipped with combination storm windows with aluminum frames. Window frames are not caulked. The crawlspace under the den is uninsulated. The basement walls and bandspace are uninsulated. Two of the four exterior doors are equipped with storm doors. All doors are weather-stripped, including thresholds.

Attic ventilation is introduced through a continuous opening between the roof and sidewall. Air exits the attic through gable vents at either end of the attic (total vent opening is approximately 20 square feet).

Heating and Air Conditioning

The house is heated and cooled with forced air. Each duct is equipped with balancing dampers plus register-grille dampers. Supply diffusers are high-sidewall located on the exterior walls. The natural-gas furnace is rated at 166,000 BTU/hour input, 132,800 BTU/hour output (80 percent rated efficiency).

Calculations show that the furnace has approximately twice the necessary heating capacity. The furnace has a conventional continuous pilot with no flue damper. The fan control bonnet thermostat is adjustable. The furnace is equipped with a central humidifier. The fan is dual speed and is normally cycled with the space thermostat. The air conditioner, while not particularly new, is functional and has a relatively low EER.

The 30-gallon water heater is gas fired and does not have an add-on insulating jacket. No water lines are insulated. The conventional open-hearth fireplace is equipped with glass doors. The thermostat is maintained at a constant 80°F in the summer and 67°F in the winter. The hot water leaves the tap at 135°F.

Summary

The "special energy efficient items" of the subject property and each of the three comparable sales are summarized in Table III.1.

2. Energy and Weather

The 1978 energy budget for the subject property is shown in Table III.2.

Table III.1. SUMMARY OF "SPECIAL ENERGY EFFICIENT ITEMS"

Item	Subject Property 1936 Ocean View	Comparable No. 1 1525 Faulkner	Comparable No. 2 1425 Kirkendall	Comparable No. 3 1307 Schuok
Glazing	Storm Sash	Double Glazing	Conventional Sash	Conventional Sash
Insulation	Ceilings: R-25 Walls: R-0 Floors: R-0	Ceiling: R-38 Walls: R-19 Floor: R-11	None	None
Weather- stripping	Yes	Yes	No	No
Shading	Some	Good	None	None

Table III.2. SUBJECT'S 1978 ENERGY BUDGET

<u>Month</u>	<u>Electricity*</u>	<u>Natural Gas*</u>
January	\$ 29.81	\$ 57.56
February	25.56	59.36
March	22.90	46.94
April	21.77	17.43
May	18.31	15.88
June	40.58	3.28
July	46.84	3.32
August	58.35	5.06
September	34.71	3.38
October	24.50	10.09
November	28.80	19.98
December	<u>31.62</u>	<u>44.62</u>
Total	\$383.75	\$286.90

Annual Cost Budget = $\frac{\text{electricity bills} + \text{gas bills}}{\text{square feet}}$

or, $\frac{\$383.75 + \$286.90}{1,873 \text{ sq. ft.}} = \$0.358/\text{sq. ft.}$

*Electric meter is read normally on the 7th or 8th of each month; gas meter is read normally on the 18th or 19th of each month.

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III-8

** To be used for classroom illustration only **

RESIDENTIAL APPRAISAL REPORT

File No. **SFRCS**

To be completed by lender	Borrower <u>Not applicable</u>		Census Tract <u>19.00</u> Map Reference <u>N/A</u>																																																	
	Property Address <u>1936 Ocean View Drive</u>																																																			
	City <u>Topeka</u>	County <u>Shawnee</u>	State <u>Kansas</u>	Zip Code <u>66604</u>																																																
	Legal Description <u>Lot 8, Block 11, OSENBAUGH ESTATES, Topeka, Shawnee Co., Kansas</u>																																																			
NEIGHBORHOOD	Sale Price \$ <u>N/A</u> Date of Sale <u>N/A</u> Loan Term <u>N/A</u> yrs Property Rights Appraised ☒ Fee ☐ Leasehold ☐ DeMinimis PUD		Actual Real Estate Taxes \$ <u>700.54</u> (yr) Loan charges to be paid by seller \$ <u>N/A</u> Other sales concessions <u>Not applicable</u>																																																	
	Appraiser/Client <u>Ms. Rosetta Stone</u>		Address <u>Same as above</u>																																																	
	Occupant <u>Owner</u>		Appraiser <u>SRAppraiser</u> Instructions to Appraiser <u>Estimate market value in fee simple.</u>																																																	
	<div style="display: flex; justify-content: space-between;"><div>Location ☒ Urban ☐ Suburban ☐ Rural</div><div>Good Avg. Fair Poor</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Built Up ☒ Over 75% ☐ 25% to 75% ☐ Under 25%</div><div>Employment Stability ☒ ☐ ☐ ☐</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Growth Rate ☒ Fully Dev. ☐ Rapid ☐ Steady ☐ Slow</div><div>Convenience to Employment ☐ ☒ ☐ ☐</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Property Values ☒ Increasing ☒ Stable ☐ Declining</div><div>Convenience to Shopping ☐ ☒ ☐ ☐</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Demand/Supply ☐ Shortage ☒ In Balance ☐ Over Supply</div><div>Convenience to Schools ☐ ☒ ☐ ☐</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Marketing Time ☒ Under 3 Mos. ☐ 4-6 Mos. ☐ Over 6 Mos.</div><div>Adequacy of Public Transportation ☐ ☒ ☐ ☐</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Present Land Use ☒ 1 Family ☐ 2-4 Family ☐ Apts. ☐ Condo ☐ Commercial</div><div>Recreational Facilities ☐ ☒ ☐ ☐</div></div>																																																			
SITE	<div style="display: flex; justify-content: space-between;"><div><div>Change in Present Land Use ☒ Not Likely ☐ Likely (*) ☐ Taking Place (*)</div><div>(*) From <u>N/A</u> To <u>N/A</u></div></div><div>Predominant Occupancy ☒ Owner ☐ Tenant <u>N/A</u> % Vacant</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Single Family Price Range <u>\$55,000</u> to <u>\$85,000</u> Predominant Value <u>\$65,000</u></div><div>Adequacy of Utilities ☐ ☒ ☐ ☐</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Single Family Age <u>15</u> yrs to <u>45</u> yrs Predominant Age <u>30</u> yrs</div><div>Property Compatibility ☒ ☐ ☐ ☐</div></div>																																																			
	Notes: FHLMC/FNMA do not consider the racial composition of the neighborhood to be a relevant factor and it must not be considered in the appraisal.																																																			
	Comments including those factors, favorable or unfavorable, affecting marketability (e.g. public parks, schools, view, noise) <u>The subject is located in a well-established older neighborhood of homes in the medium to upper value ranges. Property values appear to be increasing despite recent tightness in the supply of available mortgage funds. Although the rate of increase in values has declined, demand for new and existing residences remains apparent.</u>																																																			
	Dimensions <u>134.78' x 99.99' x 134.4' x 100'</u> - <u>Apx. 13,400</u> Sq. Ft. <u>00243028</u> ☒ Corner Lot																																																			
	Zoning classification <u>"A," single-family residential</u> Present improvements ☒ do: ☐ do not conform to zoning regulations																																																			
	Highest and best use: ☒ Present use ☐ Other (specify) <u>Not applicable</u>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Public Other (Describe) <u>N/A</u></div><div>OFF SITE IMPROVEMENTS</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Elec. ☒ <u>N/A</u> Street Access: ☒ Public ☐ Private</div><div>Topo <u>Approx. level at street grade</u></div></div>																																																			
IMPROVEMENTS	<div style="display: flex; justify-content: space-between;"><div>Gas ☒ <u>N/A</u> Surface <u>asphalt conc.</u></div><div>Size <u>Typical of area at 13,400 sf +</u></div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Water ☒ <u>N/A</u> Maintenance: ☒ Public ☐ Private</div><div>Shape <u>Irregular quadrilateral</u></div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>San. Sewer ☒ <u>N/A</u> ☒ Storm Sewer ☒ Curb/Gutter</div><div>View <u>Other residences; typical of area</u></div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>☐ Undergound Elect. & Tel. ☒ Sidewalk ☒ Street Lights</div><div>Drainage <u>Apparently adequate</u></div></div>																																																			
	Is the property located in a HUD identified Special Flood Hazard Area? ☐ No ☐ Yes																																																			
	Comments (favorable or unfavorable including any apparent adverse easements, encroachments or other adverse conditions) <u>Inspection of the subject site, a qualified professional survey, and the recorded plat of the subject subdivision reveals no adverse site influences.</u>																																																			
	<div style="display: flex; justify-content: space-between;"><div>☒ Existing ☐ Proposed ☐ Under Constr. No. Units <u>1</u> Type (det, duplex, semi-det, etc.) <u>Detached</u></div><div>Design (rambler, split level, etc.) <u>Colonial</u> Exterior Walls <u>Lapped siding</u></div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Yrs. Age: Actual <u>41</u> Effective <u>19</u> to <u>20</u> No. Stories <u>2</u></div><div>Roof Material <u>Composition shingle</u> Gutters & Downspouts ☐ None ☒ Painted aluminum</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>☐ Manufactured Housing ☒ Foundation Walls Reinforced <u>poured concrete</u></div><div>☒ 81% Basement ☐ Outside Entrance ☒ Sump Pump</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>☐ Slab on Grade ☐ Crawl Space</div><div>☒ Concrete Floor ☐ % Finished <u>0</u> Finished Ceiling <u>Not applicable</u></div></div>																																																			
ROOM LIST	<div style="display: flex; justify-content: space-between;"><div>Evidence of: ☐ Dampness ☐ Termites ☐ Settlement</div><div>Finished Walls <u>Not applicable</u></div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Comments <u>The subject residence appears to be physically and functionally sound and is considered to be in average condition.</u></div><div>Finished Floor <u>Not applicable</u></div></div>																																																			
	<table border="1" style="width:100%; border-collapse: collapse;"><thead><tr><th>Room List</th><th>Foyer</th><th>Living</th><th>Dining</th><th>Kitchen</th><th>Den</th><th>Family Rm.</th><th>Rec. Rm.</th><th>Bedrooms</th><th>No. Baths</th><th>Laundry</th><th>Other</th></tr></thead><tbody><tr><td>Basement</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>1st Level</td><td></td><td>(1)</td><td>(1)</td><td>(1)</td><td>(1)</td><td></td><td></td><td>(3)</td><td>(1)</td><td></td><td></td></tr><tr><td>2nd Level</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></tbody></table>				Room List	Foyer	Living	Dining	Kitchen	Den	Family Rm.	Rec. Rm.	Bedrooms	No. Baths	Laundry	Other	Basement												1st Level		(1)	(1)	(1)	(1)			(3)	(1)			2nd Level											
	Room List	Foyer	Living	Dining	Kitchen	Den	Family Rm.	Rec. Rm.	Bedrooms	No. Baths	Laundry	Other																																								
	Basement																																																			
	1st Level		(1)	(1)	(1)	(1)			(3)	(1)																																										
	2nd Level																																																			
	Finished area above grade contains a total of <u>7</u> rooms, <u>3</u> bedrooms, <u>1 1/2</u> baths. Gross Living Area <u>1,873</u> sq. ft. Bsmt Area <u>840</u> sq. ft.																																																			
	Kitchen Equipment: ☐ Refrigerator ☐ Range/Oven ☒ Dishwasher ☒ Fan/Hood ☐ Compactor ☐ Washer ☐ Dryer ☐ <u>N/A</u>																																																			
	HEAT: Type <u>Forced air/fuel Gas</u> Cond. <u>Good</u> AIR COND: ☒ Central ☐ Other <u>N/A</u> ☒ Adequate ☐ Inadequate																																																			
<div style="display: flex; justify-content: space-between;"><div>Floors ☒ Hardwood ☒ Carpet Over Hdwd ☐ <u>N/A</u></div><div>Quality of Construction (Materials & Finish) ☐ ☒ ☐ ☐</div></div>																																																				
<div style="display: flex; justify-content: space-between;"><div>Walls ☐ Drywall ☒ Plaster ☐ <u>N/A</u></div><div>Condition of Improvements ☐ ☒ ☐ ☐</div></div>																																																				
<div style="display: flex; justify-content: space-between;"><div>Floor/Finish ☐ Good ☒ Average ☐ Fair ☐ Poor</div><div>Rooms size and layout ☐ ☒ ☐ ☐</div></div>																																																				
INTERIOR FINISHES TO IMPROVE	<div style="display: flex; justify-content: space-between;"><div>Bath Floor ☐ Ceramic ☒ <u>Vinyl</u></div><div>Closets and Storage ☐ ☒ ☐ ☐</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Bath Wainscot ☒ Ceramic ☐ <u>N/A</u></div><div>Insulation—adequacy ☐ ☒ ☐ ☐</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Special Features (including energy efficient items) <u>Comb. sash; weatherstripping; ceil. insul.; humid.; apr. energy cost/sq. ft./yr.: \$0.36</u></div><div>Plumbing—adequacy and condition ☐ ☒ ☐ ☐</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>ATTIC: ☒ Yes ☐ No ☐ Stairway ☒ Drop-stair ☐ Scuttle ☐ Floored</div><div>Electrical—adequacy and condition ☐ ☒ ☐ ☐</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Finished (Describe) <u>None</u> ☐ Heated</div><div>Kitchen Cabinets—adequacy and condition ☐ ☒ ☐ ☐</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>CAR STORAGE: ☒ Garage ☐ Built-in ☐ Attached ☒ Detached ☐ Car Port</div><div>Compatibility to Neighborhood ☐ ☒ ☐ ☐</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>No. Cars <u>One</u> ☒ Adequate ☐ Inadequate Condition <u>Average</u></div><div>Overall Livability ☐ ☒ ☐ ☐</div></div>																																																			
	<div style="display: flex; justify-content: space-between;"><div>Appeal and Marketability</div><div>Yrs Est Remaining Economic Life <u>45</u> to <u>50</u> Explain if less than Loan Term</div></div>																																																			
	FIREPLACES, PATIOS, POOL, FENCES, etc. (describe) <u>Fireplace; covered walk to detached garage; circle driveway in front is surfaced with gravel; deck over den.</u>																																																			
	COMMENTS (including functional or physical inadequacies, repairs needed, modernization, etc.) <u>Energy efficient items, deck, and extra driveway add an increment of functional utility normally not found in the subject market. The additional increment is partly offset by smallness of garage. Other than exterior paint, no physical inadequacies are apparent.</u>																																																			

Purpose of Appraisal is to estimate Market Value as defined in Certification & Statement of Limiting Conditions (FHLMC Form 439/FNMA Form 1004B). If submitted for FNMA, the appraiser must attach (1) sketch or map showing location of subject, street names, distance from nearest intersection, and any detrimental conditions and (2) exterior building sketch of improvements showing dimensions.

Measurements	No. Stories	Sq. Ft.
26.4' x 31.8'	First	839.52
11.2' x 17.3'	First	193.76
	Total	1,033.28
26.4' x 31.8'	Second	839.52
Total above grade		1,872.80
		Rounded to

Total Gross Living Area (List in Market Data Analysis below) 1,873

Comment on functional and economic obsolescence: As noted, the subject is more functional than most comparable structures in the subject market.

Inspection of the subject property and vicinity reveals no evidence of locational obsolescence.

ESTIMATED REPRODUCTION COST - NEW - OF IMPROVEMENTS:

Dwelling	1,873	Sq. Ft. @ \$ 40.00	= \$ 74,920
		Sq. Ft. @ \$	
Extras: Pplc, disposer, dish-			
washer, range hood, humid.			2,400
Special Energy Efficient Items	see below		1,500
Porches, Patios, etc.	walk, drive, deck		1,000
Garage/Car Port	229	Sq. Ft. @ \$ 12.00	= 2,748
Site Improvements (driveway, landscaping, etc.)			1,000
Total Estimated Cost New			= \$ 83,568

Less	Physical	Functional	Economic
Depreciation	\$22,000	\$ 0	\$ 0
Depreciated value of improvements (rounded)			= \$ 61,600

ESTIMATED LAND VALUE (If leasehold, show only leasehold value) = \$ 9,500

INDICATED VALUE BY COST APPROACH = \$ 71,100

The undersigned has recited three recent sales of properties most similar and proximate to subject and has considered these in the market analysis. The description includes a dollar adjustment, reflecting market reaction to those items of significant variation between the subject and comparable properties. If a significant item in the comparable property is superior to, or more favorable than, the subject property, a minus (-) adjustment is made, thus reducing the indicated value of subject; if a significant item in the comparable is inferior to, or less favorable than, the subject property, a plus (+) adjustment is made, thus increasing the indicated value of the subject.

ITEM	Subject Property	COMPARABLE NO. 1	COMPARABLE NO. 2	COMPARABLE NO. 3
Address	1936 Ocean View Drive	1525 Faulkner Ave. Topeka, Kansas	1425 Kirkendall St. Topeka, Kansas	1307 Schuck Drive Topeka, Kansas
Proximity to Subj.		14 blocks NE	Seven blocks NE	Nine blocks NE
Sales Price	\$ N/A	\$ 69,500	\$ 55,500	\$ 56,500
Price/Living area	\$ N/A	\$ 39.09	\$ 38.43	\$ 41.15
Date Source	Inspection	Real estate agent	Real estate agent	Lender & appraiser
Date of Sale and Time Adjustment	DESCRIPTION	DESCRIPTION	DESCRIPTION	DESCRIPTION
	April, 1980	Dec., 1979	Jan., 1980	Dec., 1979
Location	Osen, Ests	Similar	Similar	Similar
Site/View	Irr; resid.	Similar	Similar	Similar
Design and Appeal	Colonial; avg.	Similar	Similar	Similar
Quality of Const.	Average	Average	Average	Average
Age	41 yrs (1939)	39 yrs (1941)	45 yrs (1935)	40 yrs (1940)
Condition	Average	Good	Average	Average
Living Area Room	Total: 8 rms, 1 Bath	Total: 8 rms, 1 Bath	Total: 8 rms, 1 Bath	Total: 8 rms, 1 Bath
Count and Total	7, 3, 1 1/2	7, 4, 1 1/2	5, 3, 1 (bath)	6, 3, 1 (bath)
Gross Living Area	1,873 Sq.Ft.	1,778 Sq.Ft. (size)	1,444 Sq.Ft. (size)	1,373 Sq.Ft. (size)
Basement & Bmt. Finished Rooms	100% No finish	Approx. 50% No finish	100% No finish	100%; 300sf rec. room
Functional Utility	Average*	Average	Average	Average
Air Conditioning	Central	Central	1 window	Central
Garage/Car Port	1-car det.	2-car det.	1-car att.	1-car att.
Porches, Patio, Pools, etc.	Extra drive; deck; cov. walk	Cov. front porch; patio	Deck; priv. fence	Deck
Special Energy Efficient Items	R-24 insul; weatherstrip; comb. sash.	R-38 ceil; R-19 wall; R-11 floor; w/strip dbl. glaze	None	None
Other (e.g. fireplaces, kitchen equip., remodeling)	Fireplace; GD; DW; HF; humidifier.	Fireplace; RO; GD; HF	GD; DW; HF	Fireplace; RO; GD; HF
Sales or Financing Concessions	Typically, conventional	Conventional	Conventional	Conventional
Net Adj. (Total)		Plus; Minus \$	Plus; Minus \$	Plus; Minus \$
Indicated Value of Subject				

Comments on Market Data: *Functional features other than those relating to energy-efficient items are considered to offset one another. Primary reliance is placed upon Sale 1, which is most similar to the subject.

Final Reconciliation: Because of the availability of indicative market data, the value suggested by the Market Data Approach is adopted as the final estimate of value.

Construction Warranty ☐ Yes ☒ No Name of Warranty Program Not applicable Warranty Coverage Expires N/A
 This appraisal is based upon the above requirements, the certification, contingent and limiting conditions, and Market Value definition that are stated in ☒ FHLMC Form 439 (Rev. 10/78)/FNMA Form 1004B (Rev. 10/78) filed with client, Not applicable 19 N/A attached.
 I ESTIMATE THE MARKET VALUE, AS DEFINED, OF SUBJECT PROPERTY AS OF April 1, 1980 to be \$?
 Appraiser(s) SRAppraiser Review Appraiser (If applicable) Not applicable
☐ Did ☐ Did Not Physically Inspect Property

ENERGY EFFICIENCY IN IV. MULTI-FAMILY RESIDENCES

While there may be considerable difference between the ways in which single-family residences and industrial properties use energy, multi-family residential properties are quite similar to single-family homes in their energy-use patterns. For a variety of reasons, however, the appraisal methodology differs markedly between one- and multi-family residential appraisal assignments.

One sense in which this is true is that the building shell, or envelope, is relatively less important, as abutting apartments help to keep each other warm. This means that, in the case of an apartment building, the operation and maintenance of mechanical systems takes on added importance.

Collection of energy-related information is very important in the multi-family appraisal assignment, since, as energy costs rise or remain higher than necessary, return on investment declines, all other things remaining equal. Moreover, if the recent trends in fuel costs continue in their upward direction, under-improved or unimproved properties may become functionally obsolete, and the appraiser must be prepared to evaluate the curability of such obsolescence.

Table IV.1 presents a recommended procedure for identifying and collecting energy information for appraisal purposes. While the procedure is similar to that recommended for all aspects of an appraisal assignment, the intentional thrust of the sample procedure is energy-directed.

The remainder of Section IV will focus upon the following:

- A. How a multi-family property uses energy;
- B. Collecting energy cost information;
- C. Identifying special energy-efficient features; and
- D. Collecting energy information.

Table IV.1. RECOMMENDED ENERGY APPRAISING PROCEDURE

- A. Collect and analyze energy consumption data covering a minimum of one year (two or three years are preferred).
1. Determine the energy consumption and cost budgets for the building. (Btu's/sq. ft., \$ Annual energy cost/sq. ft.).
 2. Compare energy budgets of subject property to available market information.
 3. If the energy budget of the subject differs from the available market information, determine whether the difference is significant enough to affect the value of the subject and, if so, measure in dollars.
 4. Support the conclusions by existing and recommended methods.
- B. If the property being appraised is of a commercial/industrial/residential (income producing) type and the energy budget of the subject varies significantly from the available market, a professional audit should be recommended. The following minimum data should be obtained by the appraiser.
1. A complete analysis of current energy management to include procedures (i.e., maintenance schedules, hours of operation, age and condition of equipment, etc.).
 2. A determination of whether the procedures actually consider energy efficiency.
 3. An identification of the property's energy consumption as it relates to the norm (comparable utilities).
 4. A list of the items that possibly can reduce energy demands.
 5. Recommended energy modifications to include first costs and potential energy savings.

Upon completion of the above, the appraiser should be able to estimate the physical deterioration and functional obsolescence--curable and incurable--within the subject. A final measurement of the obsolescence can then be carried into the approaches to value most applicable to the appraisal problem.

A How a Multi-Family Property Uses Energy

The building envelope contributes significantly to the consumption of energy in single-family property. This is still the case in multi-family properties, except that its relative effect on the total consumption may be reduced, depending on the size of the structure.

Many of the options for improving energy efficiency in multi-family property will be similar to those for single-family residences. However, additional considerations will be introduced that affect energy use. It is necessary to understand what contributes to the total energy consumption of the structure and the relative effect each variable has on the total. Once this is understood, the effect of the various options for energy reduction can be determined and included in the evaluation of the income producing capabilities of the property.

The first step will be the collection of energy-consumption and cost data, followed by a determination of the causes of that consumption, which is the energy flows within the building.

As Table IV.2 indicates, energy flows in single-family and multi-family properties are similar, although a substantial percentage of energy in a multi-family building is used to distribute the energy. Commercial properties have a different profile.

Climate has a substantial impact on energy use in buildings. For example, Figure IV.1 demonstrates the difference in energy flows attributable to climate. The graph represents two office buildings containing 126,000 square feet each located in Manchester, New Hampshire, and Orlando, Florida. The Florida building requires 30 percent less energy for operation than does the one in New Hampshire. The majority of the energy costs in the north are for heating while, in the south, lighting and electrical equipment and cooling are the major energy-use areas.

1. Non-Energized Systems

The non-energized systems--the physical features that affect energy use--are identical to those of the single-family property. These include conduction, infiltration, thermal mass of the building materials, and the siting and orientation of the property. An additional variable may be the air that is introduced into the building for ventilation. This air must be conditioned before it is introduced into the living space or its effect must be counteracted by other environmental controls.

Table IV.2. ENERGY FLOWS IN DIFFERENT PROPERTY TYPES

Single-Family Residential

<u>Building Function</u>	<u>Percent of Total Energy Usage</u>
Space Heating	53
Water Heating	12
Air Conditioning	8
Refrigeration	7
Lighting	5
Other Electrical	5
Cooking	4
Clothes Drying	1
Miscellaneous	<u>5</u>
Total	100

Multi-Family Residential

<u>Building Function</u>	<u>Percent of Total Energy Usage</u>
Building Envelope: Heating	40
Energy Distribution	20
Water Heating	10
Lighting	8
Building Envelope: Cooling	7
Internal Heat Gains: Cooling	3
Miscellaneous	<u>12</u>
	100

Commercial

<u>Building Function</u>	<u>Percent of Total Energy Usage</u>
Heating and Ventilating	26
Cooling	8
Lighting	34
Fans and Pumps	28
Miscellaneous	<u>4</u>
Total	100

Figure IV1

The relative effect that non-energized systems have on the energy consumption in multi-family buildings will vary between building types. Economical options for improving the energy efficiency of non-energized systems also will vary.

It may be beneficial to analyze more fully the transfers of energy that these special energy-efficient items are intended to curtail. A number of new expressions will be introduced at this point.

Heat-transfer coefficients are measures of the susceptibility of various building materials to heat loss. These measures include the following:

- Conductivity (k), by which is meant the heat-transfer rate through a homogeneous material such as a block of iron of unit thickness. One set of units of conductivity is the Btu's per hour transferred through one square foot of material one inch thick per degree Fahrenheit.
- Conductance (C). Not all building materials are homogeneous. A heat-transfer coefficient is therefore provided for a specific building material, such as a concrete block. The conductance of an eight-inch, two-core block may be 0.96 Btu per hour per square foot per degree Fahrenheit.
- Resistance (R). Not all walls are of a single material, but may be made up of an exterior surface like face brick and a concrete-block interior surface. To determine the insulation characteristics of the wall, it would be incorrect to add the conductances of the material because this would mean the more materials used in the wall, the greater would be the wall conductance. It is correct to add the reciprocals of the conductances ($1/C$). The reciprocal of the conductance is the resistance to heat transfer, or R-value. The overall R-value of the brick and block wall would be 1.48 (R of four-inch face brick = 0.44) + (R of eight-inch block = 1.04). This formula does not consider the R-value of the air film between the brick and block wall components.
- Overall Transmission Coefficient (U). To determine overall conductance of the wall, it is necessary to determine the reciprocal of the overall resistance ($1/R$). For brick and block materials, the overall conductance would be 0.68, or $1/1.48$. If the small resistance to heat transfer by the air film is considered, the total heat transfer coefficient of the wall would be 0.43. By including the air film, the overall transmission coefficient (U) of the wall can be found.

The heat transferred through an opaque wall section is a function of the heat-transfer coefficient of the wall section and the temperature difference across the section. The equation that relates this heat transfer is as follows:

$$q = U(T_1 - T_2), \text{ wherein}$$

q = heat-transfer rate per unit area

U = heat-transfer coefficient

$T_1 - T_2$ = Temperature difference

The rate of heat transfer through an entire wall can be calculated by multiplying the area of the wall by the heat-transfer rate per unit area. If there are multiple components in a wall, such as windows surrounded by a concrete-block wall, the sections are calculated independently and summed.

Table IV.3. TYPICAL INSULATION VALUES

	C	R
Single piece of glass	1.10	0.91
Double pane glass (1/4" air space)	0.58	1.72
8" Concrete block	0.96	1.04
4" Face brick	2.27	0.44
3/4" Wood subfloor	0.94	1.06
3-1/2" Fiberglass batt	0.09	11.00
3-1/2" Rock wool*	0.08	13.00
3-1/2" Urea Formaldehyde*	0.07	14.00
1" Beadboard polystyrene	0.28	3.60
1" Extruded polystyrene	0.20	5.00
2" "Rigid" roof deck insulation*	0.19	5.26
2" "Rigid" and urethane sandwich roof deck insulation*	0.10	10.00
Exterior air film (15 mph wind)	5.90	0.17
Exterior air film (horizontal flow)	1.47	0.68

* Varies

The total R-value for the wall shown in Figure IV.2 is the sum of the R-values of the various materials making up the wall. Exterior surface resistance is one-fourth that of an interior surface exposed to air because external air motion assists in removing heat.

In addition to heat transfer by conduction through opaque surfaces, the building designer also accounted for energy transferred directly to the space by radiation--the solar gain. Similarly, the surface temperature of a solid material may greatly exceed air temperature because of solar gain. The phenomenon may be observed on exterior surfaces such as roof decks. The designer should take this into account when sizing cooling equipment.

Methods for calculating solar gain are beyond the scope of this seminar. Additional information is available, however, in the ASHRAE Handbook of Fundamentals, 1977.*

*ASHRAE is the American Society of Heating, Refrigerating, and Air Conditioning Engineers.

Figure IV.2. Calculating R Value

	<u>R</u>
INTERIOR SURFACE	.68
3/8" GYPSUM BOARD	.32
3 1/2" BLANKET INSULATION (VAPOR BARRIER ON WARM SIDE)	11.00
3/8" PLYWOOD	.47
BEVEL SIDING	.81
EXTERIOR SURFACE	.17
OVERALL R	13.45

When discussing moisture transfer, four terms are relevant:

- Water Vapor. Water in vapor or gas form is present in all air on earth. Water vapor cannot be seen, as it is truly a gas. As such, it is intimately mixed with other gases making up the air.
- Relative Humidity. Water vapor can be added to air until the air is saturated at 100 percent relative humidity (RH). At 100 percent RH, no additional water vapor can be added without condensate forming, as in a fog. The amount of water necessary to saturate air is a function of the temperature of the air. If air were saturated at 30° (RH = 100 percent) and the air were warmed, more vapor could be added. The same air of 30°, 100 percent RH, warmed to 70°, would have a relative humidity of only about 21 percent. In many parts of the country, dry conditions are common in the home. Even though the air leaking into the house may be saturated at the outside temperature, by the time it is warmed to the house temperature, the relative humidity has dropped dramatically, thus explaining the dry condition.
- Dew Point. As a surface cools, the air immediately adjacent to the surface also cools to the point that it becomes saturated or 100 percent RH. At this point, the vapor will begin to condense on the cold surface. The temperature of the surface necessary for condensation to occur is referred to as the dew point temperature. Water vapor that permeates through the inner side of a wall will continue to migrate outward during winter until it reaches a temperature cold enough to condense the vapor. This may occur in the insulation in the wall or outer siding. In either case, the condensate can be damaging to the structure.

- Vapor Barrier.** In order to prevent vapor from entering the wall, a vapor barrier can be installed in such a location that it will, ideally, never reach the dew point temperature. Typically, the vapor barrier is placed directly behind the gypsum board on the inner wall or ceiling. A good rule to follow is to locate the vapor barrier on the side that is warmer in winter.

Knowing the heat-transfer resistance of a wall is beneficial not only for sizing heating and cooling systems, but also for investigating potential condensate problems. It is not uncommon for the interior surface of a poorly insulated wall section to "sweat" during the heating season. This is because the wall-surface temperature is below the dew point of the inside air. A window is a typical example.

Although a "sweating" wall is normally undesirable, more severe problems can arise if the condensation occurs inside the wall. This would be the case if the inside surface of the wall did not have a good vapor barrier. Moisture within the wall can destroy some forms of insulation, cause paint to peel, and, if it freezes, to cause structural damage.

In addition to conduction heat transfer, there may be a significant load on cooling systems contributed directly from solar radiation through windows. Figures IV.3 and IV.4 demonstrate the effects of solar gain and various methods for reducing cooling load.

The energy manager should be aware that solar gain may be beneficial during the heating season. Accordingly, it may be advantageous to use a window treatment that will shade the windows only during the cooling season.

Figure IV.3.

Figure IV.4.

2. Energized Systems

As the size of the building increases, the complexity of the energized system may also increase. Generally, the options for improving energy efficiency also increase with system complexity. These include such things as operating procedural changes, control strategies, and total system renovation.

The sections that follow expand on these options. They include discussion of heating, ventilating, and air conditioning equipment, lighting systems, domestic water heating, and the miscellaneous subsystems associated with them.

Because of the variety of options for improving energy efficiency, many prove to be extremely economical. The appraiser who is aware of the options and their viability will be able to determine the true value of the property as it relates to future net income. A property thought to be functionally obsolete because of high operating costs may indeed be economically modified so that it becomes energy efficient.

3. Human Systems

The single most important factor affecting energy consumption in a building is its use--the human system. The use has more impact than the insulation, glass, energy source, or heating and air conditioning system. Building occupancy, including occupancy density, schedule, activities within the building, and the energy management and control, predominantly determines the "energy budget" (energy consumption per unit area--BTU/ft²). This does not imply that two similar buildings with identical use will have the same energy consumption. The energy use per square foot of similar multi-family structures, however, is likely to be more similar than those of a multi-family and a commercial property as compared to each other.

The appraiser always should inquire about the existence of any energy-management program in a multi-family property. Competent and conscientious energy management is extremely important in such properties because of the relatively greater significance of mechanical systems and their care than is the case in single-family residences.

The individual responsible for the operation of a multi-family complex significantly affects the energy consumption of that property. For years, the primary purpose of building maintenance was to ensure the lowest occupant complaints and lowest cost of improvements. Little concern was given to the energy costs of the property because they were relatively insignificant.

As energy costs have increased, the property manager may or may not have become more aware of the operation of the property for energy efficiency. As a result, the operating procedures that affect energy consumption may vary considerably between properties.

The appraiser should be aware of the procedure followed by the property manager when assessing operating costs. Many times, changes in procedures will significantly affect the net income value of the property.

Any successful energy management program depends in part upon energy monitoring. An audit should include an inventory of energy consumption and reasons for that consumption. Completion of an audit will not only provide information for developing an energy-management program, but will reveal immediate opportunities for energy conservation. These measures may include discovering a leaking pump connection, a sticking damper actuator, a thermostat at the wrong setting, or a loaded filter.

Energy monitoring should not end with development of the management program. A successful program requires continuous monitoring of energy consumption so that progress of the program can be monitored. Another advantage of continuous monitoring may be the discovery of an unexplained jump in consumption. Such a jump may be caused by an undiscovered steam leak, a malfunctioning valve or damper, or a misread meter. Without plotting energy consumption, the problem may go unnoticed.

The appraiser should check to see if the current property manager maintains energy use information and/or has had an energy audit for the property. This information will be useful in determining whether the management is atypical or not.

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IV-12

B. Collecting Energy Cost Information

Utility costs have now become a significant portion of the operating expenses of multi-family properties. Collection of energy cost data, therefore, is a necessary part in the appraisal of income property.

This section discusses methods by which utility costs are determined, how cost histories can be obtained and interpreted, and how different properties can be compared using energy consumption.

Utility costs are a function of not only the quantity of energy consumed, but many times also when and how it is used. Rate schedules may include price differences for energy consumed at different times during the day or for different seasons, and the rate at which that energy is consumed (demand). This section discusses rate schedule interpretation so the appraiser can determine what variables have affected utility costs and if there is a potential for improvement.

1. Calculating a Building's Energy Budgets

The energy budget of a property can be established in two ways. The first is a total consumption budget that compares the annual energy consumption to area of the property. The second is a cost comparison that provides the ratio of annual utility cost to area. Either of these budgets can then be used as an index for comparing properties. Using comparable data, the appraiser can determine if the subject property is more or less energy efficient than the norm.

Energy Cost Budget

The energy cost budget is the least difficult of the two energy budgets to determine. However, because of constantly fluctuating energy costs, the comparable data must be very current or comparisons will not be valid.

The calculation is identical to that for single family. The total monthly energy cost (including all energy forms) is summed for 12 consecutive months. The sum is divided by the building area (typically in square feet) to establish the annual per-square-foot energy cost budget.

$$\frac{\text{Total Annual Energy Costs}}{\text{Area of Property}} = \text{Energy Cost Budget (Per Square Foot)}$$

Energy Consumption Budget

The energy consumed by a property does not fluctuate with world prices (except for attempts to conserve). Therefore, comparables need not be as immediately current as is the case when comparing energy costs.

As in calculating energy costs budgets, the energy consumed by the building for each month is summed over 12 months to establish the annual energy consumption. Typically, each energy form is summed independently, and the annual consumption is then converted to a common set of units (Btu's).

For example, if the property consumes natural gas in "therms" and electricity in "KWH," the annual gas consumption would be multiplied by 100,000 Btu/Therm and the annual electricity consumption would be multiplied by 3,413 Btu/KWH. The sum of the two energy forms (now converted to Btu's) would be divided by the area of the property to establish the annual energy consumption budget.

$$\frac{\text{Total Gas Consumption Converted to Btu's} + \text{Total Electric Consumption Converted to Btu's}}{\text{Area of Property}} = \text{Energy Consumption Budget}$$

The appraiser should account for property differences that would affect energy consumption just as is done with other comparables so that a true energy-consumption budget comparison can be made. Energy-consumption budget data are now an additional source of information that can be used effectively to compare property values accurately.

Energy budgets vary considerably not only because of climatic effects, but also in building design and use. For example, data from a number of multi-family properties in the Northeast varied between 68,000 Btu/Ft² to 210,000 Btu/Ft². Certainly not all the properties in the study could be assumed to be comparable because design and use differ. The appraiser should be aware of these differences and account for them.

The federal government has proposed a building standard concept for energy conservation that is based on an energy consumption budget (at the design stage of the property). Known as the "Building Energy Performance Standard" (BEPS), the program establishes maximum energy consumption budgets within which the designer must design the building. The proposed design energy consumption budget for a low-rise multi-family building in Massachusetts is 102,000 Btu/Ft² whereas the same structure in Oregon would have a budget of 99,000 Btu/Ft².

2. Use of Energy Budgets

We have already discussed using the energy budgets for comparison of properties. The appraiser can use data from the budget to begin the energy analysis of the property as well. For example, if it is determined that the energy used for space heating (possibly natural gas) is equal to or lower than the norm, but the electric consumption is high, the appraiser would first investigate electricity-consuming systems such as air conditioning. If the apartments are individually metered, but the common areas are billed to the property, and

if they are higher than the norm, the appraiser would look for wasteful interior or exterior lighting or possibly inefficient electric pool heating.

3. Utility Rate Schedules

Energy needs of buildings are supplied in a variety of ways. Electricity, gas, and/or steam may be provided by a public or investor-owned utility company, a municipality, or an electric cooperative. Although all do not fall under the same governmental jurisdiction, the suppliers will furnish a rate schedule on request.

The format of the rate schedule will vary with suppliers. In addition, many suppliers will have different rates, depending on the type and size of the customer. Many electric utilities offer a lower rate for larger customers because of the lower cost of the equipment per unit necessary to supply that consumer. The appraiser may wish to review the rate schedule with the utility supplier in order to ensure that the facility is operating under the most favorable rate. Those facilities that have experienced a substantial increase in electric consumption because of a recent expansion may be eligible for a lower rate. An example of a rate schedule has been included at the end of this section.

The appraiser should use only those rate schedules currently in effect, which will be provided by the utility company. On occasion, adjustments may be made to the schedule to reflect a change in energy costs to the utility. These are labeled "fuel adjustment."

The total charge for the energy shown on a utility bill may be based on a number of variables, including the following:

- Energy. Most electric utilities use a sliding block approach for energy charges, i.e., so much per KWH for the first 1,000 KWH, so much per KWH for the second 1,000, and so on. In most cases, the average cost per KWH decreases as consumption increases.
- Fuel Adjustment. Many electric utilities have an additional energy cost called a fuel adjustment, which reflects the changing cost of fuel. It can be a significant charge. Gas utilities have a similar charge, called a purchased gas adjustment charge, or PGA, which adjusts gas bills on the basis of fluctuations in the wholesale cost of gas.
- Demand or Capacity. The demand charge is designed so that the customer pays his/her fair share of the utility's fixed investment in the production, transmission, and distribution equipment required to meet maximum requirements. The charge is based on the rate at which electricity is consumed; the more used at any given time, the larger the utility company's investment in generation, transmission, and distribution systems. The consumer's actual demand may be computed as the average rate of energy consumed in a predetermined demand-measurement interval, usually 15 or 30 minutes. Regardless of the interval, the highest average demand in the prescribed interval recorded during a month becomes the actual demand for the month. Many utilities also

employ a special clause stating that, regardless of actual demand in a given month, the demand for which the consumer is billed will be no less than a specified percentage of demand recorded, typically 80 percent of the highest demand during the summer months. This will be specified in the rate schedule.

- Low-Power Factor Penalty. Occasionally, there will be a penalty for what is called the "low power" factor. The power that must be supplied to any induction load, such as induction motor, transformer, fluorescent light, etc., is made up of real and reactive power. Induction devices cause a shift in the voltage and current phases.

Demand Monitoring

More and more frequently, utilities are establishing demand charges for electrical usage. Under demand charging, the customer is billed not only on the amount of energy used, but by the rate at which it is used.

To do this, the utility installs a "demand" meter, which measures both total energy consumption (KWH) and demand (KW). This meter keeps track of the rate at which energy is used and registers the highest rate for a 15-30 minute period. This rate determines the average price of the total amount of energy used during the month. For example, if two houses used identical amounts of energy during a month, but one used it all in one day, that house would have a higher demand rate and would be billed at a higher average rate for the electricity than the house using electricity at a lower rate.

This means that just saving energy does not necessarily cut utility costs under a demand metered system. Both the amount and the rate at which it is used must be reduced.

It is possible to tell whether a property is being billed on a demand rate schedule by looking at the meter, the utility bill, or the utility rate schedule. It is likely that, if comparables are in the same utility area and have the same type of heating fuel, that they will be billed under the same rate schedule.

Degree Days

The degree day is an index used in a variety of ways for quantifying weather (i.e., temperature) data. The concept can be used to compare the severity of weather conditions from one period to another as a basis for predicting energy consumption in buildings or in a multiplicity of other ways.

The heating degree day is defined as the difference between 65°F and the average of the high and low temperatures for a single given day. If the high temperature for February 28 were 54° and the low were 26°, for example, the average temperature for that date would be 40°F. Thus, there would be 25 heating degree days (i.e., 65°-40°) for February 28. Summing the heating degree days for each day of a month gives the monthly heating degree days.

Summing the totals for each of the 12 months would give the annual heating degree days. Heating degree days, by zone, are shown in Table IV.4.

Cooling degree days are calculated similarly. Here, 65°F is subtracted from the average of the high and low temperatures for the day.

Table IV.4. HEAT DEGREE DAYS (By zone)

<u>Zone</u>	<u>Heating Degree Days</u>
1	0-1000
2	1001-2500
3	2501-3500
4	3501-4500
5	4501-5000
6	5001-6000
7	6001-7000
8	7001+

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Index No. _____

SCHEDULE G-79

THE KANSAS POWER AND LIGHT COMPANY
(Name of Licensee Utility)

Replacing Schedule See Note Sheet _____

Entire Service Area
(Territory to which schedule is applicable)

which was filed February 11, 1977

No amendment or variance understanding shall modify the tariff as shown herein.

Sheet 1 of 4 Sheets

GENERAL SERVICE

AVAILABLE

Electric service is available under this schedule at points on the Company's existing distribution facilities.

APPLICABLE

To any Customer using electric service supplied at one point of delivery for which no specific schedule is provided.

This schedule is not applicable to breakdown, standby, supplementary, resale or shared electric service.

CHARACTER OF SERVICE

Alternating current, 60 cycles, at the voltage and phase of the Company's established secondary distribution system most available to the service location.

NET MONTHLY BILL

Rate (See Index for rate areas) **ENERGY CHARGE**

Winter Period - Bills issued for October through June inclusive.

6.0c per KWH for the first 700 KWH
4.5c per KWH for the next 950 KWH*
2.6c per KWH for all additional KWH

plus: \$5.50 for service in Rate Area "a"
\$6.50 for service in Rate Area "b"
\$8.00 for service in Rate Area "c"

Summer Period - Bills issued for July through September inclusive

6.0c per KWH for the first 700 KWH
5.2c per KWH for the next 950 KWH*
2.5c per KWH for all additional KWH

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790247
Commission File Number

Issued September 17, 1979
with deliveries on and after SEP 26 1979
Effective SEP 26 1979
By John G. Williamson Secretary of State
For James B. Ray President of Kansas

NOTED & FILED SEP 21 1979
THE STATE CORPORATION COMMISSION OF KANSAS

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Sheet 3 of 4 Sheets

BILLING CAPACITY

Customer's average kilowatt load during the thirty-minute period of maximum use during the month; provided that if Customer permanently installs and uses as the primary source of heat for the space to be heated, three (3) kilowatts or more of electric space heating equipment, and has so informed the Company in writing, then on bills issued for November through May inclusive, such kilowatt load will be reduced by the smaller of the following:

(a) On bills for the month of:

November - 25% of installed heating capacity in kilowatts
December - 40% " " " " " "
January - 40% " " " " " "
February - 60% " " " " " "
March - 60% " " " " " "
April - 60% " " " " " "
May - 25% " " " " " "

(b) Fifty percent (50%)

(c) Seventy-five (75) kilowatts

Power Factor Adjustment **POWER FACTOR**

If the power factor for the month (determined at the Company's option by permanent measurement or by test of not less than 30 minutes duration under conditions which the Company determines to be normal) is less than ninety percent (90%) at the point of delivery, the Billing Capacity will be increased by multiplying by 90% and dividing by the power factor expressed in percent.

PAYMENT

Monthly bills will be rendered NET, payable within fifteen days of the date of the bill, and will become delinquent thereafter. Two percent shall be added to the net amount on the date the bill becomes delinquent as stated thereon.

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Sheet 2 of 4 Sheets

NET MONTHLY BILLING - Continued

Summer Period - Continued

plus: \$5.50 for service in Rate Area "a"
\$6.50 for service in Rate Area "b"
\$8.00 for service in Rate Area "c"

DEMAND

* Add 170 KWH for each of the first 45 kilowatts (KW) of Billing Capacity over 5 KW; and add 110 KWH for each additional KW of Billing Capacity.

Minimum

The above rate for zero consumption plus \$0.75 for each KW over 5 KW of the highest Billing Capacity established during the twelve months ending currently, plus applicable adjustments and surcharges.

When a special transformer installation is necessary for the benefit of the Customer or to protect the quality of service to other Customers, such minimum shall be not less than \$0.75 per kilovolt-ampere (KVA) of required transformer capacity.

Energy Cost Adjustment **FUEL ADJUSTMENT**

The rates hereunder are subject to adjustment for changes in fuel and purchased energy costs as provided in Company's "Energy Cost Adjustment" schedule.

Tax Adjustment

The rates hereunder are subject to locally imposed taxes as provided in Company's "Tax Adjustment - Electric" schedule.

Research and Development Surcharge

The rates hereunder are subject to a surcharge as provided in Company's "Research and Development Surcharge - Electric" schedule.

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Sheet 4 of 4 Sheets

OTHER TERMS AND CONDITIONS

- Company shall have the right of inspection and determination of the capacity and use of electric space heating equipment for compliance with this schedule, and will reduce the KW allowance of installed heating capacity for billing purposes when, in its judgement, such capacity exceeds that which is necessary for Customer's heating requirements.
- Individual motor units rated at more than five horsepower shall be three phase (when three phase service is supplied), unless otherwise agreed upon prior to installation.
- Individual motor units rated at ten horsepower or more shall have starting equipment satisfactory to the Company.
- Service hereunder is subject to the Company's General Terms and Conditions on file with the State Corporation Commission of the State of Kansas.

NOTE: Tariff Schedule G-79 replaces Tariff Schedules: Ga-77; Gb-77; Gc-77; Gd-77.

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C. Identifying "Special Energy-Efficient Items"

The FHLMC Single-Family Residential Appraisal Report form includes several sections for recording energy-efficient items, as discussed in Section IC. These items are grouped into ten categories and discussed more fully in Section IIC of the seminar materials.

Similarly, categories for energy-efficient items in multi-family residences can be defined. In many respects, the categories are similar to those for single-family units, with the exception that the efficiency of the mechanical and electrical systems and the automatic controls associated with those systems assume a more dominant role. The 10 categories are as follows:

1. Efficient heating and cooling systems should be used. New units should be selected for efficiency and proper sizing. Existing units should be maintained properly through a preventive maintenance system.
2. Efficient delivery systems for space heating and cooling should be used. Filters should be changed on a scheduled basis, all automatic valves and dampers should be checked regularly, steam traps should be checked, thermostats should be calibrated, etc.
3. Time switches and programmable controls reduce energy consumption. All energy equipment that is not always in use should have controls. This would include such items as domestic water circulating pumps, pool pumps, fountains, exterior lighting (consider also installing a photocell), and night setback thermostats in common areas, such as a clubhouse.
4. All units should be individually metered where practical.
5. All management-supplied appliances should be selected for energy efficiency.
6. Insulation, with adequate R-values, should be installed in roof decks, ceilings, exterior walls, and exposed basement foundations, around water heaters, hot water lines, and ducts in unconditioned spaces.
7. All windows, doors, cracks resulting from settling, and joints between envelope building materials should be caulked and weatherstripped.
8. Storm doors and windows or double glazing should be installed properly. Shading of fenestration areas should occur only during the cooling season.

9. Building design, solar orientation, shading, and landscaping can all significantly reduce energy consumption if appropriately planned and installed.
10. Alternate energy sources should be used wherever possible. This might apply to pool heating, space and water heating, and space cooling.

1. Efficient Heating and Cooling Systems

Appraisers should be aware that space-conditioning systems have different efficiencies based on their configurations and their maintenance. The appraiser may encounter a wide variety of different units in multi-family buildings. This section reviews the major types of equipment and discusses the main areas of maintenance.

Heating units generally are divided into (1) furnaces and (2) boilers. Cooling units include (1) direct expansion systems; (2) chilled water systems, including reciprocal chillers, centrifugal chillers, and absorption chillers; and (3) evaporative cooling towers.

Furnaces

Residential space heating may be accomplished through any of a variety of units that provide heated air either through ductwork or directly into the space in which the heater is located. By far, the most common residential space heating system is the central-system forced-air furnace.

In fuel-burning (oil and gas) furnaces, combustion takes place within a metal-walled heat exchanger. Circulating air passes over the outside surface so that it does not contact the fuel or the products of combustion. The products of combustion are conveyed to the outside atmosphere through a flue or vent. In an electric furnace, the resistance-type heating element either heats the circulating air directly or through a metal sheath enclosing the resistance element.

The basic difference between residential and multi-family property furnaces is the size and heating capacity of the equipment. The output capacity of a multi-family furnace may range from 150,000 Btu/h to over 1 million Btu/h. Furnaces with output capacities less than 320,000 Btu/h are generally classified as light commercial and those above 320,000 Btu/h as large commercial equipment. Besides the difference in capacity, large commercial equipment is more durable and has a more sophisticated control system.

*Portions of Sections 1 and 2 are reprinted, with permission, from the 1979 Equipment Volume, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbook and Product Directory.

Boilers

A boiler is a pressure vessel designed to transfer heat (produced by combustion) to a fluid. The definition has been expanded to include transfer of heat from electric resistance elements to the fluid, or by direct action of electrodes on the fluid. Typically, a boiler is a cast-iron or steel pressure vessel heat exchanger designed to (1) burn fossil fuels (or use electric current) and (2) transfer the released heat to water (in water boilers) or to water and steam (in steam boilers).

With few exceptions, all boilers are constructed to meet American Society of Mechanical Engineers (ASME) Codes. These are the ASME Boiler and Pressure Vessel Code Section IV for Heating Boilers (low pressure boilers), and the ASME Code Section I for Power Boilers (medium and high pressure boilers). Low pressure boilers are constructed for maximum working pressures of 15 psi steam and up to 160 psi hot water. Hot water boilers are limited to operating temperature. Medium and high pressure boilers are those designed to operate at above 15 psi steam, or above 160 psi water or 250°F water boilers.

Steam boilers are seldom used for heating today, except as replacements in existing systems and in large installations to provide steam for hot water system heat exchangers and for absorption cooling systems. Water boilers are usually low pressure, serving low temperature heating systems. The majority of water boilers used are constructed and limited by the ASME Code to 30 psi working pressure. Cast-iron boilers rated from 50-100 psi working pressure are also manufactured. Low pressure steel water boilers are available for any working pressure up to the ASME Code maximum of 160 psi. Any boiler is rated at the maximum working pressure determined by the ASME Code, and must be equipped with a relief valve opening at that rated pressure, or lower.

Boilers may be designed to burn coal, wood, various grades of fuel oil, various types of fuel gas, or to operate as electric boilers. A boiler designed for one specific fuel type may not be convertible to another type of fuel. Some boiler designs can be adapted to burn coal, oil, or gas. Several designs allow firing with oil or gas by burner conversion or by using a dual fuel burner.

Cast-iron boilers are constructed of individually cast sections, assembled into blocks (assemblies) of sections using push or screw nipples, gaskets, or an external header to join the sections pressure tight and provide passages for the water, steam, and products of combustion.

Steel boilers are fabricated into one assembly of a given size and rating, usually by welding. The heat-exchange surface past the firebox usually is an assembly of vertical, horizontal, or slanted tubes. The tubes may be firetube (flue gas inside, heated fluid outside) or watertube (fluid inside). A popular design for medium and large steel boilers is the Scotch or Scotch Marine, which is characterized by having a central fluid-backed cylindrical firebox, surrounded by firetubes in one or more passes, all within the outer shell. Steel boiler sizes range from approximately 50 MBh to the largest boilers made.

Electric boilers are in a separate class. Since no combustion occurs, no boiler heating surface and no flue openings are necessary. Heating surface is

the surface of the electric elements immersed in the boiler water. The design of electric boilers is largely determined by the shape and heat-release rate of the electric heating elements used.

Direct Expansion Systems

The most common residential cooling systems are based on a direct expansion (DX) refrigeration unit. In this system, a refrigerant such as "Freon"* evaporates within the room-side coil (evaporator), removing heat from the space. The refrigerant then is condensed in an outdoor coil (condenser), where the room heat is dissipated. The use of a refrigerant as a working fluid allows manufacturers to package cooling systems in small individual units.

Chilled Water Systems

As cooling loads increase, options other than DX systems become available. In larger capacities, there are economic advantages to the use of chilled water systems. Such a system uses the refrigerant to chill water, which in turn is used to cool room air. Several types of water chillers are described below.

Reciprocal Chillers. The reciprocating compressor is a positive displacement machine that maintains a fairly constant volume flow rate over a wide range of pressure ratios. A reciprocal chiller is distinguished from centrifugal and screw compressor-operated chillers by its use of increments of capacity reduction rather than continuous modulation. To be energy efficient, arrangements must be made to establish precise chilled liquid temperature control while maintaining stable operation free from excessive on-off cycling of compressors or unnecessary loading and unloading of cylinders.

Centrifugal Chiller. The centrifugal compressor offers a wide range of capacities continuously modulated over a limited range of pressure ratios. Its ability to vary capacity continuously to match a wide range of load conditions with nearly proportionate changes in power consumption makes it desirable for both close temperature control and energy conservation. Its ability to operate at greatly reduced capacity makes for more on-the-line time with infrequent energy-consuming starts.

The hour of the day for starting an electric-drive centrifugal liquid chiller can often be chosen by the building manager to minimize peak power demands. It has a minimum of bearing and other types of contacting surfaces that can wear; this wear is minimized by providing forced lubrication to those surfaces prior to start-up and during shutdown. Bearing wear is usually more dependent on the number of start-ups than the actual hours of operation. Thus, by reducing the number of start-ups, the life of the system is extended and its maintenance cost is reduced.

*"Freon" is a registered trademark of E.I. duPont de Nemours & Co.

Centrifugal packages are currently available from about 80 to 2,400 tons at nominal conditions exiting chilled water temperature and exiting condenser water temperature. This upper limit is continually increasing.

Absorption Chillers. Absorption machines are heat-operated refrigeration machines based on one of the earliest known principles of refrigeration. The cycle utilizes an absorbent as a secondary fluid to absorb the primary fluid gaseous refrigerant, which has been vaporized in the evaporator.

The absorption cycle and the mechanical compression cycle have in common the evaporation and condensation of a refrigerant liquid, these processes occurring at two pressure levels within the unit. The two cycles differ in that the absorption cycle uses a heat-operated generator to produce the pressure differential and the mechanical compression cycle uses a compressor; the absorption cycle substitutes physiochemical processes for the purely mechanical processes of the compression cycle. Both cycles require energy for operation; heat in the absorption cycle, mechanical energy in the compression cycle.

Absorption equipment currently manufactured in the United States is either water-cooled equipment using lithium bromide-water, where water is the refrigerant, or air-cooled equipment using ammonia-water, where ammonia is the refrigerant. These are predominantly for air-conditioning applications. In addition, water-ammonia absorption equipment has been used in large-tonnage industrial applications requiring low temperatures for process work. Typically, machines have capacities of 50 to 1,500 tons.

Evaporative Cooling Towers

There are two basic types of evaporative cooling devices. The first type involves direct contact between heated water and atmosphere. The direct-contact device (commonly called cooling tower) exposes water directly to the cooling atmosphere, thereby transferring the source heat load directly to the air. The second type involves indirect contact between heated fluid and atmosphere.

Indirect-contact towers (commonly called closed-circuit fluid coolers) contain two separate fluid circuits: (1) the external circuit in which water is exposed to the atmosphere as it cascades over the tubes of a coil bundle and (2) an internal circuit in which the fluid to be cooled circulates inside the tubes of the coil bundle. In operation, heat flows from the internal fluid circuit, through the tube walls of the coil to the external water circuit, which is cooled by evaporation. Since the internal fluid circuit never contacts the atmosphere, this type of unit can be used to cool fluids other than water and/or to prevent contamination of the primary cooling circuit with airborne dirt and impurities.

Central Heating and Cooling Unit Maintenance

The efficiency of central heating and cooling components, that is, of boilers and chillers, tends to decrease if the equipment is not properly maintained.

To burn fuel at maximum efficiency, a boiler must provide the chemically proper amount of both fuel and air. Adjustments to the metering devices are based on the results of combustion tests, which analyze the products of combustion. A flue gas test examines CO₂ content for completeness of combustion and O₂ for excess air. Measurement of the exhaust stack temperature indicates excess chimney losses. Smoke measurements check for insufficient air quantities or poor fuel preheating. Completed annually, these tests facilitate optimum boiler efficiency.

A persistent problem in all boilers is corrosion. Air trapped in boiler feedwater attacks the boiler walls, forming rust. This rust deposit acts as an insulator, reducing heat transfer from the burning fuel. Special chemicals added to the boiler feedwater either manually or automatically combat this problem. (A side effect of this protection is reduced corrosion in delivery piping.) The types and amounts of corrosion-preventative chemicals are determined by a chemical analysis of the boiler feedwater. Chemical companies will contract to provide these services and chemicals on a periodic basis. If tested in-house, an analysis should be done weekly.

Cleaning of heat-transfer surfaces--or rodding out--of boilers should be done during periods of non-use. Boilers are drained, their interior surfaces are cleaned, and they are refilled with specially treated water to reduce corrosion while not in use.

Older boilers typically have poor part-load efficiencies. As the outdoor temperature becomes warmer, the demand on the boiler decreases and boiler efficiency drops. Often compounding the problem are oversized boilers. It is not uncommon to find boilers with two to three times the capacity necessary to heat the building.

Some boilers can be derated so that their capacity more closely meets the building requirements. However, it may prove economical to replace an older boiler with a new one that modulates its capacity as a function of building demand. The appraiser may wish to seek technical assistance in determining the feasibility of such a replacement.

Control modifications to a boiler may be cost effective in improving operating efficiency. One such device controls the water discharge temperature in a water boiler as a function of outdoor temperature. As the outdoor temperature drops, the water temperature increases.

Chillers and cooling towers share the corrosion problem with boilers. Again, frequent chemical analyses and annual cleaning of chiller tubes significantly increases system operating efficiency.

Like boilers, some chillers suffer in efficiency under part load. One normally effective procedure is to elevate the chilled water discharge temperature. An appraiser may discover that a chiller has an exiting water temperature of 38°F. The building, however, may operate satisfactorily with 46°F water. Controllers can be added to regulate the discharge temperature as a function of building load. Whether the temperature is controlled manually or automatically, the temperature should not be set so high that the control of humidity is lost. Simple experimentation should prove valuable.

The discharge temperature of the water leaving a cooling tower can occasionally be regulated by a thermostat controlling a three-way valve. The thermostat may be set higher than necessary to protect the equipment and can be readjusted down, thus improving chiller efficiency. It may be appropriate to get some technical assistance in selecting an appropriate thermostat set point.

2. Efficient Delivery Systems for Space Heating and Cooling

This section reviews the types of delivery systems used for heating and cooling buildings. Delivery systems can be considered from two perspectives:

- Major components, such as "terminal equipment" (i.e., radiators and baseboard units), which are heating/cooling distributing devices; and "fluid movers," which are mechanical devices (e.g., fans and pumps) used to move the heated air or water to the rooms; and
- System configuration, which is the organization of the total system from the heating/cooling unit to the space and back.

Just as for the heating and cooling units themselves, proper maintenance of the delivery systems increases energy efficiency. This section reviews the major types of systems and discusses maintenance procedures.

Terminal Heating Equipment

Radiators, convectors, baseboard, and finned-tube units are types of heat-distributing devices commonly used in steam and low temperature water-heating systems. They supply heat through a combination of radiation and convection. In general, these types of units are placed at the points of greatest heat loss: for example, under windows, along exposed walls, and at door openings.

Radiators. A radiator is a cast-iron device constructed of columns, large tubes, or small tubes. Small-tube radiators, with a length of only 1-3/4 in. per section, occupy less space than the older column and large-tube units, and are particularly suited to installation in recesses.

Convectors. A convector is a heat-distributing unit that operates with gravity-circulated air and has a heating element with a large amount of secondary surface containing two or more tubes headered at both ends. The heating element is surrounded on all sides by an enclosure having an air inlet opening below and an air outlet opening above the heating element.

Convectors are made in a variety of depths, sizes, lengths, and enclosure or cabinet types. The air enters the enclosure below the heating element, is heated in passing through the element, and leaves the enclosure through the outlet grille at the top. These may be free standing, wall hung, or recessed, and may have outlet grilles and arched inlets or inlet grilles, as desired.

Baseboard Unit. Baseboard or baseboard-radiation units are heat-distributing units designed for installation along the bottom of walls in place of the conventional baseboard. There are two types of baseboard units: radiant-convactor and finned tube. The radiant-convactor baseboard is made of cast iron or steel. The units are provided with air openings at the top and bottom to permit circulation of room air over the wall side of the unit. This part of the unit has extended surface to provide increased heat output. The finned-tube type has a finned tube heating element concealed by a long low sheet metal enclosure or cover. A major portion of the heat is transferred to the room by convection. The output varies over a wide range, depending on the physical dimensions and the materials used.

Finned Tube Units. Finned-tube or fin-tube units are fabricated from tubing with metallic fins bonded to the tube. They operate with gravity-circulated room air, and may be installed bare, with an expanded metal grille, a cover, or an enclosure having top, front, or inclined outlets.

The finned-tube unit can be used with steam or hot water systems. It has installation advantages for distributing the heat along the entire outside wall, and thereby preventing downdrafts. It may be used as the principal source of heat in a building or as a supplementary heater to combat downdrafts along the exposed walls in conjunction with a central conditioned air system.

Unit Heaters

A unit heater is an assembly of elements including a fan and motor, a heating element, and an enclosure. Filters, dampers, directional outlets, duct collars, combustion chambers, and flues may also be included.

Unit heaters have three principal characteristics: (1) relatively large heating capacities in compact casings, (2) the ability to project heated air in a controlled manner over a considerable distance, and (3) a relatively low installed cost per Btu output. They are usually used where the heating capacity requirements, the physical volume of the heated space, or both, are too large to be handled adequately or economically by other means. By eliminating extensive duct installations, the space is freed for other uses.

Terminal Cooling Equipment

Fan-Coil Units. The fan-coil conditioner unit is a versatile room terminal that is used with both air-water and water-only systems. Its basic elements are a finned-tube coil and a fan section. The fan section recirculates air continuously from within the perimeter space through the coil, which is supplied with either hot or chilled water. In addition, the unit may contain an auxiliary heating coil that is usually of the electric resistance type but that can be of the steam or hot water type. Thus, the recirculated room air is either heated or cooled.

Room fan-coil units are available in a number of physical configurations. Low vertical units are available for use under windows with low sills; however, in

some cases, the low silhouette is achieved at a compromise of such features as filter area, motor serviceability, and cabinet style.

Horizontal overhead units may be fitted with ductwork on the discharge to supply several outlets. A single unit may serve several rooms, as might be suitable in an apartment house where individual room control is not essential and a common air return is feasible.

Unit Ventilators. A heating unit ventilator is an assembly whose principal functions are to heat, ventilate, and cool a space by introducing outdoor air in quantities up to 100 percent of its rated capacity. The heating medium may be steam, hot water, gas, or electricity. The essential components of a heating unit ventilator are: fans, motor, heating element, dampers, filters, and outlet grilles (or diffusers), all encased in a housing.

An air-conditioning unit ventilator is similar to a heating unit ventilator but, in addition to the normal winter function of heating, ventilating, and cooling with outdoor air, it is also equipped to cool and dehumidify during the summer season. It is usually arranged and controlled to introduce a fixed quantity of outdoor air for ventilation during warm periods in mild weather. The typical unit is equipped with a control system that permits the heating, ventilating, and cooling effect to be varied while the fans are operating continuously. In normal operation, the discharge air temperature from a unit is varied in accordance with the room requirements.

With the heating unit ventilator, cooling can be provided whenever the outdoor temperature is below the room temperature by bringing in outdoor air as required, providing what is called ventilation cooling. Air conditioning unit ventilators can provide mechanical cooling in cases where the outdoor air temperature is too high to be used effectively for ventilation cooling.

Room Air Conditioners. A room air conditioner is an encased assembly designed as a unit primarily for mounting in a window or through a wall. These units are designed for the delivery of air to the room either without ducts or with very short ducts up to a maximum of about 48 in. The basic function of a room air conditioner is to provide comfort by cooling, dehumidifying, filtering or cleaning, and circulating the room air. It may also provide ventilation by introducing outdoor air into the room and/or exhausting room air to the outside. The conditioner may be designed to provide heating by reverse cycle (heat pump) operation, by electric resistance elements, or by a combination of both.

Fluid Movers

Fans. The fan is the heart of any air-conditioning system. It is an air pump--a machine that creates a pressure difference and causes air flow. The impeller imparts a both static and kinetic energy, varying in proportion depending on the fan type.

Fans are generally classified as centrifugal fans or axial flow fans according to the direction of air flow through the impeller. The general configuration of a centrifugal fan is shown in Figure IV.5, with the various parts of the fan identified. A similar description of an axial flow fan is shown in Figure IV.6. There are a number of subdivisions of each of the general types.

Figure IV.5. Centrifugal Fan Components

Figure IV.6. Axial Fan Components

All fans produce pressure by altering the velocity vector of the flow. The fans produce pressure and/or flow due to the rotating blades of the impeller, which impart kinetic energy to the air in the form of velocity changes. These velocity changes result from tangential and radial velocity components in the case of centrifugal fans, and from axial and tangential velocity components in the case of axial flow fans.

Pumps. Centrifugal pumps are used in heating and air conditioning to produce water flow in piping. Other pumps, such as reciprocal or rotary pumps, play a minor role in this industry. Pump selection often is made by an equipment manufacturer for a specific application. Typical of these are rotary oil pumps that are incorporated into oil burners.

In centrifugal pumps, part of the output torque supplied by a driver is converted into pressure energy by the action of centrifugal force, which is a function of the impeller vane peripheral velocity. After liquid enters the eye of the impeller, energy is added to the liquid by the impeller rotation. The casing collects the liquid as it leaves the impeller and guides it out the discharge nozzle. The pressure energy added by the pump is used to: (1) overcome the friction caused by flow through heating and air-conditioning equipment, i.e., piping, valves, coils, chillers, or boilers; and (2) raise the water to higher elevations such as to the top of a cooling tower.

Centrifugal pumps are used in heating and air conditioning for four major applications. These are: (1) condenser water (cooling tower), (2) chilled water, (3) hot water, and (4) boiler feed and condensate.

Forced Air Heating and Cooling Systems

Single Zone Systems. Single zone duct systems deliver warm air from a furnace or from an air handling unit or section of a package air conditioner. The same system, when equipped with cooling coils, is used to deliver cool and dehumidified air as well as warm air through common duct work.

These systems are the simplest and probably the most commonly used. They can comprise just a single supply system with air intake filters, supply fan, and heating coil or can become more complex with the addition of a return air duct, return air fan, cooling coil, and various controls to optimize their performance. Basically, the system supplies air at a predetermined temperature to one zone or the entire building, the quantity of heating or cooling being controlled either by modulating the supply air temperature or by turning the system on and off.

The energy output of a single duct system to meet a space load is determined by the volume/temperature differential relationship, i.e., to maintain a space temperature of 65°F, the heating load could be met by a system supplying 10,000 cfm at 105°F, or 6,000 cfm at 125°F.

Figure IV.7. Representative Single-Duct System

Terminal Reheat Systems. Terminal reheat systems are commonly used and very wasteful. Basically, supply air is cooled to a fixed point (usually 55°F). The cool air is supplied through ducts to all outlets, individually or in groups, where it is then reheated to a temperature compatible with the demands of that space. Under partial or light loads, most or all of the re-heat coils will still be operating because the supply air is too cold for direct use in certain parts of the building. Only under peak cooling loads do the majority of reheat coils turn off.

Terminal reheat systems were developed to overcome the zoning deficiencies of single duct systems and basically comprise a single-duct, single-zone system with individual heating coils in each branch duct to zones of similar loads. Reheat systems were also developed to give closer control of relative humidity in selected spaces.

Figure IV.8. Representative Terminal Reheat System

Dual-Duct Systems. Dual-duct systems, as the name implies, have two ducts, one trunk to supply warm air and the other to supply cool air to mixing boxes that then deliver air in one duct to the conditioned space. Warm and cool supply air is proportioned in the mixing boxes at the point of use, to provide supply air to the room at the temperature that meets the thermal demand. This type of system, while not usually described as a terminal reheat system, does, in fact, operate essentially on the same principles. Air is cooled down to a fixed level and then reheated to the point of use by being mixed with warm air. It is, inherently, a wasteful system.

Dual-duct low-velocity systems supply hot and cold air in individual ducts to the various zones of the building. Control of mixing is normally achieved by automatic dampers in the branch ducts, the damper being positioned according to

the dictates of the space thermostat. Each duct should be analyzed as a single zone system to determine whether the air volume or its temperature set point can be advantageously changed to conserve energy.

Return air is a mixture of all zones and reflects the average building temperature. In some designs of central station equipment, it is possible to stratify the return air and the outdoor air by installing splitters so that the hottest air favors the hot deck and coldest air favors the cold deck. This will reduce both heating and cooling loads.

Figure IV.9. Representative Dual-Duct Low-Velocity System

Dual-duct high velocity systems operate in the same manner as low velocity systems except that the supply fan runs at a high pressure and each zone requires a mixing box with sound attenuation.

Considerable quantities of energy are required to operate the fan at high pressure; close analysis of pressure drops within the system should be made and fan pressure should be reduced to the minimum.

Multi-Zone Systems. A multi-zone unit, with the exception of new ones, normally consists of a fan that discharges air either through a cooling coil to a cold deck or through a heating coil to a hot deck. Both hot and cold decks are equipped with modulating dampers that automatically control the quantities of

hot and cold air to one supply duct serving the space. This system is also a form of reheat; the overheating and overcooling of the supply air carries the penalty of inherent waste of energy.

Figure IV. 10. Representative Multi-Zone System

Dampers in these units often leak. As the system compensates for the additional cool or hot air, it wastes energy.

New model multi-zone units are now available with individual heating and cooling coils for each zone supply duct and the supply air is heated or cooled only to the degree required to meet the zone load. These new units use far less energy than the older versions.

Variable Air Volume Systems. Variable air volume systems (VAV) include an air handling unit that typically supplies either heated or cooled air at constant temperatures to variable air volume boxes for each zone or for each individual outlet. Variable air volume boxes regulate the quantity rather than the temperature of the warm or cool air supplied to the space in the heating or cooling season, respectively. Varying air quantity with the appropriate supply

temperature is one of the most efficient modes of operation in terms of energy usage.

Figure IV. 11. Representative Variable Volume System

VAV systems are basically a modification of single-zone, single-duct systems to allow different conditions in multiple zones to be met by varying quantities of constant temperature air. The air quantity supplied to the zone can be modulated in two different ways.

Dump boxes installed in the zone-supply duct modulate the amount of air through the outlets by bleeding off unused quantities of air and dumping them into the ceiling void and back into the return air system. This type of VAV system maintains constant fan volume and constant flow in all the trunk ducts and can waste energy by mixing the treated dump air with the return air. This system, however, has practical advantages when used with direct expansion cooling coils since it maintains constant flow through the coils regardless of load, which is necessary to obtain correct operation of refrigerating equipment.

In the second type of VAV system, the air volume is controlled at the outlet by closing down dampers as the zone load decreases. This type of system varies the total supply volume handled by the fan by increasing the resistance to air flow under light loads.

Figure IV. 12. Representative Induction Unit System

Induction Systems. Induction systems are commonly used for heating and cooling perimeter zones where large fluctuations of heating and cooling loads occur.

Primary air is either heated or cooled and supplied at high pressure to the induction units located within the conditioned space. Primary air is discharged from nozzles arranged to induce room air into the induction unit approximately four times the volume of the primary air. The induced air is cooled or heated by a secondary water coil. The water coil may be supplied by a two-pipe system, whereby either chilled water or heated water is available, but not simultaneously; by a three-pipe system where separate supplies of hot water or chilled water are continuously available and, after passing through the unit, are mixed into a common return; or by a four-pipe system, where a supply and return of hot water and chilled water are both continuously available.

Radiant Panel Systems

Radiant panel systems combine controlled temperature room surfaces with central station air conditioning. The controlled temperature surfaces may be located in the floor, walls, or ceiling, and the temperature maintained by circulating water, air, or electric resistance. The central station air system can be a

basic, one-zone, constant temperature, constant volume system; or the air system can encompass some or all of the features used in dual-duct, multi-zone, or variable volume systems.

Warm air and electric heating elements are two concepts that have been used where local factors have influenced such use. The warm air system consists of a special cavity construction where air is supplied to a cavity behind or under the panel surface. These systems have generally been used as radiant panels in floors subject to extreme cold. Electric heating elements embedded in the floor or ceiling construction and unitized electric ceiling panels are used in residences, apartments, and various applications for local spot heating. Two major factors in the consideration of electric radiant panels are local electric codes and basic energy costs.

Radiant panel systems are similar to other air-water systems in terms of the arrangement of the system components. Room thermal conditions are maintained primarily by direct transfer of radiant energy, rather than by convective heating and cooling.

For heating apartment buildings, pipe coils are embedded in the masonry slab. Care must be exercised that the coils are positioned so as not to overheat one apartment when maintaining desired temperatures in another. Installations have been made with pipes embedded in a hung plaster ceiling and the system has been utilized for cooling as well as heating. In recent years, there has been an increased application of electric resistance elements embedded in the floor or behind a skimcoat of plaster at the ceiling. The electric panels are relatively easy to install and have the advantage of simplified individual room control.

In residences, embedded pipe coil systems, electric resistance panels, and forced warm air panel systems have all been used. The embedded pipe coil system has been the most common, utilizing grid coils in the floor slab or copper tubing systems in the plaster ceiling. These systems are well suited to residences of normal construction, with normal glass areas. Lightweight metal panel ceiling systems have been applied to residences. Prefabricated electric panels have also been used to advantage, particularly in add-on rooms.

Maintaining Energy Efficiency in Air, Water, and Steam-Delivery Systems

Proper central system maintenance is not enough to guarantee efficient total system operation. The energy-delivery system must also be properly serviced to achieve minimum cost operation.

The two items that are simplest to maintain in an air-delivery system are the filters and the fan belts. Filters are provided to remove dust which would otherwise collect on the heating and cooling coils, reducing their effectiveness. As filters accumulate dirt, the amount of air flowing through them decreases. Regular cleaning or changing of filters helps to maintain satisfactory control.

Drive belts are typically used to deliver energy from a motor to the fan, in a manner similar to the operation of an automotive fan. Slippage occurs as these

belts stretch and wear. This wastes energy by reducing the amount delivered to the fan. A worn belt can be efficient if it has proper tension. The alignment between motor and fan pulleys should be examined, since misalignment will accelerate belt wear.

Once the air has been conditioned, it must be delivered to the load. With individual room systems, fan coil units, or single-zone systems, this is not a problem. However, with multi-zone or dual-duct systems, problems can arise. Control dampers are used to mix properly the heated and cooled air. When no cooling is required, no air should flow through the cold deck (cooling coil). However, misaligned or ill-fitting dampers leak air through the cold deck, providing an extra load for the hot deck. A similar situation occurs when no heating is required. This can be corrected by repairing or adding flexible seals on the edges of the dampers. This is a relatively inexpensive option that can save significant amounts of energy.

The outside air damper deserves special attention. Its function is to provide proper amounts of outside air to the building. Problems develop that are similar to those for other dampers. Additionally, an improper setting can deliver excessive amounts of outside air, which needlessly increases the load on the coils. Proper adjustment of the controlling linkages will eliminate this additional load.

Water-delivery systems are subject to the corrosion problems mentioned in an earlier section. Additionally, the devices used to control waterflow, the automatic control valves, can waste energy through improper operation. If heating water is leaking through a control valve at a coil in a room that does not require heat, energy is obviously wasted, while the room is made uncomfortable. Further, the heating may require cooling to maintain satisfactory conditions in the room. These valves, whether operated by electricity or air pressure, have a finite lifetime due to the repeated movements of the valve stem. Repairs can be made to the larger assemblies while replacement of smaller units is usual.

Steam-delivery systems also require maintenance of their control valves. Called steam traps, these devices assure that no steam passes through the radiator without condensing. When traps fail, steam flows into the return lines where its uncontrolled condensation or its return to the boiler do not efficiently meet the load. Trap failures can be detected by listening to a trap, or by measuring inlet and outlet surface temperatures. Repairs and replacements are both common solutions to trap failure.

Proper operation of the delivery system does not assure efficient operation of the total system. Thermostats must be maintained to assure proper functioning. Thermostats can lose their calibration, that is, incorrectly interpret the space temperature. Properly calibrated thermostats call for heating and cooling at the proper times, conserving energy.

Thermostats can also develop mechanical problems, which can provide false signals to the controlled equipment. These false signals can needlessly heat or cool rooms. Replacement with similar or more modern thermostats is a common solution. Thermostats are now available that allow the occupant to develop an individual reset schedule. Dead band thermostats, which do not call for heating or cooling within a wide (10-15°F) range, are also used as replacements.

As already explained, the manner in which a building is used significantly affects its energy requirement. However, not all systems control the environment with the same energy efficiency. Varying degrees of inefficiency are inherent in different types of environmental control systems.

Not only are there differences in efficiency of energy-conversion devices such as boilers and chillers, but there are also energy-efficiency differences in delivering and controlling the conditioned media (hot water, air, etc.) to the occupied space. Two variables affect the energy consumed in controlling and delivering the media. The first is the energy consumed by the fans and/or pumps. The second is the effect of the method by which the desired condition of the energy-transfer media is controlled.

The energy-conversion efficiency of new boilers is usually higher than old. The efficiency of low pressure steam boilers and hot water boilers are comparable if they are of equal age and have received equal maintenance.

Central cooling units may vary in their energy requirements depending on their type. Generally, the energy requirements of an absorption unit is greater than that of an electric-driven machine. However, the cost to operate the absorption machine may be less because of the type of energy it consumes (gas costs versus electricity costs). Typically, central electric refrigeration equipment will have reciprocating compressors. Only in the larger central cooling systems will centrifugal compressors be used. The seasonal efficiency of a reciprocating unit is typically lower than that of a centrifugal unit because of differences in part-load performance of the machines.

In a central system, once the medium is conditioned (heated or cooled), it must be delivered to the space by fans or pumps (with the exception of steam where only condensate return pumps are necessary). The energy requirements are generally greater to remove conditioned air than conditioned water. Therefore, one would expect higher energy-delivery costs in a central forced-air system.

As noted earlier, there are a variety of methods to control the condition of the air delivered to the room. The simplest is that found in a single-zone forced-air furnace, where a single thermostat controls the operation of the furnace. In multiple-zone buildings, using forced air from a central air handler, the air may be simultaneously heated and cooled. This would occur in reheat, multi-zone, and dual-duct systems. Such a control scheme would be energy efficient. These systems would have a higher energy cost than would the variable air volume system that controls the amount of air delivered to a space rather than the temperature of that air. The two other forced-air systems described earlier--induction and single-zone fan/coil systems--would have energy requirements falling between simultaneous heating and cooling and the variable air volume.

A unitary packaged heating and/or cooling unit, such as a roof-top unit, window air conditioner, or unit ventilator may have a low total energy requirement compared to a central system (if the unit has been well maintained). The reason is twofold: first, control of the unit is directly from the room conditioner; second, there is little or no energy required to move the air or water through ducts or pipes.

Depending on the heating zone, the heat pump will usually require the least energy. However, because of the cost of electricity versus gas, the seasonal heating cost may still be greater than a gas-field heating system. Typically, heat pumps used in multi-family buildings use outdoor air as a heat source. Occasionally, the heat source will be well water, which will result in an even lower energy cost. Well-designed solar-assisted heat-pump systems can be expected to have lower seasonal heating costs as well.

3. Time Switches and Other Programmable Controllers

Regardless of its efficiency, equipment in operation longer than necessary wastes energy. Certain items within a building complex function during well-established intervals; furthermore, operation is unnecessary. Proper control of these items can result in appreciable energy savings.

The most common automatic control device used to start and stop equipment is the time switch (or time clock). These can be as simple as a tennis-court light timer, or control multiple pieces of equipment. These devices can provide minute-by-minute to day-by-day control and/or provide for separate programs for weekends. Reserve-power features are available which keep the switch on schedule for up to three hours during a power outage. Manual override features are also available. Use of time switches can reduce the daily operating periods for domestic hot-water circulating pumps, swimming pool pumps, fountains, security lights, and other items whose continual operation is not required.

Photocells can take the place of time switches for certain operations. These cells can be adjusted to start or stop a device 30 minutes before or after sundown. Street and highway lights are common examples. An advantage of photocells over time switches is their lower installed cost.

Many special-purpose rooms, such as clubhouses, are frequently unoccupied for long periods. During these times, lowering the room setpoint would save energy. Reset (or night setback) thermostats can provide for the automatic lowering of the space temperature during unoccupied periods. Furthermore, the reset thermostat will raise the setpoint sufficiently early so that comfort conditions are obtained before the room is again occupied. In essence, the room's occupants need not know the temperature was reduced.

4. Individually Metered Dwellings

Meters are provided by the utilities to monitor energy flows into a building. During periods of cheap energy, it was simplest to use one meter for each utility, that is, one gas meter and one electric meter. Approximately one-third of multi-family dwellings are thus equipped. While this method provides for simple installation, the residents of the dwelling are not directly responsible for their energy use, and incentives for energy conservation are lost. Studies indicate that individually metered all-electric buildings consume approximately 15 to 20 percent less energy than all-electric master-metered buildings.

In order to provide conservation incentives, Congress provided, in the Public Utility Regulatory Act of the National Energy Act, ~~for~~ regulatory authorities and non-regulated utilities formally to consider the "prohibition of master metering." If adopted by a utility and where feasible, each dwelling would be charged for its own energy use. This includes both electric and gas utilities.

Electric utilities have begun to structure their billing practices to reflect more accurately the true costs of electrical generation. Among these practices is the sum of multiple meters for one dwelling. This separates electrically-heated domestic water from energy used for lighting, each being charged at a different rate.

A practice gaining popularity is demand billing. Here the customer is charged for both the KWH used and, for the maximum demand, or KW, during that period. Demand meters can be distinguished by the presence of a KW indicator.

Other possibilities include time-of-day billing, which attempts to refine further the true generation cost. This places a high charge (about 16¢/KWH) on energy used during peak times, while charging significantly less (1¢/KWH) for electricity used during off-peak periods. Sophisticated metering equipment is required for time-of-day billing. The appraiser should determine whether higher than normal energy may be caused by master metering. Depending on energy type and local utility commission rulings, conversion to individual metering may be possible. Obviously, if the property is individually metered, only the costs of maintaining the common areas will accrue to the owner. This is important to consider when collecting comparables.

5. Appliances

When choosing appliances, differences in energy consumption and cost of operation can be noticed for different types of appliances. Manufacturers of household appliances have begun to publish estimated energy-consumption data for their appliances which can be used for comparative selection. An examination of published data can lead to some initial conclusions. For example, a "frost-free" refrigerator uses more than twice as much electricity as a manual defrost model. If freezers are to be supplied, a chest model will use less energy than an upright model. There is little difference between different models of electric ranges, although gas energy will cost less than electric energy for cooking. Electric ranges with "self-cleaning" ovens will use more energy than conventional models. Most dishwasher lines offer a model or models equipped with an "energy saver" switch which disconnects the heater from the drying cycle, eliminating approximately half of the energy consumption. There is little evidence of any significant differences in energy consumption between models of clothes washers and clothes dryers, although, again, the cost of operating a gas dryer will be less than costs for an electric dryer. Gas dryers should be equipped with an electric ignition device rather than a standing gas pilot. The pilot for a gas dryer will consumer four dryer-loads of gas each day.

Recent developments in insulation materials have reduced energy consumption in newer refrigerators and freezers.

Interior and Exterior Lighting

As mentioned in the single-family dwelling sections, fluorescent lighting is much more energy efficient than incandescent lighting. For residential spaces, however, fluorescent lighting has found application in only kitchen and bathroom areas because of its color and intensity. In multi-family dwellings, fluorescent lighting should be used in all common areas and hallways. For areas using incandescent lighting, dimmers could reduce energy requirements by allowing the resident to reduce lighting levels.

Complexes using area and parking-lot lighting should be using some form of high-efficiency lighting. Although mercury vapor is not as efficient as fluorescent, it is generally better suited for exterior flood lighting. It may be more efficient than incandescent, and thus will have lower operating costs. The light source can be recognized by the blue color. High-pressure sodium lighting is the most efficient light source available. It is generally used where large areas are to be illuminated with relatively few light sources. It emits a yellow/pink or orange colored light.

6. Insulation

The fundamentals of insulation and recommended insulation values are similar for single- and multi-family residences. These have been discussed in a previous section.

An item that requires additional discussion is roof-deck insulation. This material is similar in appearance to rigid board insulation, mentioned earlier. Composition typically is of polyurethane isocyanurate, or glass fiber. It is placed between the roof deck (concrete or metal) and the tar and gravel (or tar only) roofing on flat-roofed structures. Deck insulation differs from typical rigid boards in that it is designed to withstand both the application of the heated tar used for roof membranes and the traffic associated with roof areas. Insulation wedges can be purchased that aid in the proper sloping of flat roofs. This prevents ponding, which can severely damage a roof.

The initial thickness of insulation should be similar to those recommended earlier. If roof repairs are required, adding insulation is suggested, although the economics of adding insulation to a sound roof are questionable.

7. Caulking and Weatherstripping

The requirements for caulking and weatherstripping multi-family dwellings are essentially similar to single-family dwellings, mentioned earlier.

8 Storm Doors and Windows

The use of storm windows in multi-family dwellings provides advantages comparable to those described in earlier sections for single-family units. Storm doors also reduce energy losses, although their use must be carefully considered from the standpoint of economics.

The use of storm doors reduces infiltration through the openings. Conduction also is reduced by the addition of a dead air space. The savings obtained are significant for apartments with individual exterior doors. These savings are insignificant for apartments with common exterior entrances, since the number of building openings is reduced.

Double-door entrances, or vestibules, provide additional savings for buildings with common entrances by reducing the quantities of outside air entering the building. While their use is recommended for new designs, the addition of vestibules to existing buildings cannot be economically justified at this time.

9. Building Design, Solar Orientation, Shape, and Landscaping

The use of trees around a smaller building can greatly influence building energy consumption. The south face of the structure should be guarded by deciduous trees. These trees can provide shade during the summer months and, in the winter, will lose their leaves, allowing passive solar-heat gains within a building.

The reduction of infiltration in single family buildings is equally important in multi-family buildings. In addition to caulking and weatherstripping, the building can be protected from detrimental wind effects by sheltering the structure with trees or shrubs, fences, or other buildings.

Tests have shown that significant reductions in infiltration can be achieved with appropriate landscaping. If the structure is protected on the windward side, the appraiser could assume that the infiltration will be less than for a structure which is generally exposed to the wind. As the height of the structure increases, however, the benefit of landscaping decreases.

10. Alternate Energy Sources

The previous discussion on alternate energy sources and uses applies equally well to multi-family dwellings.

D. Collecting Energy Information

The energy auditing tools available for multi-family property are similar to those described for single-family property with only minor exceptions.

1. Utility Audits

The physical size or complexity of the property may determine the tools available. Some utilities are offering assistance with energy audits, particularly on smaller units. The appraiser is encouraged to determine what services may be available from the local utilities.

2 Do-It-Yourself Audits

In addition to utilities, many governmental agencies and professional associations publish instructional booklets for the preparation of multi-family energy units. Two such publications are:

Energy Cost Reduction for Apartment Owners and Managers
Institute of Real Estate Management
National Association of Realtors
Chicago, Illinois

Energy Audit Workbook for Apartment Buildings
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161

Cost: \$6.00
Date: 1978

In addition, many states have audit manuals for multi-family properties. Appraisers should contact the state energy office for information. A listing of these offices is included in the Appendix.

3. Engineering Audits

As the complexity of the property increases, the auditing capabilities of workbook type audits and some utilities may be exceeded. In these cases, the appraiser may wish to seek the assistance of an energy management specialist to aid in determining the energy-efficiency potential of the property.

Serious consideration must be given in the selection of a specialist. Generally there are three types of organizations offering energy management services. Certain contractors or installers may have an energy specialist employed who makes the recommendations, which are then implemented by the contracting firm. The specialist fee is many times absorbed in the cost of implementation. Secondly, some equipment manufacturer representatives offer an energy management service as a precursor to the use of their equipment. There may or may not be a fee associated with this service. Lastly, there are energy management consultants who are completely independent of a contracting or manufacturing organization. Many times they are professional engineers or registered architects who specialize strictly in energy management consulting. The appraiser is encouraged to seek references before selecting a specialist.

A. Using Energy Information in Appraisal

As students of the seminar know, the appraisal process involves three approaches--the Income Approach, the Cost Approach, and the Market Sales Comparison Approach--by which the value of a property can be estimated. While one or another of the three approaches may be better suited than the others to a particular appraisal assignment, it is generally true that any increment of value that is indicated by one approach probably can be measured through the other two approaches as well.

Preceding portions of Section IV have discussed how a multi-family building uses energy and appropriate methods for identification and collection of energy data. In addition, the seminar introduced a recommended procedure. Ideally, the seminar student now, at least in a general way, could examine energy expenses and attribute them to the presence or absence of certain energy-conserving techniques (ECT's). The remainder of this section will demonstrate that the standard three approaches to value are suited for calculation of any value increment attributable to ECT's. As noted below, however, a comparatively new concept--life cycle costing--will be introduced in Section V as a technique to assist in evaluating the curability of obsolescence caused by inadequacies in ECT's.

1 The Income Approach

The premise underlying the Income Approach to Value is that a property has some present value resulting from its anticipated capability of producing future net income streams. An important point to remember is that, no matter what the appraiser is able to learn about gross income, any valuation process involving capitalization depends upon a projection of (stabilized) annual net operating income generated by the property.

Classical appraisal theory calls for the following steps:

1. Estimation of stabilized or market-indicated gross potential rental income;
2. Subtraction of a market-indicated allowance for vacancy and collection losses;
3. Addition of any other property income not affected by items 1 and 2 above;
4. Deduction of projected annual property expenses in order to arrive at a net operating income; and
5. Capitalization by the proper technique for the property being appraised.

Property expenses typically are categorized as follows:

1. Fixed Expenses, whose amounts vary little with changing occupancy, such as property taxes and insurance;
2. Operating Expenses and Repairs, by which is meant all out-of-pocket costs necessary for providing services to tenants; in the case of apartment buildings, this would at least include utility expenses for common areas; and
3. Reserves for Replacement of appliances, mechanical systems, and other building components whose useful (or economic) lives are shorter than the projected life of the structure.

Because fixed expenses tend to be well defined items that do not relate specifically to ECT's, this discussion pertains more directly to operating expenses. A discussion of reserves for replacements would be more appropriate after introduction of the concept of life cycle costing in Section V and is, therefore, omitted here.

When estimating operating expenses, projected rates of increase in fuel expenses should be considered. In the absence of supportable information concerning likely future trends in such costs, the projection may be based upon recent historic trends in the costs of fuel. The authors of the course materials are aware, for example, of the following increase in the cost of electricity for a specific location:

November, 1974:	\$0.032 per KWH
January, 1979:	0.056 per KWH

Being certain that adjustments have been made for any differences in the quantity of kilowatt hours consumed in the above example, this represents a 75.0% increase ($\$0.024/\0.032) over a 50-month period, or 1.5% per month ($0.750/50$ months), which translates into an annual fuel-inflation rate of:

$12 \text{ months} \times 0.0150 = 0.18,$
or 18% per year (straight line)

In stabilizing the projected annual expense for electricity, the anticipated increase should be included in the calculations. The appraiser should be aware, however, that the 18 percent indicated increase is based upon a short historic period in which extremely rapid increases have been evident. The appraiser may elect to apply a lower average annual rate of increase if he/she expects the rate to decline; otherwise, it may be necessary to incorporate into the calculations the conversion of the subject property to a less expensive fuel at some point in the projected holding period.

Table V.1. STABILIZATION OF FUEL EXPENSES (All-electric property)

<u>Year</u>	<u>Per-unit Fuel Expense</u> <u>(18% Annual Increase)*</u>
0	\$ 450.00
1	531.00
2	626.58
3	739.36
4	872.45
5	1,029.49
6	1,214.80
7	1,433.46
8	1,691.49
9	1,995.95
10	<u>2,355.23</u>
Total	\$12,939.81

Table V.1 indicates a total fuel expense (electricity only) of \$12,939.81 per unit over 11 years (including Year 0), or an annual average of \$1,176.35. While averaging annual allowances for fuel expenses interjects a conservative bias by assigning equal, non-compounded value to dollars saved in Year 1 and dollars expended in Year 10, this technique generally would be acceptable. A more supportable technique would be to apply a sinking-fund rate to dollars set aside in earlier years but not expended until later years. Whichever technique the appraiser selects, he/she should be consistent in estimating all expense items. Similarly, uniform procedures should be employed in estimating inflation rates for all fuel sources.

Once all expense items have been estimated and stabilized, the normal capitalization procedures appropriate for the subject property will incorporate the effects of income adjustment for ECT's.

2. The Cost Approach

The premise behind the Cost Approach to Value is that the value of a property is equal to the sum of depreciated replacement cost and land value. Classical appraisal theory calls for the following steps:

1. Estimation of total current reproduction cost new;
2. Subtraction of the dollar amount of all accrued depreciation in order to arrive at depreciated current reproduction cost new;

3. Addition of land value (estimated through market comparison) to arrive at overall property value.

Accrued depreciation falls into the following categories:

1. Physical deterioration, by which is meant the wearing-away of the improvements as a result of time passage and the activities of natural elements.
2. Functional obsolescence, meaning the loss in value resulting from decreased capacity of the structure or its components to perform the function for which it was intended, in terms of current market standards as of the date of the appraisal; and
3. Locational obsolescence, which is a reduction in utility experienced by a structure as a result of negative environmental forces outside the boundaries of the property.

As is the case with market data adjustments to income-producing properties, the proper measure of obsolescence is the capitalized value of net rental differences resulting from physical deterioration, functional obsolescence, and/or locational obsolescence. The authors of the course materials assume that most energy-related net rent losses would be caused by physical deterioration, such as the wearing-away of weatherstripping or the sagging of insulation batts; or by functional obsolescence, such as the installation of an antiquated furnace or boiler or the exposure of long segments of uninsulated heating pipes. Because the concept of life cycle costing will be introduced in Section V of this book, no discussion is included here concerning the measurement of curability of depreciation.

Table V.2 shows the measurement of functional obsolescence resulting from energy inefficiency in a master-metered building. Comparable data indicate annual utility expenses of \$0.80 per square foot, while utility-expense records indicate an \$0.85 expense for the subject. The comparable properties appear to have no abnormal deficiencies in energy components, although the subject property appears to lack the level of insulation typical in the comparable properties. Accordingly, an annual loss of \$0.05 per square foot (\$0.85 for subject, less \$0.80 for the typical market) is imputed to the inferior insulation of the subject.

Table V.2. MEASUREMENT OF FUNCTIONAL OBSOLESCENCE RESULTING FROM
INADEQUATE INSULATION (Landlord responsible for service)

Gross Building Area (Sq. Ft.)	30,000
Times Total Annual Loss from Deficiencies in Insulation (per Sq. Ft.)	<u>\$0.05</u>
Total Income Lost	\$1,500.00
Capitalized at a Derived Rate (for example, 12%)	<u>±0.12</u>
Amount of Functional Obsolescence Attributable to Insulation Deficiencies	\$12,500.00

Table V.3 shows the measurement of functional obsolescence resulting from energy inefficiency in an individually-metered building. Comparable data indicate annual common-area utility expenses of \$0.80 per square foot, while records indicate an expense of \$0.85 per square foot of common areas in the subject property. Again, an apparent deficiency exists in the subject's insulation.

Table V.3. MEASUREMENT OF FUNCTIONAL OBSOLESCENCE RESULTING FROM
INADEQUATE INSULATION (Tenant responsible for own service)

Square Feet of Common Areas	3,000
Times Total Annual Loss per Square Foot Resulting from Deficiencies in Insulation	<u>\$0.05</u>
Total Income Lost	\$150.00
Capitalized at a Derived Overall Rate (for example, 12%)	<u>±0.12</u>
Amount of Functional Obsolescence Attributable to Insulation Deficiencies	\$1,250.00

3. The Market Sales Comparison Approach

The assumption underlying the Market Sales Comparison Approach is that, given typically informed and knowledgeable buyers and sellers in the marketplace, a typical buyer would be indifferent between exactly comparable, substitutable properties. Any physical, functional, or locational differences between two properties may result in different value indications for the properties, although these may be offsetting and the relative importance of such differences tends to vary in different market areas and, indeed, from buyer to buyer.

In the case of an income-producing property, the proper measurement of value adjustments is the capitalized value of net rental differences attributable to physical, functional, financial (economic) and locational differences, after application of any adjustment for changes in the market since sale of the comparable property.

Table V.4. MARKET ADJUSTMENT FOR ENERGY (Apartment unit basis)

Annual Energy Expense of Comparable Unit	\$510.00
Annual Energy Expense of Subject Unit	<u>450.00</u>
Savings Inuring to Subject	\$ 60.00
Capitalized at a Derived Rate (for example, 12%)	<u>÷0.12</u>
Amount of Adjustment per Unit	\$500.00

The "savings inuring to subject" is a net rental item because money not spent for energy remains to be incorporated into net operating income. Adjustments for other factors, of course, should be treated similarly.

Conclusion

While this section introduces little new information, it is intended to illustrate that the appraisal process already provides effective mechanisms by which to incorporate energy considerations into the valuation process. Section V will introduce the concept of life cycle costing. As mentioned throughout this section, this concept will be useful in making more meaningful measurements of obsolescence in the Cost Approach as well as being helpful in making appropriate allowances for reserves for replacement of short-lived building components and systems in the Income Approach.

B. Life-Cycle Costing

Logic dictates that first costs--also known as acquisition or start-up costs--are not the only consideration in making economic judgments between two or more operations. It should be clear that, in some cases, a higher first cost is justifiable if there are greater savings throughout the life of the product. For example, most people would agree that a more expensive refrigerator expected to last 15 years is a "better buy" than a slightly less expensive one that will last only five years.

Factors such as the expected costs of maintaining the product over its life and annual operating costs also are commonly considered in everyday decision-making. Given two refrigerators equal in every other way, the one that uses less electricity every year clearly is worth some additional first cost. This is a simple example of life cycle costing, which is a form of discounted-cash-flow analysis (DCF).

In terms of normal DCF, the concept illustrated in the first example above is the present value of a reversion represented by the replacement costs of the two refrigerators, one in 15 years and the other in only five years. The one with the longer life has a greater present value (i.e., first-cost value) than the other because the cost of replacing it is further in the future. It is possible to compare the values of the reversions by using the following formula:

$$v^n = \frac{1}{(1 + i)^n}$$

where v^n is the present value of the future reversion, i is the discount rate or rate of interest, and n is the number of years over which the reversion is deferred.

Assuming that the refrigerators have anticipated future cost of \$500.00 each and that 15 percent is an appropriate rate of interest for the discount, the two units compare as follows:

$$v^n \text{ (Five-year Refrigerator)} = \$500 \times \frac{1}{(1 + .15)^5} = \$248.59$$

$$v^n \text{ (15-year Refrigerator)} = \$500 \times \frac{1}{(1 + .15)^{15}} = 61.45$$

Present value of savings earned by purchasing unit with longer life	\$187.14
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What the preceding figures illustrate is that, in terms of present value, it costs \$187.14 more to replace the refrigerator with a five-year life than it does to replace the one with the 15-year life.

In the case of the two refrigerators that are identical except for their fuel consumption, the concept illustrated is valuation of an annuity represented by the annual fuel expenses saved by purchasing the more efficient unit. The formula for valuing an annuity is as follows:

$$an = \frac{1 - v^n}{i}$$

where an is the annuity value being sought, v^n is the reversion rate calculated in the same manner as in the first example above, and i , again, is the discount or interest rate. Because of the cumbersome nature of the computation, it is common to refer to tables listing annuity values for each interest rate (i) and each time period (n) (see Table V.5).

Returning to the example, the more efficient refrigerator is expected to save average annual fuel expenses of \$12.00, and an interest rate of 15 percent again is considered appropriate. Each refrigerator has an expected useful life of 15 years. The additional first-cost value allocable to the more efficient unit is calculated as follows:

$$v^n = \frac{1}{(1 + .15)^{15}} = .12289$$

$$an = \$12 \times \frac{1 - .12289}{.15} = \$70.17$$

One drawback of DCF has been that it has not provided for an orderly analysis of the effects of inflation--for example, the first case, in which refrigerators with different expected lives were compared, was based on the assumption that the refrigerators could be replaced for \$500.00 each, regardless of whether the expense would be incurred in Year 5 or in Year 15. The second case did not consider anticipated rises in the costs of fuel needed to operate two similar refrigerators.

The importance of inflation is demonstrated by an example wherein a given machine is known to need replacement of a part after about eight years' use, and the replacement in today's terms would cost \$15.00. If the general rate of inflation is 18 percent per year, then the \$15.00 present cost is equivalent to a future cost of \$56.38, which can be determined either by reference to available tables or by use of the following formula:

$$\text{Future Cost} = \$15 \times (1 + i)^n$$

$$\text{Future Cost} = \$15 \times (1 + .18)^8 = \$56.383$$

A prudent investor might wish to set aside enough money today to grow to \$56.83 at a compound rate of interest in the eight-year period. Banks, however, do not normally pay a rate of interest as high as the inflation rate. Assuming a rate of six percent, the future value of \$56.38 has a present value

Table V.5. PRESENT VALUES (Based on interest rates and years)

n	4%	5%	6%	7%	8%	10%	12%	15%
1	0.96154	0.95238	0.94340	0.9346	0.9259	0.9091	0.8929	0.8696
2	0.92456	0.90703	0.89000	0.8734	0.8573	0.8264	0.7972	0.7561
3	0.88900	0.86384	0.83962	0.8163	0.7938	0.7513	0.7118	0.6575
4	0.85480	0.82270	0.79209	0.7629	0.7350	0.6830	0.6355	0.5718
5	0.82193	0.78353	0.74726	0.7130	0.6806	0.6209	0.5674	0.4972
6	0.79031	0.74622	0.70496	0.6663	0.6302	0.5645	0.5066	0.4323
7	0.75992	0.71068	0.66506	0.6227	0.5835	0.5132	0.4523	0.3759
8	0.73069	0.67684	0.62741	0.5820	0.5403	0.4665	0.4039	0.3269
9	0.70259	0.64461	0.59190	0.5439	0.5002	0.4241	0.3606	0.2843
10	0.67556	0.61391	0.55839	0.5083	0.4632	0.3855	0.3220	0.2472
11	0.64958	0.58468	0.52679	0.4751	0.4289	0.3505	0.2875	0.2149
12	0.62460	0.55684	0.49697	0.4440	0.3971	0.3186	0.2567	0.1869
13	0.60057	0.53032	0.46884	0.4150	0.3677	0.2897	0.2292	0.1625
14	0.57748	0.50507	0.44230	0.3878	0.3405	0.2633	0.2046	0.1413
15	0.55526	0.48102	0.41727	0.3624	0.3152	0.2394	0.1827	0.1229
16	0.53391	0.45811	0.39365	0.3387	0.2919	0.2176	0.1631	0.1069
17	0.51337	0.43630	0.37136	0.3166	0.2703	0.1978	0.1456	0.0929
18	0.49363	0.41552	0.35034	0.2959	0.2502	0.1799	0.1300	0.0808
19	0.47464	0.39573	0.33051	0.2765	0.2317	0.1635	0.1161	0.0703
20	0.45639	0.37689	0.31180	0.2584	0.2145	0.1486	0.1037	0.0611
21	0.43883	0.35894	0.29416	0.2415	0.1987	0.1351	0.0926	0.0531
22	0.42196	0.34185	0.27751	0.2257	0.1839	0.1228	0.0826	0.0462
23	0.40573	0.32557	0.26180	0.2109	0.1703	0.1117	0.0738	0.0402
24	0.39012	0.31007	0.24698	0.1971	0.1577	0.1015	0.0659	0.0349
25	0.37512	0.29530	0.23300	0.1842	0.1460	0.0923	0.0588	0.0304
26	0.36069	0.28124	0.21981	0.1722	0.1352	0.0839	0.0525	0.0264
27	0.34682	0.26785	0.20737	0.1609	0.1252	0.0763	0.0469	0.0230
28	0.33348	0.25509	0.19563	0.1504	0.1159	0.0691	0.0419	0.0200
29	0.32065	0.24295	0.18456	0.1406	0.1073	0.0630	0.0374	0.0174
30	0.30832	0.23138	0.17411	0.1314	0.0994	0.0573	0.0334	0.0151

of \$37.03, which can be determined either by reference to tables or by use of the reversion formula,

$$\text{Present Value} = \$56.83 \times \frac{1}{(1 + i)^n}$$

$$\text{Present Value} = \$56.83 \times \frac{1}{(1 + .055)^8} = \$37.030$$

If the interest rate were equal to the inflation rate--i.e., if the value of money put in a bank grew at the same rate that inflation eroded the value of money--the two rates would cancel out, and the present value of a future cost would be the same as today's cost for the item.

Much as in the preceding example, life cycle costing allows analysis of expenses and savings associated with an energy-conserving application (see Table V.6).

Table V.6. PRESENT VALUE CONCEPTS

<u>Item</u>	<u>Year 0</u>	<u>1 2 3 Year n</u>	<u>Related Factors</u>
First Cost	-		N/A
Salvage Value	+	←	Inflation, Interest Rates
Repairs and Replacement Cost	-	←	Inflation, Interest Rates
Maintenance and Operating Costs	-	- - - -	Inflation, Interest Rates
Savings Value	+	+ + + +	Fuel Inflation, Interest Rates
Net Present Value =			

The calculations depend upon a number of assumptions. Some of these--including first-cost estimates, maintenance requirements, major repair/replacement costs, salvage value, length of useful life, and timing of maintenance and repairs--are subject to normal errors in estimation, but may nonetheless be valued in accordance with classical present value or DCF practices. Appropriate adjustments should be made on the basis of normal judgments about probable future changes in these costs.

Other factors--particularly fuel-inflation rates--are assumptions that require broader judgments about the future directions of the economy in general and fuel prices in particular. When beginning the use of life cycle costing as a tool, it may be desirable to experiment with the effects of various assumptions

for these rates in order to become familiar with the implications of different assumed features.

To determine the present value of a series of annual events of a constant nature, such as annual maintenance costs or annual fuel savings for the entire life cycle period, the following equation can be used:

$$P_e = F \frac{a(a^n - 1)}{a - 1} \text{ where } a = \frac{1 + g}{1 + i}$$

In this equation, the current annual expense or savings (F) is multiplied by a factor that takes into account the number of years in the life cycle (n), the inflation rate (g), and the interest rate (i).

Since the equation represents a relationship among three factors (life cycle period, interest rate, and inflation rate), it can be expressed in a series of tables, one table for each proposed life cycle period. The tables indicate multipliers for each interest rate combination. The multiplier is used with current cost or savings in order to arrive at the present value of the total cost or savings over the life cycle period. The tables are, in effect, composite annuity tables to be applied to periodic expenses or savings; no reversion tables are necessary, as anticipated changes in the cost of replacement or the value of salvageable items can be adjusted prior to discounting back to the present in accordance with classical DCF theory.

Basic Formulas

Symbols are as follows:

PV = Present Value
S = Fuel Savings or Operating Costs
a = Adjusted Discount Factor
n = Projection Period
f = Fuel Inflation Rate
g = General Inflation Rate
i = Interest Rate
F = Future Reserve Payments or Expenses

Formula No. 1

Present Value of Savings or
Operating Cost:

$$PV = S \frac{a(a^n - 1)}{a - 1}, \text{ where}$$

$$a = \frac{1 + (f \text{ or } g)}{1 + i}$$

Formula No. 2

Present Value of Future Replacements:

$$PV = F \times \frac{\text{Reversion Constant for Interest Rate}}{\text{Reversion Constant for General Inflation Rate}}$$

Operations

In the following operations, assumptions are that

Inflation Rate of Fuel (f) = 18 percent
General Inflation Rate (g) = 12 percent
Interest Rate (i) = 15 percent

Table V.6 illustrates this process.

A. Estimate first costs through market research or examination of other sources of information. The first cost of a contemplated energy-conserving application generally is conceived to be a one-time expense at Time Zero (i.e., at the present date); such being the case, it is not necessary to apply a reversion rate in order to isolate present value. In this instance, present value equals present (first) cost.

B. Estimate the present value of future salvage value. Using the present-value equation, find both the interest constant (i.e., the reversion constant for the interest rate of 15 percent) and the general inflation constant (the reversion constant for the inflation rate of 12 percent).

$$\text{Present Value} = \text{Future Salvage Value} \times \frac{\text{Reversion Constant for Interest Rate}}{\text{Reversion Constant for Inflation Rate}}$$

The reversion constant for the interest rate is calculated as follows:

$$v^n = \frac{1}{(1 + i)^n}$$

while the reversion constant for the inflation rate would be calculated by the following adaptation of the formula:

$$v^n = \frac{1}{(1 + g)^n}$$

Example: If it were determined that the item has a ten-year life and anticipated future salvage value of \$7.50 in terms of today's dollars, then the interest constant can be calculated to be 0.2472, and the inflation constant is determined to be 0.3220. The present value of the future salvage value of the item, given the assumptions made here concerning inflation and other factors, can be computed as follows:

$$\text{Present Value} = \$7.50 \times \frac{.2472}{.3220} = \$5.76$$

C. Determine the present value of future repair and replacement costs. Using the present-value equation, find both the interest constant (by the method illustrated above) and the inflation constant (also by the method demonstrated above) for the appropriate year of the life cycle for the particular repair or replacement cost and multiply as follows:

$$\text{Present Value} = \text{Cost of Future Repair} \times \frac{\text{Reversion Constant for Interest Rate}}{\text{Reversion Constant for Inflation Rate}}$$

This should be repeated for each repair item or replacement item on the schedule, with constants found for each of the necessary years into the cycle. Example: If the schedule calls for a \$15.00 repair in Year 8 of the life cycle and the interest rate again is assumed to be 15 percent and inflation is assumed to be 12 percent, then the interim calculations, using the reversion formula, indicate an interest constant of 0.3269 and an inflation constant of 0.4039. The present value of this particular expense is as follows:

$$\text{Present Value} = \$15.00 \times \frac{.3269}{.4039} = \$12.14$$

The appraiser should be certain to remember to sum the present values of all such repair and replacement costs.

D. Determine the present value for regular annual maintenance and operating costs. In this instance, the following formula is applicable. It is as follows:

$$P_e = F \frac{a(a^n - 1)}{a - 1} \text{ where } a = \frac{1 + g}{1 + i}$$

Example: If annual maintenance of a device expected to last 10 years is estimated at \$2.00, the general inflation rate is assumed to be 12 percent, and the interest rate is assumed to be 15 percent, then

$$P_e = \$2.00 \frac{a(a^{10} - 1)}{a - 1} \text{ where } a = \frac{1 + .12}{1 + .15}$$

Carrying out the computations,

$$P_e = \$2.00 \times 8.67185 = \$17.34$$

E. Determine the present value of future fuel-cost savings. Using the formula employed in the immediately preceding illustration, find the appropriate constant, given the fuel-cost inflation rate and the interest rate assumed. This results in the following equation:

$$P_e = F \frac{a(a^n - 1)}{a - 1} \text{ where } a = \frac{1 + f}{1 + i}$$

Example: If the interest rate is assumed to be 15 percent and the fuel-inflation rate is assumed to be 18 percent and these figures are applied to an example where annual fuel savings are estimated to be \$8.62 over a 10-year period, then

$$P_e = \$8.62 \frac{a(a^{10} - 1)}{a - 1} \text{ where } a = \frac{1 + .18}{1 + .15}$$

Carrying out the computations,

$$P_e = \$8.62 \times 11.55315 = \$99.59$$

It may also be instructive to employ the results of a series of computations in order to arrive at a benefit/cost ratio for a contemplated energy-related application. This can be done as follows:

$$\begin{array}{r} \text{(PV salvage + PV fuel savings)} \\ - \text{(PV repair + PV maintenance)} \\ \hline = \text{Net Present Value of Savings} \end{array}$$

Example: Using the values found in the preceding examples,

$$\text{Net Present Value} = (\$5.76 + \$99.59) - (\$12.14 + \$17.34) = \$75.87$$

In order to ascertain the benefit/cost ratio, the net present value is divided by the estimated first cost. Assuming a first cost of \$50.00, this is done as follows:

$$\frac{\$75.87}{\$50.00} = 1.52$$

This means that \$1.52 in benefit is gained for each dollar spent at the present time. The benefit/cost ratios of various applications for a given property can be used in deciding which of several possible applications would be the most cost-effective for the property.

Exercises

Formula No. 1

Factors to Know:

S = Annual Fuel Savings

\$10

i = Interest Rate

15%

f = Fuel Inflation Rate

18%

n = Projection Period

10 years

$$PV = S \times \frac{a(a^n - 1)}{a - 1}, \text{ where}$$

$$a = \frac{1 + .18}{1 + .15} = 1.026087$$

$$PV = \$10 \times \frac{1.026087 (1.026087^{10} - 1)}{1.026087 - 1}$$

$$PV = \$10 \times 11.553151 = \$115.53$$

Formula No. 2

Factors to Know:

F = Future Reserve Payments \$10

i = Interest Rate 15%

g = General Inflation Rate 12%

Projection Periods - Each 5 Years for 15 Years

Total Present Worth - Future Replacements \$28.66

$$PV = F \times \frac{\text{Reversion Constant for Interest Rate}}{\text{Reversion Constant for Inflation Rate}}$$

$$5 \text{ Years: } PV = \$10 \times \frac{.4972}{.5674} = \$8.76$$

$$10 \text{ Years: } PV = \$10 \times \frac{.2472}{.3220} = \$7.68$$

$$15 \text{ Years: } PV = \$10 \times \frac{.1229}{.1827} = \$6.73$$

Total Present Value of Future Replacements	<hr/> \$23.17
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Table V.7. COMPOSITE ADJUSTMENT FACTORS

		<u>2-Year Life Cycle</u>							
		Inflation Rate (g)							
		8%	9%	10%	11%	12%	13%	14%	15%
Interest Rate (i)	8%	-	2.03	2.06	2.08	2.11	2.14	2.17	2.20
	9%	1.97	-	2.03	2.06	2.08	2.11	2.14	2.17
	10%	1.95	1.97	-	2.03	2.05	2.08	2.11	2.14
	11%	1.92	1.95	1.97	-	2.03	2.05	2.08	2.11
	12%	1.89	1.92	1.95	1.97	-	2.03	2.05	2.08
	13%	1.87	1.90	1.92	1.95	1.97	-	2.03	2.05
	14%	1.84	1.87	1.90	1.92	1.95	1.97	-	2.03
	15%	1.82	1.85	1.87	1.90	1.92	1.95	1.97	-
		<u>5-Year Life Cycle</u>							
		Inflation Rate (g)							
		8%	9%	10%	11%	12%	13%	14%	15%
Interest Rate (i)	8%	-	5.14	5.28	5.43	5.58	5.74	5.90	6.06
	9%	4.86	-	5.14	5.28	5.43	5.58	5.73	5.89
	10%	4.73	4.87	-	5.14	5.28	5.42	5.57	5.72
	11%	4.61	4.74	4.87	-	5.14	5.28	5.42	5.57
	12%	4.49	4.61	4.74	4.87	-	5.14	5.27	5.42
	13%	4.37	4.49	4.62	4.74	4.87	-	5.13	5.27
	14%	4.26	4.38	4.50	4.62	4.74	4.87	-	5.13
	15%	4.16	4.27	4.38	4.50	4.62	4.75	4.87	-

$$\text{Composite Factor} = \frac{a(a^n - 1)}{a - 1} \quad a = \frac{1 + g}{1 + i}$$

Table V.7. (Continued)

		<u>7-Year Life Cycle</u>							
		<u>Inflation Rate (g)</u>							
		8%	9%	10%	11%	12%	13%	14%	15%
Interest Rate (i)	8%	-	7.26	7.54	7.82	8.12	8.42	8.74	9.07
	9%	6.75	-	7.26	7.53	7.81	8.11	8.41	8.72
	10%	6.51	6.75	-	7.26	7.53	7.81	8.10	8.40
	11%	6.28	6.51	6.75	-	7.26	7.52	7.80	8.09
	12%	6.07	6.29	6.52	6.75	-	7.25	7.52	7.79
	13%	5.86	6.08	6.29	6.52	6.76	-	7.25	7.51
	14%	5.67	5.87	6.08	6.30	6.53	6.76	-	7.25
	15%	5.49	5.68	5.88	6.09	6.31	6.53	6.76	-
		<u>10-Year Life Cycle</u>							
		<u>Inflation Rate (g)</u>							
		8%	9%	10%	11%	12%	13%	14%	15%
Interest Rate (i)	8%	-	10.52	11.08	11.66	12.28	12.93	13.63	14.36
	9%	9.51	-	10.52	11.07	11.65	12.26	12.90	13.59
	10%	9.05	9.51	-	10.51	11.06	11.63	12.23	12.87
	11%	8.63	9.06	9.52	-	10.51	11.05	11.61	12.21
	12%	8.23	8.64	9.07	9.52	-	10.50	11.04	11.60
	13%	7.86	8.25	8.65	9.08	9.53	-	10.50	11.03
	14%	7.52	7.88	8.26	8.66	9.08	9.53	-	10.50
	15%	7.20	7.54	7.90	8.27	8.67	9.09	9.53	-

$$\text{Composite Factor} = \frac{a(a^n - 1)}{a - 1}$$

$$a = \frac{1 + g}{1 + i}$$

Table V.7. (Continued)

		<u>15-Year Life Cycle</u>							
		<u>Inflation Rate (g)</u>							
		8%	9%	10%	11%	12%	13%	14%	15%
Interest Rate (i)	8%	-	16.16	17.43	18.81	20.31	21.96	23.75	25.71
	9%	13.94	-	16.15	17.40	18.77	20.26	21.88	23.65
	10%	12.99	13.95	-	16.14	17.38	18.73	20.20	21.80
	11%	12.13	13.01	13.96	-	16.13	17.36	18.69	20.14
	12%	11.35	12.15	13.03	13.97	-	16.12	17.33	18.65
	13%	10.64	11.38	12.18	13.04	13.98	-	16.11	17.31
	14%	10.00	10.68	11.41	12.20	13.06	13.99	-	16.10
	15%	9.41	10.03	10.71	11.43	12.22	13.07	14.00	-
		<u>20-Year Life Cycle</u>							
		<u>Inflation Rate (g)</u>							
		8%	9%	10%	11%	12%	13%	14%	15%
Interest Rate (i)	8%	-	22.06	24.39	27.00	29.95	33.27	37.02	41.26
	9%	18.18	-	22.04	24.34	26.92	29.83	33.11	36.81
	10%	16.59	18.20	-	22.02	24.30	26.85	29.72	32.95
	11%	15.19	16.62	18.21	-	22.00	24.25	26.78	29.61
	12%	13.95	15.22	16.64	18.23	-	21.99	24.21	26.71
	13%	12.86	14.00	15.26	16.67	18.24	-	21.97	24.17
	14%	11.90	12.91	14.04	15.29	16.69	18.26	-	21.95
	15%	11.03	11.95	12.96	14.08	15.33	16.72	18.27	-

$$\text{Composite Factor} = \frac{a(a^n - 1)}{a - 1}$$

$$a = \frac{1 + g}{1 + i}$$

Table V.7. (Continued)

		<u>25-Year Life Cycle</u>							
		<u>Inflation Rate (g)</u>							
		8%	9%	10%	11%	12%	13%	14%	15%
Interest Rate (i)	8%	-	28.24	32.01	36.40	41.50	47.46	54.41	62.54
	9%	22.23	-	28.21	31.94	36.27	41.30	47.17	54.00
	10%	19.87	22.25	-	28.18	31.87	36.14	41.11	46.88
	11%	17.85	19.91	22.27	-	28.15	31.79	36.02	40.91
	12%	16.12	17.90	19.95	22.30	-	28.12	31.72	35.90
	13%	14.63	16.18	17.95	19.99	22.32	-	28.09	31.66
	14%	13.34	14.70	16.24	18.00	20.02	22.34	-	28.06
	15%	12.22	13.41	14.76	16.30	18.05	20.06	22.36	-
		<u>35-Year Life Cycle</u>							
		<u>Inflation Rate (g)</u>							
		8%	9%	10%	11%	12%	13%	14%	15%
Interest Rate (i)	8%	-	41.50	49.54	59.53	71.99	87.56	107.06	131.55
	9%	29.78	-	41.43	49.37	59.23	71.48	86.77	105.87
	10%	25.59	29.82	-	41.36	49.21	58.93	70.99	86.00
	11%	22.20	25.66	29.86	-	41.30	49.06	58.64	70.51
	12%	19.44	22.29	25.73	29.90	-	41.24	48.90	58.35
	13%	17.17	19.53	22.37	25.79	29.95	-	41.18	48.75
	14%	15.29	17.26	19.62	22.45	25.86	29.99	-	41.12
	15%	13.72	15.38	17.36	19.71	22.53	25.92	30.02	-

$$\text{Composite Factor} = \frac{a(a^n - 1)}{a - 1} \quad a = \frac{1 + g}{1 + i}$$

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Capitol Lake Plaza
Pierre, South Dakota 57501
(605) 773-3603

Tennessee

Mr. Leon Guthrie
Acting Executive Director
Tennessee Energy Authority
Suite 707
226 Capitol Boulevard Building
Nashville, Tennessee 37219
(615) 741-2994

Texas

Mr. Tom Wright
Director of Conservation
Texas Energy and Natural
Resources Advisory Council
411 West 13th Street, Room 803
Austin, Texas 78701
(512) 475-5491

Trust Territories of the Pacific

Mr. Koichi L. Wong
Director of Public Works
Office of the High Commissioner
Saipan, Mariana Islands 96950
Dial 9-967-1221; ask for 342-4246

Utah

Mr. Jack Lyman, Director
Utah Energy Office
231 East 4th South, Suite 101
Salt Lake City, Utah 84111
(801) 533-5424

Vermont

Mr. Ronald A. Allbee, Director
State Energy Office
State Office Building
109 State Street
Montpelier, Vermont 05602
(802) 828-2393

Virgin Islands

Dr. Frank Prince, Director
Virgin Islands Energy Office
P.O. Box 2996
St. Thomas, U.S. Virgin Islands 00801
(809) 774-0750

Virginia

Mr. George L. Jones
State Coordinator
State Office of Emergency and Energy
Services
310 Turner Road
Richmond, Virginia 23225
(804) 745-3305

Washington

Mr. Jack Wood, Acting Director
State Energy Office
400 East Union Street
Olympia, Washington 98504
(206) 753-4409

West Virginia

Mr. John F. Herholdt, Director
Fuel and Energy Office
Governor's Office of Economic
and Community Development
1262-1/2 Greenbrier Street
Charleston, West Virginia 25305
(304) 348-8860

Wisconsin

Mr. Willie Nunnery
Deputy Secretary
Department of Administration
Division of State Energy
1 West Wilson Street, Room 201
Madison, Wisconsin 53702
(608) 266-7958

Wyoming

Ms. Pamela A. Abel
Energy Conservation Coordinator
Energy Conservation Office
320 West 25th Street
Capitol Hill Office Building
Cheyenne, Wyoming 82002
(307) 777-7131

B: Glossary of Energy Terms

BRITISH THERMAL UNIT (Btu):

A standard unit for measuring heat. One Btu is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit. In the U.S., the capacity of furnaces and boilers is expressed in terms of the number of Btu's emitted per hour. Fuel oil, natural gas, electricity, and all other heat sources are also rated in Btu's.

BUILDING ENERGY PERFORMANCE STANDARD (BEPS):

A standard requiring that a building be designed to meet a specified level of energy use per year. (See "Energy Budget.")

CAULKING:

A flexible material used to fill gaps at fixed joints on a building, in order to reduce the passage of air and moisture. Also includes materials known as "sealants," "putty," and "glazing compounds."

CLIMATIC ZONE:

An area across the country which reflects similar climatic conditions as established by the number of heating and cooling degree days.

CLOCK THERMOSTAT:

A device which is designed to reduce energy consumption by regulating the demand on the heating or cooling system of a building and which includes (1) a temperature control device for interior spaces including more than one temperature control level, and (2) a clock or other automatic mechanism for switching from one control level to another. (See "Thermostat.")

COEFFICIENT OF PERFORMANCE (COP):

A measure of operating efficiency, expressed as the ratio of useful output energy to input energy. In percentage terms, the COP indicates what portion of the fuel input is converted to useful heating or cooling.

$$\frac{\text{Output Btu's}}{\text{Input Btu's}} = \text{COP}$$

Example: If a gas furnace has a rated output of 135,000 Btu/hr and a rated input of 168,750 Btu/hr, the COP is .80.

CONDUCTION, THERMAL:

The transmission of heat through or within a solid object. Generally, heat flows through more dense materials at faster rates than through less dense substances and always flows from a higher temperature to a lower one. Materials which do not permit high rates of heat flow are poor thermal conductors and good insulators.

CONVECTION:

The transmission of heat by the movement of a fluid, such as air. Fluids are heated by conduction when they come into contact with a surface or object of higher temperature. Different portions of the fluid are heated to different temperatures, stimulating movement within the fluid as, for instance, when warmer air expands and rises. The movement creates convection currents which transfer heat.

CORD:

A cubic measure, especially of wood; the quantity of wood in such a measure. A pile of cut wood 8 feet long, 4 feet high, and 4 feet wide (128 cubic feet) is the recognized measure in the United States. One cord of wood generates approximately 18,000,000 Btu's.

CUBIC FEET OF NATURAL GAS:

A common unit of natural gas consumption. One thousand cubic feet (MCF) of natural gas yields approximately one million Btu's of heat energy.

Note: A well-maintained natural gas heating unit is able to convert up to 80% of the natural gas energy to useful heat.

Example: If a home requires 14,000,000 Btu's of heat per month and its gas furnace is 70% efficient, it will use approximately 20 MCF of natural gas (20,000,000 Btu's) to produce that heat.

DAMPER:

A hinged plate in the flue of a furnace or fireplace which, acting as an air valve, is used to regulate the draft and to control the amount of heat lost through the chimney. Also, a device to deaden vibrations. (See also "Flue Opening Modification.")

DEGREE DAYS, COOLING (DDC):

For a given locality, the annual sum of the number of Fahrenheit degrees of each day's mean temperature above a given reference temperature (usually 65°F); used as a measure of summer cooling needs. (See "Degree Days, Heating.")

DEGREE DAYS, HEATING (DDH):

For a given locality, the annual sum of the number of Fahrenheit degrees of each day's mean temperature below a given reference temperature (usually 65°F); used as a common measure of winter heating needs. (See "Degree Days, Cooling.")

Note: Mild climates range from 500 to 2,500 DDH; moderate climates from 2,500 to 4,000 DDH; and severely cold climates from 4,000 DDH on up.

ELECTRICAL IGNITION:

A device which, when installed in a gas-fired furnace, boiler, or appliance, automatically ignites the gas burner or the gas pilot light only as needed, thus saving gas.

ENERGY AUDIT:

An inventory of the physical characteristics of a building which contribute to thermal efficiency, in order to identify appropriate energy conservation measures, estimate the cost of installing such measures, and estimate the dollar savings likely to result from installing such measures.

ENERGY BUDGET:

The desired maximum energy use per year in a building.

ENERGY COST INDICATOR:

See "Energy Usage Display Meter."

ENERGY EFFICIENCY:

The ability of an appliance or of a building's energy system to produce a given effect with a minimum of effort, expense, or waste, in comparison to other buildings or appliances of a similar nature; quantitatively, the ratio of output to energy expended in achieving that output. (See "Energy Efficiency Ratio.")

ENERGY EFFICIENCY RATIO (EER):

A measure of the efficiency of an electric heat pump, air conditioner, or vapor compressor heating or cooling device, expressed as the ratio of output in Btu's per hour to the energy input in watts.

$$\frac{\text{Btu/hr}}{\text{Watts}} = \text{EER}$$

Note: The generally recognized minimum EER for good performance is 7.0.

Example: If the rated cooling capacity of an air conditioner is 24,000 Btu/hr and the power required to achieve this cooling is 3500 watts (3.5 kilowatts), the EER is 6.9.

ENERGY-EFFICIENT APPLIANCE:

An appliance equipped with special energy-saving features which reduce the operating costs of the appliance.

Note: Appliance testing, labeling, and public information procedures which estimate annual operating expenses are now required for many appliances such as clothes washers and dryers, dishwashers, refrigerators and refrigerator-freezers, water heaters, and kitchen ranges and ovens.

ENERGY USAGE DISPLAY METER:

A device which displays the dollar cost of energy usage in a building or building unit. It may show cost information for use of electricity, gas, oil, or any combination of these. The device may measure energy usage of the whole building, of individual units, or of individual appliances or systems on an instantaneous or cumulative basis.

FLUE DAMPER:

See "Flue Opening Modification."

FLUE OPENING MODIFICATION

An automatically operated damper which is installed (a) downstream from the draft hood in gas-fired furnaces or downstream from the barometric damper in oil-fired furnaces, (b) on a furnace located in a heated area of a building, or (c) in a fireplace chimney, and which conserves energy by reducing the outward flow of heated air through the chimney when the furnace or fireplace is not in operation. Also called a "vent damper."

GALLONS OF FUEL OIL:

A standard unit of fuel oil consumption. One gallon of fuel oil equals approximately 138,000 Btu's.

HEAT PUMP:

A device, similar in operation to an air conditioner, which extracts heat from the outdoor air in winter and moves it indoors. It is usually operated by electricity but is more efficient than electric resistance heat under many climate conditions. In the summer, a heat pump provides cooling like an ordinary central air conditioner.

INFILTRATION, AIR:

The flow of air into a building through cracks around doors, windows, and other openings in the building envelope.

INSULATION:

Any material used to reduce the transfer of heat, cold, or sound. The level of resistance to heat flow varies by type and amount of insulation materials. (See "R-value.") Also, the non-conductive coating of electrical wires.

INSULATION, CEILING:

A material designed to resist heat transfer which is installed between the conditioned area of a building and an unconditioned attic. Where the conditioned area of a building extends to the roofs, the term also applies to such material used between the underside and upperside of the roof.

INSULATION, DUCT:

A material designed to resist heat transfer which is installed on a heating or cooling duct in an unconditioned area of a building.

INSULATION, FLOOR:

A material designed to resist heat transfer which is installed between the first level conditioned area of a building and an unconditioned basement, crawl space, or the outside beneath it. Where the first level conditioned area of a building is on a ground floor conditioned slab, the term also applies to such material installed around the perimeter or on the slab.

INSULATION, PIPE:

A material designed to reduce heat transfer which is installed on a heating or cooling pipe in an unconditioned area of a building.

INSULATION, WALL:

A material designed to reduce heat transfer which is installed with or on the walls between conditioned and unconditioned areas of a building or the outside.

INSULATION, WATER HEATER:

A material designed to reduce heat transfer which is in blanket form suitable for wrapping around the exterior surface of the water heater casing.

INVESTMENT COSTS:

The initial costs of design, engineering, purchase, and installation exclusive of sunk costs.

KILOWATT HOUR (kWh):

A common unit of electrical energy consumption. One kilowatt-hour is the total energy consumed when one thousand watts are drawn for one hour. One kWh of electricity equals approximately 3,413 Btu's.

Example: If an electric furnace with a 10,000-watt element runs for 15 minutes, it uses 2.5 kWh and produces 8,523.5 Btu's.

$$10,000 \text{ W} \times \frac{15}{60} \times 3.413 \frac{\text{Btu/hr}}{\text{W}} = 8,532.5 \text{ Btu}$$

LIFE-CYCLE COST:

The total costs of owning, operating, and maintaining a building or capital equipment over its useful life, including its fuel and energy costs.

LIFE-CYCLE COSTING:

The analysis of the cost of an investment over its economic or useful life, often related to building energy costs. Life-cycle costs are determined on the basis of the discounted present value of aggregate future payments or benefits derived from current investment. Life-cycle costing makes apparent the trade-offs between additional dollars invested today and reduced costs in the future.

MECHANICAL IGNITION:

A device which, when installed in a gas-fired furnace, boiler, or appliance, automatically ignites the gas burner or the gas pilot light only as needed, thus saving gas.

PAY-BACK PERIOD:

The time required for complete recovery of an investment. Simple pay-back refers to the length of time necessary to recapture initial investment.

$$\frac{\text{Investment}}{\text{Annual income or savings}} = \text{Pay-back years}$$

Discounted pay-back refers to the time required to recapture initial outlay, conditioned by assumptions regarding the time value of money. Often used with the concept that all income is considered a return of capital until the entire investment is recaptured and that income received after complete pay-back is considered profit.

RADIATION, THERMAL:

The transmission of heat through space by wave motion, independent of any medium, as in the transmission of heat and light from the sun. When radiant waves strike an object, heat is transferred to the object at a rate dependent upon the surface properties of the object. Materials which reflect much and absorb little of the radiant energy, such as aluminum foil, are called reflectors.

RETROFIT:

A modification in the design, construction, material, or equipment of an existing building in order to reduce energy use.

R-VALUE:

A measure of a material's resistance to heat transfer; higher resistance ratings signify better insulating values. Equal to 1 divided by the U-value of the material.

$$\frac{1}{U\text{-value}} = R\text{-value}$$

SOLAR DESIGN, ACTIVE:

A building design which uses solar collectors outside the building envelope to gather energy for space and/or water heating. Heat energy is transferred from the collector by mechanically pumping a fluid medium such as water or air to a distribution or storage location.

SOLAR DESIGN, PASSIVE:

A building design which takes into account the position and intensity of the sun to provide interior heating. Placement of thermal mass, window location and size, and shading are considered in passive solar design. Collection, storage, and distribution of solar energy are achieved by natural heat transfer phenomena (conduction, convection, radiation) without the use of pumps, blowers, or other mechanical or electrical devices.

SOLAR SPACE HEATER:

A space-heating system designed to absorb the sun's energy and use this energy to heat living space by the use of mechanically forced energy transfer, such as fans or pumps.

SOLAR WATER HEATER:

A water-heating system designed to absorb the sun's energy and to use this energy to heat water for use other than space heating in a building; includes thermosiphon hot water heaters.

STORM DOOR:

A second door, installed outside or inside a prime door, creating an insulating air space; a door with enhanced resistance to heat transfer through the glass area by affixing two or more sheets of glazing material; a prime exterior door with an R-value of at least 2. Also called a "thermal door."

STORM WINDOW:

A window or glazing material placed outside or inside an ordinary or prime window, creating an air space between them in order to provide greater resistance to heat flow than the prime window alone.

THERM:

A standard unit for measuring heat combustion, equal to 100,000 Btu's; usually used for measuring natural gas energy.

THERMAL COMFORT:

The balance achieved by the exchange of heat between the human body and the surrounding environment.

THERMAL DOOR:

See "Storm Door."

THERMAL POND SYSTEM:

Containers, such as tanks or water bags, filled with water or other fluids which, when placed on a rooftop, capture the sun's rays and radiate stored heat directly into a building. Movable insulation is used to regulate heat absorption and radiation.

THERMAL RESISTANCE:

The ability of an insulating material to retard the flow of heat from warm to cold temperatures through walls, floors, ceilings, roofs, doors, or windows; quantified in the form of R-value.

THERMAL WINDOW:

A window unit which reduces heat transfer through the use of two or more sheets of glazing material which create one or more insulated air spaces. It may also have an insulating frame and sash and reflective films.

U-VALUE:

A measure of the amount of heat transferred through a given material in a specified amount of time. The lower the U-value, the greater the ability of the material to transfer heat. Equal to 1 divided by the R-value.

$$\frac{1}{U\text{-value}} = R\text{-value}$$

VAPOR BARRIER:

A moisture-impervious material, such as plastic, aluminum foil, or paint, used to retard the passage of vapor or moisture into walls and floors, thus preventing condensation within due to lower temperature. Normally, such material is placed on the side of the insulation which faces the interior of the building, except in the most southerly, humid climates.

VENT DAMPER:

See "Flue Opening Modification."

VENTILATION:

The process of supplying air to, or removing it from, a room or building, either naturally by openings or mechanically by fans; influences thermal comfort. In an unconditioned space, ventilation is accomplished with outside air; in conditioned space, ventilation is normally recirculated air with a small admixture of outside air.

WEATHERSTRIPPING:

Narrow strips of material placed over or in movable joints of windows and doors to reduce the passage of air and moisture.

WIND ENERGY DEVICE:

Equipment that uses wind energy to produce energy in any form for personal residential purposes.

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C: Energy Legislation and Real Estate

As noted elsewhere in this notebook, energy consumed by residential and commercial buildings currently accounts for about one-third of the total energy consumed in the United States, or the equivalent of 13.8 million barrels of oil daily. Most of the 74 million residential buildings and 1.5 million commercial buildings in the United States were constructed when energy was relatively inexpensive and abundant; few, if any, energy-savings considerations were incorporated in their designs. As a result, a large percentage of the energy used in these structures is wasted.

Now and increasingly in future years, the real estate industry will be affected by governmental incentive or regulatory programs that relate to the use of energy in residential properties. This Appendix highlights certain existing and proposed national legislation that will affect real estate appraisers. As suggested elsewhere in the notebook, each appraiser should make an effort to keep his/her knowledge current regarding the role of governmental policy in dealing with the energy problem. Subsequent pages will deal with:

1. New Building Energy Performance Standards (BEPS);
2. Appliance Labeling and Standards;
3. Energy Audits;
4. Energy Financing Programs;
5. Solar Information Programs; and
6. The Energy Tax Act.

Students are reminded once again that state and local governments also are establishing requirements in the areas of building codes and standards, tax incentives, financing programs, and energy information. A roster of "State Energy Officers" is included in Appendix A.

1. New Building Energy Performance Standards (BEPS)

Under the Energy Conservation Standards for New Buildings Act of 1976 (P.L. 94-385), the Department of Housing and Urban Development (HUD) was mandated to develop, promulgate, implement, and monitor energy performance standards for new residential and commercial buildings. In 1977, the Department of Energy (DOE) Reorganization Act (P.L. 95-91) transferred responsibility for developing and promulgating the standards to DOE.

The concept of energy-performance standards represents an innovative approach to energy conservation because it addresses the whole building rather than its

individual components. The standards will specify design energy goals, or "budgets" (expressed, for example, in Btu's per square foot per year), for the building design, but will not specify the materials, methods, or processes to be used to meet those goals. Building designers thus will retain substantial flexibility in making trade-offs and introducing innovations in designing energy-efficient buildings, including the use of nondepletable energy sources.

Additional information on energy performance standards is available from:

Mr. James L. Binkley
Division of Buildings and Community Systems
Office of Conservation and Solar Applications
Department of Energy
20 Massachusetts Avenue, N.W.
Washington, D.C. 20545
(202) 376-5924
(800) 424-5168

2. Appliance Labeling and Standards

Labeling

Section 324 of the Energy Policy and Conservation Act (1975) mandated the Voluntary Energy Labeling Program for Appliances. The objective of the program was to develop labels disclosing energy consumption and cost information for major household products. The Federal Trade Commission (FTC) has the responsibility for publishing labeling rules and designing the actual labels to be affixed to the products by the manufacturers. The labels are to be designed so that the information displayed will be easily understood by the consumer. Estimated annual energy costs of the product and the range of annual energy costs of similar products are required by the Act to be included on the label. The FTC also may require that additional information relating to energy consumption be displayed or distributed where the products are sold.

Standards

Under the National Energy Conservation Policy Act (1978), appliance manufacturers are required to meet minimum efficiency standards for their products. Test procedures and minimum standards are being developed by DOE. For additional information on this program, contact:

Mr. James A. Smith, Branch Chief
Consumer Products Efficiency Branch
Department of Energy
20 Massachusetts Avenue, N.W.
Room 224
Washington, D.C. 20545
(202) 376-4814

Table B.1. APPLIANCES

	FTC Labeling	DOE Standards
1. Refrigerators, Refrigerator-freezers	X	X
2. Freezers	X	X
3. Dishwashers	X	X
4. Clothes Dryers		X
5. Water Heaters	X	X
6. Room Air Conditioners	X	X
7. Home Heating Equipment		X
8. Television Sets		X
9. Kitchen Ranges and Ovens		X
10. Clothes Washers	X	X
11. Humidifiers and Dehumidifiers		X
12. Central Air Conditioners		X
13. Furnaces	X	X
14. Any other type of consumer product that the Secretary may classify as a covered product		

3. Energy Audits

Many utility companies and state energy offices currently have available energy-auditing services that can determine the energy efficiency of a property and enumerate cost-effective improvements that can be made to upgrade the property. The appraiser should request that his client furnish him any information that may be available.

Project Conserve: A Questionnaire Audit

Updated Project Conserve is a computerized audit that is available through many state energy offices. A simple questionnaire for information about a home is completed and then analyzed by a computer program keyed to the proper local

cost and climatic factors. The result of the analysis is a printed report providing estimated costs and savings that may be expected as a result of taking appropriate energy-conserving actions.

For information, contact the State Energy Office or:

Ms. Carol Norris
Office of Buildings & Community Systems
Department of Energy
20 Massachusetts Avenue, N.W.
Room 1210
Washington, D.C. 20585
(202) 376-5933

Residential Conservation Service--An On-site Audit

The Residential Conservation Service (RCS), established by the National Energy Conservation and Policy Act (1978), requires large, regulated utilities to provide several services to their residential customers. Nonregulated utilities and home-heating suppliers may be included at each state's discretion. These services include the following:

- A. Energy audits upon request;
- B. Information about estimated savings in energy costs for the measures; and
- C. Arrangements upon request for the purchase, installation, financing, and billing of energy-conservation and renewable-resource measures, with appropriate attention given to consumer protection.

The RCS program applies to existing single- to four-family dwelling units with heating and/or cooling systems. The rule will divide energy-conservation measures into two categories: (1) energy-conservation measures that conserve energy but do not use a renewable energy source; and (2) renewable resource measures that make use of solar and wind energy. The conservation measures covered by the RCS program include the following:

- A. Caulking and weatherstripping of doors and windows;
- B. Furnace-efficiency modifications;
- C. Clock thermostats;
- D. Ceiling, attic, wall, and floor insulation;
- E. Water heat insulation;
- F. Storm windows and doors;
- G. Heat-absorbing or heat-reflective glazed windows and door materials;
- H. Load-management devices;

- I. Duct insulation;
- J. Pipe insulation;
- K. Thermal windows; and
- L. Thermal doors and energy usage display meters.

Renewable-resource measures covered by the RCS program include the following:

- A. Solar domestic hot-water systems;
- B. Active solar space-heating systems;
- C. Combined active solar space-heating and domestic hot-water systems;
- D. Passive solar space-heating and cooling systems;
- E. Wind-energy devices; and
- F. Replacement solar swimming-pool heaters.

The rule also requires utility suppliers to furnish information including savings in energy costs from "energy conservation practices." These practices were included in the rule because they (1) save energy; (2) have minimal or no cost; and (3) can be installed or practiced independently of the suggested measures. DOE believes that many energy-conservation practices are at least as effective as installing measures that require a much greater investment. Energy-conservation practices included in the rule are:

- A. Changing furnace and air conditioning filters;
- B. Installing flow restrictors in shower heads and faucets;
- C. Installing low-flow shower heads and faucets;
- D. Sealing leaks in pipes and ducts;
- E. Raising thermostat settings in summer;
- F. Reducing thermostat settings on water heaters;
- G. Closing vents, valves, and doors in infrequently used rooms; and
- H. Reducing average thermostat settings in winter.

Additional measures may be implemented by individual states. For more information, contact:

Mr. James R. Tanck, Director
Residential Conservation Services
Department of Energy
Mailstop 2221C
20 Massachusetts Avenue, N.W.
Washington, D.C. 20585
(202) 376-4020

4. Energy Financing Programs

The following financing programs were mandated under the National Energy Conservation Policy Act:

Weatherization Grants for Low-Income Families

Legislation extended to 1980 a grant program for states to purchase and install weatherization materials for homes occupied by low-income families, especially the elderly and the handicapped. Low-income families are defined as those with incomes of 125 percent or less of the federally established poverty level. Eligible materials include insulation, storm windows and doors, caulking and weatherstripping, furnace-efficiency modifications, and clock thermostats. The maximum grant expenditure for any dwelling unit is \$800.00. Grants can be used both for owner-occupied and renter-occupied residences.

A separate, \$25 million grant program has been established under the Farmers Home Administration to finance the weatherization of low-income residences in rural areas.

Energy-Conservation Financing Program

The Government National Mortgage Association (GNMA), under HUD, is directed to buy and sell home-improvement loans for energy-conservation measures, with priority for elderly and moderate-income families. Moderate income is defined as 100 percent or less of the median income for the area. Loans may not exceed \$2,500.00.

Solar-Energy Financing Program

GNMA also has been authorized to purchase up to \$100 million of reduced-interest loans to homeowners and builders for the purchase and installation of solar-heating and cooling equipment in residences. Support for up to \$8,000.00 per unit is provided. The financing program is available for five years, with loan repayments due within 15 years.

Other Residential Financing Programs

Legislation has authorized HUD to insure loans for energy-conserving improvements to multi-family housing and to make grants and establish standards for

such improvements to federally-assisted housing. HUD also is authorized funds to make energy-conserving improvements to public housing. The mortgage limits for housing insured by FHA or the Farmers Home Administration (FmHA) may be increased to account for the increased cost of solar-energy systems. Other provisions direct that the minimum energy-conservation standards governing new housing insured by FHA or FmHA be strengthened. DOE and HUD also are required to conduct studies of energy conservation in apartment buildings and possible needs for mandatory standards governing all existing residential buildings.

5. Solar Information Programs

DOE has established a hot line to provide the public with information about solar heating and cooling technologies. The toll-free number of the National Solar Heating and Cooling Information Center is 800-523-2929.

As an additional service, DOE is developing and presenting informational programs for appraisers and other real estate professional people in order to explain solar technologies and to discuss methods of valuing them. Information about these workshops is available through the solar hot line.

6. The Energy Tax Act

The Energy Tax Act contains provisions relating to a variety of energy concerns. Among these are the following:

Residential Insulation and Conservation

A non-refundable credit of up to \$300.00 is provided for 15% of the first \$2,000.00 invested in qualifying energy equipment. The property claimed for the credit must be installed between April 20, 1977, and December 31, 1985, in a principal residence already in existence on April 20, 1977. Condominiums and cooperatives are included in the credit if used as a principal residence; vacation homes are not. "Qualifying property" includes insulation, caulking, weatherstripping, modified flue openings, storm or thermal doors and windows, automatic furnace-ignition systems, clock thermostats, and similar items.

Residential Solar

A non-refundable credit for investments in solar, wind, and other renewable sources of energy is available for both new and existing residences. The credit would be 30% of the first \$2,000.00 and 20% of the next \$8,000.00 spent, for a maximum credit of \$2,200.00. Any investment from April 20, 1977, through December 31, 1985, will be eligible if the equipment is used to heat or cool a home or provide hot water.

Business Energy Tax Credits

The Act provides a variety of tax credits for investment by business. A 10% investment tax credit, non-refundable except for solar equipment, is provided for investment in:

1. Alternative Energy Property--i.e., boilers and other combustors using coal or an alternative fuel; equipment to produce alternative fuels; pollution-control equipment; equipment for handling and storage of alternate fuels; and geothermal equipment. The credit complements and provides economic underpinning for the coal-conversion regulatory program. The credit is not available to utility companies.
2. Solar or Wind Energy Property--a refundable credit for investment in equipment using renewable energy to generate electricity or to heat or cool or to provide hot water. This credit also is unavailable to utilities.
3. Specially Defined Energy Property--this applies to equipment intended to improve the heat efficiency of existing industrial processes, including heat exchangers and recuperators.

Restriction of Investment Tax Credit and Accelerated Depreciation on New Oil- and Gas-Fired Boilers

New industrial oil- or natural gas-fired boilers will not be eligible for an investment tax credit and will be limited to straight-line depreciation unless the use of coal at any such facility is precluded by federal air-pollution regulations or existing state air-pollution regulations.

The credit and accelerated depreciation for new oil- or natural-gas fired boilers are also allowed for certain exempt uses, including residential use; transportation use; farming use; use in any facility that is not an integral part of manufacturing, processing, or mining; use in highly efficient facilities capable of converting to synthetic fuels (i.e., those with heat rates of 9,500 Btu per KWH or lower); and use in production or distribution of oil or natural gas.

Depreciation Allowance for Early Retirement of Oil- or Gas-Fired Boilers

If the taxpayer can demonstrate that an oil- or gas-fired boiler will be retired earlier than anticipated originally, the useful life may be decreased and the remaining basis subjected to straight-line depreciation over the shortened remaining life.

D: Energy Information Forms

Verification Form

Builder _____

Model _____

Address _____

As developed for use in the ECH₂ONERGY program, this non-exclusive checklist gauges the relative ranking of energy-efficient construction materials and water conservation devices and techniques in a home in the Denver area. (There may be other energy-efficient construction materials and water conservation devices or techniques built into this home that are not represented on this form.)

A rating of zero represents a home with no insulation, single pane windows and no energy-efficient materials or water saving devices or techniques. The higher the rating . . . the more energy and water efficient the home.

The Goal: Save Energy & Water

At first, there was only one ECH₂ENERGY home. It was put on display for public inspection in the summer of 1979 by the Home Builders Association of Metropolitan Denver, Public Service Company of Colorado and the Denver Water Department. Into that home, the three sponsors incorporated quality energy and water conservation materials and equipment. The idea was to demonstrate that, by utilizing such materials in today's homes, buyers can save substantially on energy and water costs and, at the same time, participate in America's campaign to achieve a greater degree of energy self-sufficiency.

The ECH₂ENERGY idea, in short, captured the interest of the public, people who are openly concerned about mounting utility costs for gas, electricity and water. Their interest, indeed, proved that people are fully aware that the familiar PITI (principal/interest/taxes/insurance) formula no longer constitutes all of the homeowner's expense. To that, and spiraling skyward, must be added the "E factor" . . . energy and water costs. People like you have made it quite clear to homebuilders that they want homes today with features that keep the E factor as low as possible.

Homes Are Rated

Result: Many leading builders have joined together under the ECH₂ENERGY banner and are constructing homes built to rigid energy and water conservation standards. And, the ECH₂ENERGY concept has the endorsement of Public Service Company of Colorado and the Denver Water Department.

The sponsors have developed an easily understood scorecard system that provides a specific energy and water rating for homes. The system measures all insulation factors, types of windows and doors, air infiltration, heating ducts, hot water conservation and water conservation factors . . . the higher the score, the more energy efficient the home.

More and more leading Denver and Colorado builders are joining the ECH₂ENERGY program every month. Their participation is proof that they are providing you, the customer, with cost-effective housing.

Lenders Like the Idea Too

Builders and home buyers aren't the only ones who have expressed interest in the fact that ECH₂ENERGY-built homes save money for the buyer. Lenders are becoming increasingly enthusiastic about the program too.

You see, in making a home loan, the lender's rule-of-thumb has been to make loans on which the PITI does not exceed 25 percent of the buyer's gross monthly income. For example, if you have a gross monthly income of \$1,600, you normally cannot qualify for a home loan involving a monthly payment of more than \$400.

Unfortunately, this lending practice rules out home ownership for many people. The pride of home ownership long has been a goal for many Americans.

Fortunately, the use of ECH₂ENERGY construction standards is causing lenders to view housing loan commitments somewhat more generously than in the past . . . and for good reason. Lenders know that ECH₂ENERGY-built homes include features that lead to efficient use of energy and water. Money saved through that efficient use can then logically be earmarked for a somewhat higher monthly home payment without jeopardizing your budget.

Thus, as the program grows in popularity, both with builders and buyers, lenders are demonstrating their willingness to consider home loans with monthly payments that exceed the traditional 25 percent of the prospective buyer's monthly gross income.

Advantages for the Buyer

The advantages for you in owning an ECH₂ENERGY home include: (a) more favorable consideration in home loan qualification, (b) more efficient use of energy and water, and (c) higher resale value.

For America, the ECH₂ENERGY program means intelligent use of our nation's natural resources.

ECH₂ENERGY homes make a lot of sense in today's market. And, with utility costs constantly on the rise, they will make even more sense for today's home buyers in the years ahead.

If you're looking for a new home, it is to your advantage to do business with a member firm of the Home Builders Association of Metropolitan Denver who proudly certifies that his homes are built to meet the standards of the ECH₂ENERGY program.

Energy Conservation Rating

Circle appropriate number in each section and enter total of circled numbers below.

Factors Built Into Model Indicated

Type of Structure

Savings vary. Find out why in the seller's fact sheet on R-values. Higher R-values mean greater insulating power. ("R-value" is a term used to describe a material's resistance to heat flow.)

		Ranch with Crawlspace	Ranch with Basement	Two Story with Basement	Bi-Level	Tri-Level with Crawlspace	Tri-Level with Basement
Ceiling Insulation	R 0	0	0	0	0	0	0
	7	20	25	16	17	19	18
	11	23	28	17	17	22	20
	19	24	30	19	21	24	21
	22	24	31	19	21	24	22
	30	25	31	19	22	25	22
	33	25	32	20	22	25	23
	38	26	32	20	22	25	23
Frame Wall Insulation With Fiberboard Sheathing	R 0	0	0	0	0	0	0
	7	5	7	11	6	7	6
	11	6	7	12	7	8	+7
	13	6	7	12	7	8	7
	19	8	9	14	8	9	8
	17	8	9	14	8	9	8
W/Foam Sheathing							
Foundation or basement wall insulation	R 0	0	0	0	0	Crawl Space	Grade Wall
entire inside	7	—	7	5	8	—	—
entire inside	11	—	9	6	9	—	8
entire inside	13	—	9	7	10	—	8
outside 4' down	5	16	6	4	8	2	5
outside 4' down	10	18	9	6	10	3	7
						Base-ment	Grade Wall
						7	—
						8	—
						8	—
						7	8
						8	9
Floor Insulation over Unheated areas	R 0	-OR- 0	0	0	0	-OR- 0	0
	7	16	—	—	—	2	—
	11	18	—	—	—	3	—
	13	19	—	—	—	3	—
	19	20	—	—	—	3	—
Type of Windows							
Single Pane		0	0	0	0	0	0
Double Pane		5	6	10	8	7	7
Double Pane Wood or Metal w/Thermal Break		6	7	11	9	8	8
Triple Pane		7	8	13	11	10	9
Front Door							
Solid Wood		0	0	0	0	0	0
Solid Wood & Storm or foam core		1	1	1	1	1	1
Air Infiltration							
Windows .50 cfm/ft		1	1	1	1	1	1
Windows .20 cfm/ft		2	2	3	3	3	2
Inside Film Vapor Barrier		2	2	3	3	3	2
Foam Sheathing		3	4	5	6	5	5
Caulking		3	4	5	6	5	5
Outside Combustion Air to furnace room		3	4	5	6	5	5
Fireplace							
Outside Air For Combustion		1	1	1	1	1	1
Glass Door		1	1	1	1	1	1
No Fireplace		2	2	2	2	2	2
Heating Ducts in crawl spaces Insulated		3	0	1	1	3	2
Hot Water Conservation							
Solar Assisted Domestic Hot Water Heating		6	7	7	6	7	6
Total Energy Score

The Public Service Company of Colorado has advised in the preparation of this form and approves the suggested ratings.

January 1980

Water Conservation Rating

Circle appropriate number in each section of Part I, and complete indicated calculations for score in Part I, Part II and total.

Builder Features

	Points	Score
Part I.		
Inside the home		
1.		
Toilet		
5 gallon tank	3	
4 gallon or less tank	5	
Toilet with shallow trap	8	
Toilet with dual cycle flush	8	
2.		
Shower heads supplied	1	
Showers with flow restrictors	6	
Showers with thermo, mix valve	2	
3.		
Kitchen Features		
Kitchen tap with aerator	2	
Sink with vegetable spray	1	
Kitchen tap with flow restrictor	2	
Dishwasher, 15 gal. cycl. or less	1	
Dishwasher with energy saver	1	
4.		
Water lines from water heater, insulated	2	
Sub total A (Maximum 31 points)		

5. Sewer Charge & Rate Adjustment
(Outside Denver multiply subtotal A by 0.8) _____
(Inside Denver multiply subtotal A by 1.3) _____

Part I Score (subtotal A _____ x Item 5 _____) =

Part II

Outside the Home

A. Gross area of lot or bldg. site in sq. ft. _____

B. Less area for:

House foundation area _____

All walks & driveways _____

Not on Public R.O.W. _____

Patios @ Grade _____

*Estimated Unplanted areas next _____

to house foundation _____

Total Plantable area = A - B = C _____ sq. ft.

Points for Part II

C equals less than 3,000 sq. ft. 15
5,000 sq. ft. 10
8,000 sq. ft. 4
10,000 sq. ft. 2

Total score Part II

Add Total Score Part I and Part II
Total Water Conservation Score

Total Water Conservation Score

Total Energy Score

TOTAL ECH₂ENERGY RATING

The Denver Water Board has advised in the preparation of this form and approves the suggested ratings.

Outside Water Saving Ideas

Water is scarce in the Denver area. Average annual precipitation is 17 inches. Denver area water companies are eliminating a minimum charge for water and are going to charge for all of the water you use. Therefore it saves you money to be waterwise and not waste water needlessly.

You can usually save the most water outside your home.

1. The Denver area experiences warm dry summers. Historically approximately 50% of a homeowner's annual water consumption is used in watering the yard.
2. Denver area soils are mostly clay which absorbs water very slowly. Steep slopes planted with lawn encourage water runoff and waste.
3. Groundcovers other than lawn will decrease the need for water and reduce water waste and runoff and save you money.
4. *Much of the Denver area soil contains materials which swell when wet. This can cause considerable structural problems if landscaping is planted close to the house foundation and requires watering. Lawn next to the house also dries out faster from reflected sun heat. Save water and reduce trouble by keeping landscaping that requires irrigation 6 ft. away from the house foundation.
5. Certain plants are healthier and require less water in the Denver area. Consult your nurseryman or landscape architect.
6. The above suggestions are offered as helpful hints since your homebuilder does not provide landscaping nor does he want to interfere with your individual choice or desires.
7. The Home Owners Warranty Corporation of Colorado (H.O.W.) and your home builder endorse landscaping techniques which require minimal irrigation. Keep your warranty protection intact by following that guideline.

Additional Information

These are other energy and water saving features, offered by this builder, that have not been included on the non-exclusive checklist.

The Home Builders Association of Metropolitan Denver, the Public Service Company of Colorado and the Denver Water Board does not verify the accuracy of information provided by individual builder/member participants in this ECH₂ENERGY program.

Prepared By

Name _____ Date _____

Title _____ Firm _____

Verified By

Signature _____

Appraiser _____ Date _____

Loan Qualification Guideline

The ECHOENERGY Energy Efficiency Rating system is presented as an aid to home buyers and home mortgage loan institutions.

By using the verification form, home buyers and lenders can see how features of the ECHOENERGY homes, built by participating HBA members, contribute to the reduction of home operating costs. This chart illustrates how the reduction in operating costs permits easier loan qualifying standards for buyers of ECHOENERGY homes.

This guideline was prepared by members of the ECHOENERGY Committee. Final determination as to the value or use of the ECHOENERGY Rating System is made by each home mortgage lending institution.

A Program of

Public
Service
Company
of
Colorado

 PROJECT CONSERVE

ENERGY CONSERVATION ALTERNATIVES
 FOR THE HOME OF

RICHARD B HAYTER
 OF CURRENT RESIDENT
 634 HARRISON
 TUPEKA, KS 66603

THE COSTS AND SAVINGS SHOWN BELOW ARE ESTIMATES. SAVINGS WILL VARY WITH COSTS OF FUEL AND SEVERITY OF THE WEATHER. COSTS WILL VARY WITH THE TYPE AND QUALITY OF MATERIALS AND THE CONSTRUCTION OF YOUR HOME.

ENERGY CONSERVING ACTION	ANNUAL DOLLAR SAVINGS (CURRENT PRICES)	VOLUME OF FUEL SAVED (CUFT) WINTER SUMMER (KWHR)	COST ESTIMATES BASED ON	ESTIMATED COSTS	YEARS TO RECOVER INVESTMENT	YIELD ON INVESTMENT PRESENT COSTS	WITH INFLATION
INSTALL STORM WINDOWS ON REMAINING 4 WINDOWS	FROM: \$ 0 TO: \$ 10	4900 6000	DO-IT-YOURSELF CONTRACTOR	\$ 50 TO \$ 105 \$ 70 TO \$ 120	10.2 11.8	7.5% 6.0%	11.3% 9.7%
INSTALL 3-4 INCHES (R-11) MOPE CEILING INSULATION	FROM: \$ 5 TO: \$ 6	1700 2100	50 MORE INSULATION 70 ECONOMICALLY JUSTIFIABLE AT THE PRESENT TIME				
INSTALL STORM DOORS ON REMAINING 2 DOORS	FROM: \$ 5 TO: \$ 10	3600 4500	20 STORM DOOR(S) 30 ECONOMICALLY JUSTIFIABLE AT THE PRESENT TIME				
DAYTIME WINTER THERMOSTAT SETTING IS CURRENTLY AT 60 DEGREES NIGHT THERMOSTAT SETTING IS CURRENTLY AT 55 DEGREES NIGHT							
SET WINTER THERMOSTAT AT 60 DEGREES NIGHT	FROM: \$ 20 TO: \$ 25	12300 19200	THERMOSTAT ADJUSTMENT IS A RECOMMENDED, NO COST ACTION				
SET WINTER THERMOSTAT AT 55 DEGREES NIGHT	FROM: \$ 35 TO: \$ 45	21100 26100	THERMOSTAT ADJUSTMENT IS A RECOMMENDED, NO COST ACTION				

RICHARD B HAYTER

PAGE 2

THE FOLLOWING INFORMATION IS A LISTING OF THE CHARACTERISTICS OF YOUR HOME TAKEN FROM YOUR QUESTIONNAIRE. THESE DATA WERE USED IN THE CALCULATION OF THE ABOVE ESTIMATES OF COSTS AND SAVINGS. AN ASTERISK (*) INDICATES THAT AN ASSUMED VALUE WAS USED, DUE TO AN INCOMPLETE QUESTIONNAIRE RESPONSE OR A POSSIBLE ERROR IN PROCESSING. IF THE INFORMATION PRESENTED BELOW DOES NOT APPEAR TO DESCRIBE YOUR HOME ACCURATELY YOU MAY WISH TO SUBMIT ANOTHER QUESTIONNAIRE.

GENERAL	ATTICS	DOORS
BUILT: BETWEEN 1921 - 1945	ATTIC OR CRAWL SPACE UNDER ROOF: YES	NO. OF DOORS: 3 DOUBLE WOOD
STYLE: TWO-STORY	ATTIC HEATED: NO	3 WOODEN
HEATING FUEL: NATURAL GAS	PRESENT INSULATION: 7-8 INCHES	4 WOOD & GLASS
HEATING SYSTEM LAST SERVICED: WITHIN 6 MONTHS	PRESENT INSULATION: BATTING	3 BUTCH DOOR
WINTER THERMOSTAT: DAYTIME 65 - 68 DEG.	ATTIC VENTILATED: YES	3 SLIDING GLASS DOOR
EVENING 65 - 68 DEG.	ATTIC FAN: NO	3 DOOR WITH VESTIBULE
NIGHT 65 - 68 DEG.	PERMANENT FLOORING INSTALLED: NO	
LIVING AREA: 1601 TO 2000 SQ. FT.	WINDOWS	NO. OF STORM DOORS 2
AIR CONDITIONED: YES - ELECTRIC CENTRAL	NO. OF WINDOWS: 22 DOUBLE HUNG	DOORS WITH AIR LEAKAGE: NONE
SUMMER THERMOSTAT: DAYTIME ABOVE 78 DEG.	4 TILTING	DOORS WEATHERSTRIPPED/CAULKED: ALL
NIGHT ABOVE 78 DEG.	4 CASHEMENT	
YEARLY FUEL COST: HEATING-\$ 350 COOLING-\$ 350	4 SLIDING PANE	
	4 PICTURE/BAY	
MAJOR APPLIANCES	STORM SASH UP DOUBLE GLAZING ON 22 WINDOWS	OTHER ENERGY CONSUMERS
COOKING STOVE: ELECTRICITY	WINDOWS RATTLE: NONE	COLOR TV SET: YES
OVEN: ELECTRICITY	WINDOWS WITH AIR LEAKAGE: NONE	OUTSIDE GAS LIGHT: NO
WATER HEATER: NATURAL GAS	WINDOWS WEATHERSTRIPPED/CAULKED: ALL	FROST FREE REFRIG.: NO
CLOTHES DRYER: ELECTRICITY		FROST FREE FREEZER: NO

 * PROJECT CONSERVE *

ENERGY CONSERVATION ALTERNATIVES
 FOR THE HOME OF

COMPARABLE NO 1
 OR CURRENT RESIDENT
 1925 FAULKNER AVE
 TOPEKA, KS 66604

ANALYSIS OF YOUR ANSWERS TO THE PROJECT CONSERVE QUESTIONNAIRE HAS INDICATED
 THAT YOU HAVE ALREADY TAKEN THE FOLLOWING ENERGY CONSERVING ACTIONS:

1. AVERAGE THERMOSTAT SETTING IS 67 DEGREES
2. 12 INCHES OF CEILING INSULATION
3. ALL POSSIBLE WINDOWS HAVE STORM WINDOWS
4. ALL POSSIBLE DOORS HAVE STORM DOORS
5. ADEQUATE WEATHER STRIPPING AND CAULKING AROUND DOORS AND WINDOWS

YOU HAVE TAKEN ALL THE MAJOR ENERGY CONSERVING ACTIONS WE WOULD
 RECOMMEND AT THIS TIME

COMPARABLE NO 1

PAGE 2

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 INCOMPLETE QUESTIONNAIRE RESPONSE OR A POSSIBLE ERROR IN PROCESSING. IF THE INFORMATION PRESENTED BELOW DOES NOT APPEAR TO
 DESCRIBE YOUR HOME ACCURATELY YOU MAY WISH TO SUBMIT ANOTHER QUESTIONNAIRE.

GENERAL	ATTICS	DOORS
BUILT: BETWEEN 1921 - 1945	ATTIC OR CRAWL SPACE UNDER ROOF: YES	NO. OF DOORS: 0 DOUBLE WOOD
STYLE: TWO-STORY	ATTIC HEATED: NO	0 WOODEN
HEATING FUEL: NATURAL GAS	PRESENT INSULATION: 9 OR MORE	3 WOOD & GLASS
HEATING SYSTEM LAST SERVICED: 6 MOS. TO 1 YEAR	PRESENT INSULATION: BATTING	0 DUTCH DOOR
WINTER THERMOSTAT: DAYTIME 65 - 68 DEG.	ATTIC VENTILATED: YES	0 SLIDING GLASS DOOR
EVENING 65 - 68 DEG.	ATTIC FAN: NO	0 DOOR WITH VESTIBULE
NIGHT 65 - 68 DEG.	PERMANENT FLOORING INSTALLED: NO	
LIVING AREA: 1601 TO 1800 SQ. FT.	WINDOWS	NO. OF STORM DOORS: 3
AIR CONDITIONED: YES - ELECTRIC CENTRAL	WOOD FRAME	DOORS WITH AIR LEAKAGE: NONE
SUMMER THERMOSTAT: DAYTIME 75 - 78 DEG.	NO. OF WINDOWS: 20 DOUBLE HUNG YES	DOORS WEATHERSTRIPPED/CAULKED: ALL
NIGHT 75 - 78 DEG.	0 TILTING	
YEARLY FUEL COST: HEATING-\$ 250 COOLING-\$ 250	0 CASEMENT	
	0 SLIDING PANE	
	0 PICTURE/BAY	
MAJOR APPLIANCES	OTHER ENERGY CONSUMERS	
COOKING STOVE: NATURAL GAS	COLOR TV SET: YES	
OVEN: NATURAL GAS	OUTSIDE GAS LIGHT: NO	
WATER HEATER: NATURAL GAS	FROST FREE REFRIG.: NO	
CLOTHES DRYER: ELECTRICITY	FROST FREE FREEZER: NO	
	STORM SASH OR DOUBLE GLAZING ON 20 WINDOWS	
	WINDOWS RATTLE: NONE	
	WINDOWS WITH AIR LEAKAGE: NONE	
	WINDOWS WEATHERSTRIPPED/CAULKED: ALL	

 * PROJECT CONSERVE *

ENERGY CONSERVATION ALTERNATIVES
 FOR THE HOME OF

COMPARABLE NO 2
 OR CURRENT RESIDENT
 1425 KIRKENHALL ST
 TOPEKA , KS 66604

THE COSTS AND SAVINGS SHOWN BELOW ARE ESTIMATES. SAVINGS WILL VARY WITH COSTS OF FUEL AND SEVERITY OF THE WEATHER. COSTS WILL VARY WITH THE TYPE AND QUALITY OF MATERIALS AND THE CONSTRUCTION OF YOUR HOME.

ENERGY CONSERVING ACTION		ANNUAL DOLLAR SAVINGS (CURRENT PRICES)	VOLUME OF FUEL SAVED WINTER SUMMER (CUFT)	COST ESTIMATES BASED ON	ESTIMATED COSTS	YEARS TO RECOVER INVESTMENT	YIELD ON INVESTMENT PRESENT WITH COSTS	INFLATION
INSTALL STORM WINDOWS ON ALL WINDOWS	FROM: \$ 85 TO: \$ 105	43400 93600		DO-IT-YOURSELF \$ 220 TO \$ 440 CONTRACTOR \$ 305 TO \$ 510	4.2 4.9	23.0% 20.0%	27.0% 23.9%	
INSTALL 3-4 INCHES (R-11) MORE CEILING INSULATION	FROM: \$ 20 TO: \$ 25	10800 13300		DO-IT-YOURSELF \$ 95 TO \$ 105 CONTRACTOR \$ 160 TO \$ 225	4.0 8.6	24.3% 10.0%	26.1% 13.9%	
INSTALL 5-7 INCHES (R-19) MORE CEILING INSULATION	FROM: \$ 25 TO: \$ 30	13100 16200		DO-IT-YOURSELF \$ 150 TO \$ 185 CONTRACTOR \$ 210 TO \$ 290	5.4 9.1	16.3% 9.0%	20.2% 13.4%	
INSTALL 7-9 INCHES (R-22) MORE CEILING INSULATION	FROM: \$ 25 TO: \$ 35	13700 16900		DO-IT-YOURSELF \$ 190 TO \$ 210 CONTRACTOR \$ 240 TO \$ 335	6.3 10.2	13.0% 7.5%	18.6% 11.3%	
INSTALL WEATHERSTRIPPING/CAULKING ON DOORS/WINDOWS	FROM: \$ 50 TO: \$ 60	25000 30800		DO-IT-YOURSELF \$ 30 TO \$ 55	0.9	>100.0%	>100.0%	
INSTALL STORM DOORS ON ALL DOORS	FROM: \$ 20 TO: \$ 25	11100 13800		STORM DOOR(S) WOULD SAVE ENERGY BUT WOULD NOT BE ECONOMICALLY JUSTIFIABLE AT THE PRESENT TIME				
SET WINTER THERMOSTAT AT 68 DEG DAY/EVE, 60 DEG NIGHT	FROM: \$ 30 TO: \$ 35	14600 18000		THERMOSTAT ADJUSTMENT IS A RECOMMENDED, NO COST ACTION				
SET WINTER THERMOSTAT AT 68 DEG DAY/EVE, 55 DEG NIGHT	FROM: \$ 45 TO: \$ 55	22100 27200		THERMOSTAT ADJUSTMENT IS A RECOMMENDED, NO COST ACTION				
HEATING SYSTEM SHOULD BE SERVICED REGULARLY.								

HEATING SYSTEM SHOULD BE SERVICED REGULARLY.

COMPARABLE NO 2

PAGE 2

THE FOLLOWING INFORMATION IS A LISTING OF THE CHARACTERISTICS OF YOUR HOME TAKEN FROM YOUR QUESTIONNAIRE. THESE DATA WERE USED IN THE CALCULATION OF THE ABOVE ESTIMATES OF COSTS AND SAVINGS. AN ASTERISK (*) INDICATES THAT AN ASSURED VALUE WAS USED, DUE TO AN INCOMPLETE QUESTIONNAIRE RESPONSE OR A POSSIBLE ERROR IN PROCESSING. IF THE INFORMATION PRESENTED BELOW DOES NOT APPEAR TO DESCRIBE YOUR HOME ACCURATELY YOU MAY WISH TO SUBMIT ANOTHER QUESTIONNAIRE.

GENERAL	ATTICS	DOORS
BUILT: BETWEEN 1921 - 1949	ATTIC OR CRAWL SPACE UNDER ROOF: YES	NO. OF DOORS: 0 DOUBLE WOOD
STYLE: TWO-STORY	ATTIC HEATED: NO	0 WOODEN
HEATING FUEL: NATURAL GAS	PRESENT INSULATION: NONE	2 WOOD & GLASS
HEATING SYSTEM LAST SERVICED: MORE THAN 2 YRS.	*PRESENT INSULATION: NONE	0 DUTCH DOOR
WINTER THERMOSTAT: DAYTIME 65 - 68 DEG.	ATTIC VENTILATED: YES	0 SLIDING GLASS DOOR
EVENING 69 - 75 DEG.	ATTIC FAN: NO	0 DOOR WITH VESTIBULE
NIGHT 65 - 68 DEG.	PERMANENT FLOORING INSTALLED: NO	
LIVING AREA: 1401 TO 1600 SQ. FT.	WINDOWS	NO. OF STORM DOORS 0
AIR CONDITIONED: NO - NONE	NO. OF WINDOWS: 17 DOUBLE HUNG WOOD FRAME YES	DOORS WITH AIR LEAKAGE: ALL
SUMMER THERMOSTAT: DAYTIME DEG.	0 TILTING	DOORS WEATHERSTRIPPED/CAULKED: NONE
NIGHT DEG.	0 CASERENT	
YEARLY FUEL COST: HEATING-\$ 350 COOLING-\$ 0	0 SLIDING PANE	
	0 PICTURE/BAY	
MAJOR APPLIANCES		OTHER ENERGY CONSUMERS
COOKING STOVE: ELECTRICITY	STORM SASH OR DOUBLE GLAZING ON 0 WINDOWS	COLOR TV SET: YES
OVEN: ELECTRICITY	WINDOWS RATTLE: ALL	OUTSIDE GAS LIGHT: NO
WATER HEATER: NATURAL GAS	WINDOWS WITH AIR LEAKAGE: ALL	FROST FREE REFRIG.: NO
CLOTHES DRYER: ELECTRICITY	WINDOWS WEATHERSTRIPPED/CAULKED: NONE	FROST FREE FREEZER: NO

 * PROJECT CONSERVE *

ENERGY CONSERVATION ALTERNATIVES
 FOR THE HOME OF

COMPARABLE NO 3
 OR CURRENT RESIDENT
 1307 SCHVOK DRIVE
 TOPEKA, KS 66604

THE COSTS AND SAVINGS SHOWN BELOW ARE ESTIMATES. SAVINGS WILL VARY WITH COSTS OF FUEL AND SEVERITY OF THE WEATHER. COSTS WILL VARY WITH THE TYPE AND QUALITY OF MATERIALS AND THE CONSTRUCTION OF YOUR HOME.

ENERGY CONSERVING ACTION	ANNUAL DOLLAR SAVINGS (CURRENT PRICES)	VOLUME OF FUEL SAVED WINTER (CUFT) SUMMER (KWHR)	COST ESTIMATES BASED ON:	ESTIMATED COSTS	YEARS TO RECOVER INVESTMENT	YIELD ON INVESTMENT PRESENT COSTS	WITH INFLATION
INSTALL STORM WINDOWS ON ALL WINDOWS	FROM: \$ 100 TO: \$ 125	45500 56200	350 430	DO-IT-YOURSELF \$ 210 TO \$ 415 CONTRACTOR \$ 290 TO \$ 480	3.3 3.8	30.0%	33.9%
INSTALL 3-4 INCHES (R-11) MORE CEILING INSULATION	FROM: \$ 30 TO: \$ 40	10600 13000	260 330	DO-IT-YOURSELF \$ 85 TO \$ 90 CONTRACTOR \$ 140 TO \$ 195	2.4 5.1	42.0%	44.9%
INSTALL 5-7 INCHES (R-19) MORE CEILING INSULATION	FROM: \$ 40 TO: \$ 45	12800 15900	320 400	DO-IT-YOURSELF \$ 135 TO \$ 160 CONTRACTOR \$ 180 TO \$ 250	3.5 5.4	29.0%	32.3%
INSTALL 7-9 INCHES (R-22) MORE CEILING INSULATION	FROM: \$ 40 TO: \$ 50	13400 16500	330 410	DO-IT-YOURSELF \$ 170 TO \$ 180 CONTRACTOR \$ 210 TO \$ 295	3.7 6.1	26.5%	30.2%
INSTALL WEATHERSTRIPPING/CAULKING ON DOORS/WINDOWS	FROM: \$ 70 TO: \$ 85	26800 33100	430 540	DO-IT-YOURSELF \$ 30 TO \$ 55	0.6	>100.0%	>100.0%
INSTALL STORM DOORS ON ALL DOORS	FROM: \$ 30 TO: \$ 40	12500 15400	170 210	STORM DOORS: WOULD SAVE ENERGY BUT WOULD NOT BE ECONOMICALLY JUSTIFIABLE AT THE PRESENT TIME			
SET WINTER THERMOSTAT AT 48 DEG DAY/EVE, 60 DEG NIGHT	FROM: \$ 65 TO: \$ 80	32300 39900		THERMOSTAT ADJUSTMENT IS A RECOMMENDED, NO COST ACTION			
SET WINTER THERMOSTAT AT 60 DEG DAY/EVE, 55 DEG NIGHT	FROM: \$ 80 TO: \$ 95	40400 49900		THERMOSTAT ADJUSTMENT IS A RECOMMENDED, NO COST ACTION			

HEATING SYSTEM SHOULD BE SERVICED REGULARLY.

COMPARABLE NO 3

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THE FOLLOWING INFORMATION IS A LISTING OF THE CHARACTERISTICS OF YOUR HOME TAKEN FROM YOUR QUESTIONNAIRE. THESE DATA WERE USED IN THE CALCULATION OF THE ABOVE ESTIMATES OF COSTS AND SAVINGS. AN ASTERISK (*) INDICATES THAT AN ASSUMED VALUE WAS USED, DUE TO AN INCOMPLETE QUESTIONNAIRE RESPONSE OR A POSSIBLE ERROR IN PROCESSING. IF THE INFORMATION PRESENTED BELOW DOES NOT APPEAR TO DESCRIBE YOUR HOME ACCURATELY YOU MAY WISH TO SUBMIT ANOTHER QUESTIONNAIRE.

GENERAL BUILT: BETWEEN 1921 - 1945 STYLE: TWO-STORY HEATING FUEL: NATURAL GAS HEATING SYSTEM LAST SERVICED: NOT SERVICED WINTER THERMOSTAT: DAYTIME 69 - 75 DEG. EVENING 69 - 75 DEG. NIGHT 69 - 75 DEG. LIVING AREA: 1201 TO 1400 SQ. FT. AIR CONDITIONED: YES - ELECTRIC CENTRAL SUMMER THERMOSTAT: DAYTIME 71 - 74 DEG. NIGHT 71 - 74 DEG. YEARLY FUEL COST: HEATING-\$ 450 COOLING-\$ 450 MAJOR APPLIANCES COOKING STOVE: NATURAL GAS OVEN: NATURAL GAS WATER HEATER: NATURAL GAS CLOTHES DRYER: ELECTRICITY	ATTICS ATTIC OR CRAWL SPACE UNDER ROOF: YES ATTIC HEATED: NO PRESENT INSULATION: NONE PRESENT INSULATION: NONE ATTIC VENTILATED: YES ATTIC FAN: NO PERMANENT FLOORING INSTALLED: NO WINDOWS NO. OF WINDOWS: 16 DOUBLE HUNG YES 0 TILTING 0 CASEMENT 0 SLIDING PANE 0 PICTURE/BAY STORM CASH OR OTHER GLAZING ON 0 WINDOWS WINDOWS RATTLE: ALL WINDOWS WITH AIR LEAKAGE: ALL WINDOWS WEATHERSTRIPPED/CAULKED: NONE	DOORS NO. OF DOORS: 0 DOUBLE WOOD 0 WOODEN 2 WOOD & GLASS 0 DUTCH DOOR 0 SLIDING GLASS DOOR 0 DOOR WITH VESTIBULE NO. OF STORM DOORS 0 DOORS WITH AIR LEAKAGE: ALL DOORS WEATHERSTRIPPED/CAULKED: NONE OTHER ENERGY CONSUMERS COLOR TV SET: YES OUTSIDE GAS LIGHT: NO FROST FREE REFRIG.: NO FROST FREE FREEZER: NO
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How to Finance Your Home & Apartment Improvements

To carry out your energy conservation plan, you may require financial assistance. There are various sources from which you may be able to qualify for a loan or grant.

<u>TALK TO</u>	<u>AVAILABLE FINANCING</u>	<u>TERMS</u>	<u>TAX CREDITS & CHANGES</u>
1) Your Utility Company.	Energy Conservation Plan Financed amount: <u>Minimum loan</u> <u>Maximum loan</u> \$200 per eligible customer. \$1,500 single family home. \$2,500 two family home. \$3,000 three family home.	Varies, but term generally ranges between 1 & 7 yrs.	15% to first \$2,000 of expenditure (\$300). Residence in existence as of 4/20/77 & equipment installed as of that date to 12/31/85.
NOTE: Installation of approved energy conservation measure must provide an estimated payback period of 8 years or less.			
2) Community Action Program (CAP) Agency.	Community Services Administration (CSA). Winterization Program for low income families. Maximum grant: \$350. Department of Energy (DOE) Winterization Program for low income families. Maximum grant: \$400 to be used exclusively for materials.	Grants - no repayment. Grants - no repayment.	To be processed through (DOE) Winterization Program. Under \$400 material cost. Community Services Adm. (CSA) omitted. Grant increased to \$800 per unit (owner or tenant occupied).
3) Farmer's Home Administration	Weatherization Program for rural families. Maximum loan: \$1,500 from Farmer's Home Adm. Grant 504-Winterization Program for rural senior citizens. Maximum grant or loan is \$5,000.	5 years. Loan varies. Grant requires no repayment.	Same tax credit as #1 above.
4) Commercial, Savings/Loan, or Mutual Savings Bank.	1. Home Improvement loan. 2. FHA/HUD Title I loan. NOTE: The maximum permissible amount that can be borrowed under Title I is \$10,000. Terms of Home Improvement Loans & HUD Title I loans are similar. Title I loans are guaranteed to the lender.	Varies, up to 10 years.	Same tax credit as #1 above.
5) Your Credit Union.	Depends on the Credit Union, but usually includes Title I loans. See above.	Repayment time varies with type of loan.	Same tax credit as #1 above.
6) Any of the above.	Government National Mortgage Association (GNMA). Solar purchase/installation. Maximum loan \$8,000 per unit.	Fifteen (15) yrs.	30% to first \$2,000 of expenditure (\$600). 20% over \$2,000 to \$10,000 of expenditure. Maximum credit \$2,200. Program available to 1983.

These figures may vary from year to year. Contact the organization that administers the grants or loans for detailed information. Even if you don't get your loan or grant, you may be eligible for a tax credit for conservation measures you use in your home. Contact your local Internal Revenue Service

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

WASHINGTON, D.C. 20410
November 23, 1979

OFFICE OF THE ASSISTANT SECRETARY FOR
HOUSING—FEDERAL HOUSING COMMISSIONER

IN REPLY REFER TO:

Mortgagee Letter 79-37

TO : ALL HUD APPROVED MORTGAGEES

SUBJECT: Solar Energy Increase in Dollar Limitation

To encourage the use of solar energy in homes, HUD received legislation to allow an increase of up to 20 percent in the maximum insurable mortgage amount if such an increase is necessary for residences in which solar energy equipment has been installed. HUD regulations have been changed to permit an increase in the maximum dollar limitations from \$60,000 to \$72,000 for Sections 203(b), 203(n), 233, 244, 245, and 809, and from \$45,000 up to \$54,000 for Section 203(i) when the increase is directly attributable to the cost and installation of the solar energy system in the property. Applicable mortgage amounts for two-, three-, and four-unit dwellings are appropriately affected. For two- and three-unit dwellings, the increased amount is from \$65,000 to \$78,000 and for a four-unit dwelling, the increase is from \$75,000 to \$90,000. The interim rule was published August 9, 1979 and effective September 26, 1979.

An eligible solar energy system is defined as any addition, alteration or improvement to an existing or new structure which is designed to utilize wind or solar energy to reduce energy requirements obtained from other sources. Solar heating and domestic hot water systems are not acceptable without operational 100 percent back-up conventional systems. Active and passive solar energy systems are permitted in this program. The systems must comply with HUD Handbook 4930.2, Intermediate Minimum Property Standards for Solar Heating and Domestic Hot Water Systems. Descriptions of various types of active and passive solar systems are included in Appendix C of these standards.

The solar energy system's contribution to value will be limited by its replacement cost or by its effect on the market price of the dwelling.

In the event that market data is not available to indicate the additional amount which would be paid for a property containing a solar energy system, the amount of increase would be the lesser of the actual cost of the solar system installed in the subject house or 20 percent of the market value of the property. The difference in added value contributed by the solar system in comparison to the conventional system must represent a reasonable

proportion of the total value of the property and may never exceed 20 percent of the market value of the property without a solar energy system. Instructions to this effect are included in HUD Handbook 4150.1, Valuation Analysis for Home Mortgage Insurance.

The following steps set forth the procedure which will be utilized in determining the applicability of the new authorization:

- (1) Value of property without a solar system is estimated.
- (2) The cost of the solar system is determined (the amount allowed cannot exceed 20 percent of the value of the house without a solar system).
- (3) The estimate of value of the property is increased by the amount established in Step 2. Estimated closing costs are then included.
- (4) The appropriate loan-to-value ratio is applied to the total of the estimate of value plus estimate of closing costs. If the mortgage amount is \$60,000 or less, the new authority to increase the dollar limitation is not applicable.
- (5) If the mortgage amount is greater than \$60,000, the portion of the mortgage amount above \$60,000 must be directly attributable to the total cost of the solar system, i.e., the increase above \$60,000 must be equal to or less than the cost of the solar system.....
- (6) Under no circumstances can the increased mortgage amount, even if supported by the actual cost of the solar system, exceed 20 percent of the \$60,000 dollar limitation for a one-unit dwelling or \$72,000.

This procedure, as well as the procedure in determining the maximum mortgage amount, is utilized in the following examples of a Section 203(b) case:

Examples: A property has a \$40,000 market value without a solar energy system. Assume that a solar energy system costs \$9,600. The adjustment for solar heating would be the lesser of the difference in the cost of solar heating equipment (\$9,600) or 20 percent of the market value of the subject property without solar heating (20 percent X \$40,000 = \$8,000). The estimated market value of the

subject property with solar energy would be \$48,000 (\$40,000 + 8,000). Assume closing costs of \$1,500. The loan-to-value ratio would then be applied to \$49,500 to arrive at a mortgage amount of \$47,500. Since a mortgage amount of less than \$60,000 is involved, the new regulatory change allowing for an increase in the maximum dollar limitation would not apply to this example.

In a second example, retain all the above assumptions, and change the market value of the property (without solar heating) to \$70,000. The adjustment for the solar system would be the lesser of the difference in the cost of the solar heating system (\$9,600) or 20 percent of the market value of subject property without solar energy (20 percent X \$70,000 = \$14,000). The estimated market value of the subject property with solar energy would be \$79,600 (\$70,000 + \$9,600). The loan-to-value ratio would then be applied against this value plus closing costs (\$1,500) to arrive at an amount of \$77,500. Since only \$9,600 can be attributed to the solar system, the mortgage amount is limited to \$69,600. Only \$9,600 of the value above \$60,000 can be added to the \$60,000 dollar limitation since that is the amount necessary to accommodate the installation of the solar equipment. Because the new authority only provides for an increase of up to 20 percent of existing limits, the maximum mortgage amount on any one-unit single family dwelling could never exceed \$72,000.

Basing the adjustment on differences in cost shall be discontinued when sufficient market data has been accumulated to demonstrate those additional amounts typically paid in market prices for solar energy systems of various capacities and types. Thereafter, adjustments to value shall be based on differences observed in the housing market. Once this occurs, the increase above \$60,000 for the mortgage amount, when the value of the property with the solar system is based on market comparisons, cannot exceed the difference between the value of the property with a solar system and the value of that same property without a solar system. This restriction corresponds to that set forth in Step 5 when value is based on cost estimates of the solar system and not by market comparison.

Example: Assume an estimate of value for a property with a solar system of \$70,000. For the same property without the solar system, assume an estimate of value of \$65,000.

Also, assume the cost of the solar system is \$7,000. The maximum insurable mortgage amount would be \$65,000. To calculate the mortgage amount, the first step is to apply the loan-to-value ratio to the estimate of value plus closing costs, \$71,500 (\$70,000 + \$1,500), giving a maximum mortgage of \$68,400. However, based on market comparisons, the value is only increased by \$5,000. Accordingly, the mortgage amount above \$60,000 is limited to what the market attributes to the value of the solar system, i.e., \$5,000, not the cost of the solar system, \$7,000.

If a Veterans Administration Certificate of Reasonable Value is involved and a solar system is included, the value established on the CRV will reflect the presence of the solar system. If the mortgagee requests a mortgage based on the solar system which exceeds the \$60,000 limitation, it is the responsibility of the mortgagee to secure from the local VA office a copy of the Residential Appraisal Report on the property, VA Form 26-1803, and submit it with the VA CRV. This form will enable the local HUD office to determine the incremental increase in the value of the property added by the solar system. Once the increase has been identified by the HUD office, the aforementioned procedure for determining the maximum mortgage amount would govern. It is appropriate to note that in arriving at the VA established reasonable value of a property with a solar system, the amount the solar system increases the value is based on market comparisons and not on the actual cost of the solar system.

Sincerely,

Lawrence B. Simons
Assistant Secretary

GPO 863 225

U.S. Department of Housing and Urban Development
Washington, D.C. 20410

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