Nebraska Public Buildings Energy Program

Energy Calculation Handbook

Table of Contents

Page Number

Evaluating Your Current Energy Consumption

INSTRUCTIONS

Before choosing building improvements to save energy and dollars, you should study your past fuel and electric bills to see how effectively you are presently using energy. Gather together your energy bills for the past twelve months. If you don't have these bills, contact your fuel and/or electric supplier for copies.

Worksheet One and your collected energy bills will help you evaluate your current energy use. Copy the information concerning fuel units, kilowatt hours, and costs for each of the past twelve months from your bills to the blanks provided on Worksheet One. Complete the simple calculations using Table 1.

Table 1: Heating Value

Heating Fuel	Heating Value
Electricity (KWH)	0.003413
Natural Gas (ccf, hcf, or therms)	0.1
Natural Gas (mcf)	1.0
Propane LPG (gal)	0.095
Fuel Oil (gal)	0.14

Once you have completed your calculations, look carefully at your "Comparison to Average" figure. If it is below 60%, your building is using below-average amounts of energy. There may still be some excellent dollar and energy-saving opportunities in your building, but the savings from such opportunities may be less than expected due to the building's low energy use.

If your "Comparison to Average" figure is over 150%, your building is probably using excessive amounts of energy. Many of the projects in this book could help you save energy; however, there may be basic design needs in your building or its mechanical or control systems which are beyond the scope of this book. You may need to employ professional assistance to evaluate your energy conservation opportunities.

If your "Comparison to Average" figure is near 100%, your building is about average. There are a number of building improvements that will save you dollars and energy. The rest of this book will help you identify and evaluate some of these improvements.

Evaluating Your Current Energy Consumption

WORKSHEET ONE

Current Energy Use For Building: ____________
Heating Fuel

Fuel: ________________________ **Electricity**

Fuel Units	Cost		KWH	Cost
		Jan.		
		Feb.		
		March		
		April		
		May		
		June		
		July		
		Aug.		
		Sept.		
		Oct.		
		Nov.		
		Dec.		
		TOTAL		

[ ] Total Heating Fuel Units	X	[ ] Heating Value	=	[ ] Heating Energy
[ ] Total Electric KWH	X	**0.003413**	=	[ ] Electric Energy
[ ] Heating Energy	+	[ ] Electric Energy	=	[ ] Total Energy (mBTU/Year)
[ ] Total Energy	÷	[ ] Sq. ft. of Floor Area	=	[ ] Energy Use Index (mBTU/ Sq. ft. Year)
[ ] Energy Use Index	X	**893** Comparison to Average	=	[ ] %

Correction Factors and Costs

INSTRUCTIONS

This book was designed to help you identify and evaluate a variety of energy-saving building improvements. Before you study these building improvements, please complete Worksheet Two. You will need the results of this worksheet to evaluate many of the projects described in this book. Worksheet Two will help you make more accurate evaluations by accounting for the climate in your area as well as the thermostat setting and heating unit in your building.

Climate: Find the county in which your building is located on the state map and copy the number given for that county into the Climate Correction Factor box on Worksheet Two. For example, if your building is located in Cherry County, copy the number "1.09" into the Climate Correction Factor box on Worksheet Two.

Setback: Locate the row and column in Table 2 which best describes the way your building is operated. Copy that number into the Setback Factor box on Worksheet 2. For example, if your building is occupied for 40 hours per week and the unoccupied temperature in the building is 60 degrees, copy "0.99" in the Setback Factor box.

Efficiency: Locate the type of heating unit used in your building on Table 3. Copy the factor for your heating system in the Efficiency Factor Box on Worksheet Two. For example, if your building uses a coal boiler converted to gas or gas and oil, your efficiency factor is 1.27. Now, complete the calculations on Worksheet Two. You will refer to your results later.

Correction Factors for Worksheet Two

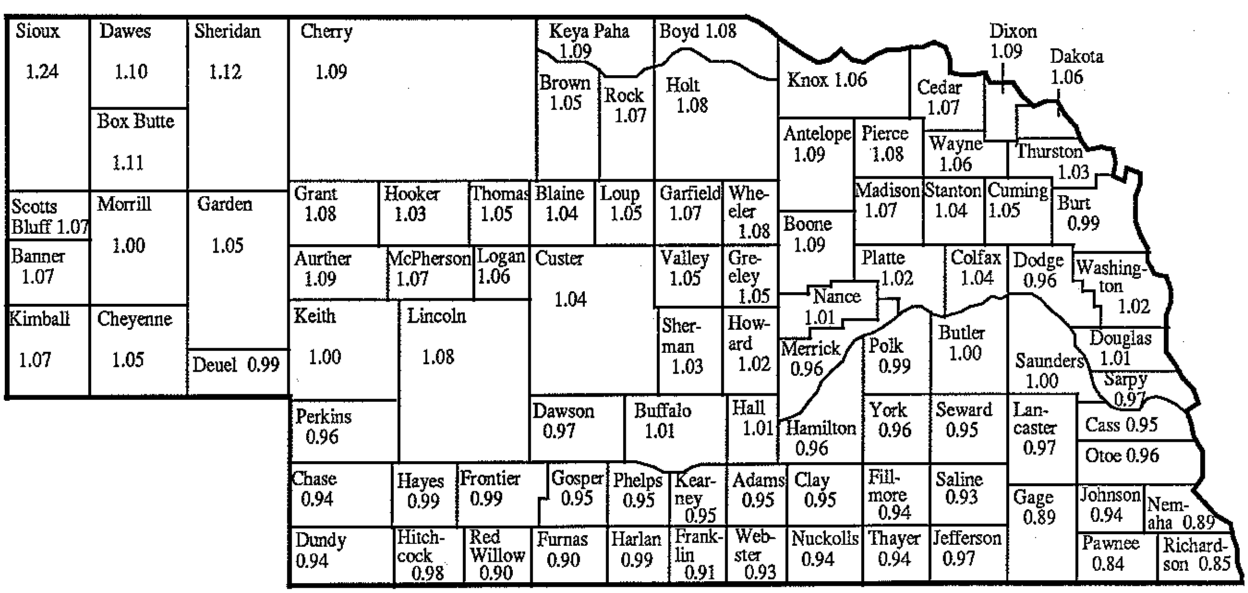
Table 2: Setback Factor

Thermostat Setback Temp.		Occupied Hours Per Week					
		20	30	40	50	60	70
No Setback		1.20	1.20	1.20	1.20	1.20	1.20
Unoccupied Temp	64	1.07	1.08	1.10	1.11	1.11	1.12
	60	0.95	0.96	0.99	1.00	1.02	1.04
	56	0.82	0.84	0.88	0.90	0.93	0.95

Table 3: Efficiency Factor

Heating Unit	Factor
Electric boiler, furnace baseboard etc.	0.70
High efficiency natural gas or LPG forced-air furnace	0.78
Standard natural gas or LPG forced-air furnace	1.00
Natural Gas, LPG or gas/oil burner	1.08
Oil boiler or furnace, or oil converted to gas	1.17
Coal boiler converted to gas or gas/oil	1.27

Figure 1. Climate Factor by County



Correction Factors and Costs

WORKSHEET TWO

Heating Correction Factor and Costs

Building ______________________________

[ ]	X	[ ]	X	[ ]	=	[ ]
Correction Factor		Setback Factor		Efficiency Factor		Heating Correction Factor

Fuel Cost

[ ]	÷	[ ]	=	[$]
Total Heating Fuel Cost (Worksheet One)		Heating Energy (Worksheet One)		Fuel Cost/ mBTUs

Power Cost

[$]	÷	[ ]	=	[$]
Total Electric Cost (Worksheet one)		Total Electric KWH		Electric Power Cost/KWH

Thermostat Setback

INSTRUCTIONS

The greater the difference between the temperature inside your building and the temperature outside, the more it costs to maintain a comfortable indoor climate. A small change in your thermostat setting can mean a big change in your dollar and energy savings--without discomfort for building occupants.

In most buildings, simply turning down the thermostat when the building is unoccupied is one of the easiest, most cost-effective energy conservation measures. Even if you currently setback your thermostat, you may be able to save even more by setting back a few more degrees. Or, you may increase your savings by decreasing the number of hours your building is occupied. For example, you might begin performing maintenance and custodial tasks during the time that the building is already occupied by other people.

You can manually turn down your thermostat or you can use a programmable clock-thermostat to do the job. There is no difference in savings. If your building is used on a predictable schedule, a programmable thermostat may be advantageous. It can begin warming the building before occupants arrive, ensuring their comfort. And, a programmable thermostat never forgets to set the temperature back after people have left the building. On the other hand, if a reliable person manages the thermostat setback, it is much cheaper to let them continue.

Calculating Your Savings

Use the table below to complete the calculations on Worksheet Three.

Table 4: Setback Factor

Thermostat Setback Temp.		Occupied Hours Per Week 20	30	40	50	60	70
No Setback		1.0	1.0	1.0	1.0	1.0	1.0
Thermostat Setting	64	.89	.90	.91	.92	.92	.93
	60	.79	.80	.82	.83	.85	.86
	56	.68	.70	.73	.75	.77	.79

Comments and Cautions

Some people argue that setting back the thermostat allows buildings to get too cold--that it takes more energy to warm the building again than was saved by the setback. This is not true, except in buildings heated by electric heat pumps. In all other buildings, you simply need to ensure that the lower setback temperature is not harmful to building contents or plumbing.

Thermostat Setback

WORKSHEET THREE

Building ______________________ **Area** ______________________

By ______________________ **Date** ______________________

Description of existing conditions and proposed setback project

Existing Conditions: ______________________

____

____

____

____

Proposed Project: ______________________

____

____

____

Energy and Cost Savings

[ ] ÷ [ ] = [ ]

New Setback Factor (Table 4) ÷ Old Setback Factor (Table 4) = Setback Change

1.0 – [ ] = [ ]

1.0 – Setback Change = Setback Savings

[ ] X [ ] = [ ]

Total Heating Energy (Worksheet One) X Setback Savings = Energy Savings mBTU/Year

[ ] X [ ] = [$]

Energy Savings X Fuel Cost (Worksheet One) = Cost Savings Per Year

Economic Analysis

[$] ÷ [$] = [ ]

Project Cost ÷ Cost Savings = Simple Payback in Years

Energy Savings From Insulating Roof or Ceiling

INSTRUCTIONS

Insulation is one of the best-known and most basic energy-saving measures. All materials resist the flow of heat, but some resist it much more than others. These materials are insulators. Usually, they are lightweight, porous materials which are added to roofs, walls, and ceilings to form a blanket around the building.

Normally, it makes good sense to insulate uninsulated parts of your building before adding to parts already insulated. In addition to reducing heat loss, insulation makes the people in your building more comfortable. Interior surfaces of walls and ceilings stay warmer, and it takes less time to warm the building to a comfortable temperature after night setback.

Calculating Your Savings

The steps for calculating the annual energy and cost savings which you could realize from insulating a roof or ceiling are found on Worksheet Four.

First, measure the portion of the roof or ceiling to be insulated. Exclude parts of the roof extending over unheated areas, such as porches or overhangs. Calculate the area in square feet and record the square footage in the Area to be Insulated box on Worksheet Four.

Next, locate the chart from Table 5, 6, or 7 which best describes your roof or ceiling. Find the row and column corresponding to your proposed project and copy the table entry into the Energy Conservation Value box on Worksheet Four. For example, if your building has a wood roof deck with a ceiling but is not currently insulated and you plan to add two inches of insulation, your Energy Conservation Value is .0297. If your building has a metal roof with one inch of spray-on insulation and you plan to add another two inches of spray-on insulation, your Energy Conservation Value is .0190.

Complete the calculations on Worksheet Four to estimate your savings.

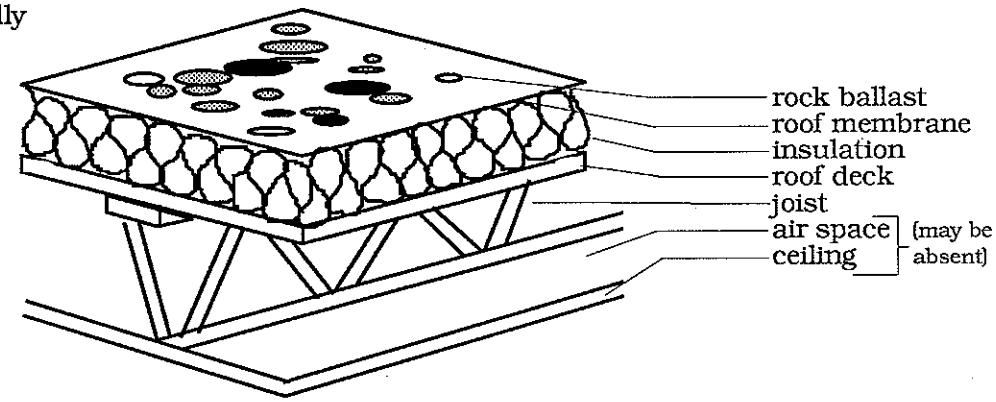
Comments and Cautions

Make sure that there is adequate ventilation above an insulated ceiling. One square foot of ventilation area for every 150 square feet of ceiling area is recommended.

Usually the roof must be replaced when a built-up roof is insulated, so it is normally recommended to insulate such roofs only when a new roof is necessary. This reduces the cost to a reasonable value.

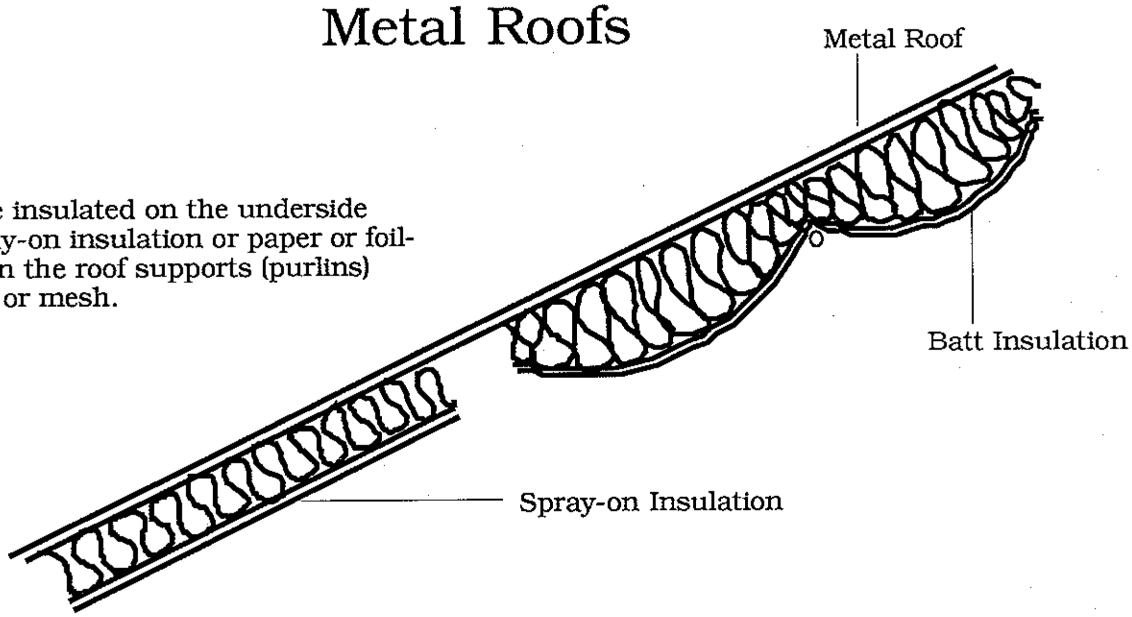
Built Up Roofs

Flat built-up roofs are usually insulated with rigid foam or plastic boards laid on the roof deck. A waterproof membrane--typically tar or asphalt--is applied over the insulation boards to protect them from water damage. New insulation (usually a smooth-skin polystyrene) may be added before a new roof is installed.



Metal Roofs

Metal roofs may be insulated on the underside using either a spray-on insulation or paper or foil-faced batts between the roof supports (purlins) supported by rods or mesh.



Ceilings

Ceilings are usually insulated with batts or loose-fill insulation which is blown or poured-in. The attic space over the insulation must be ventilated to prevent moisture buildup.

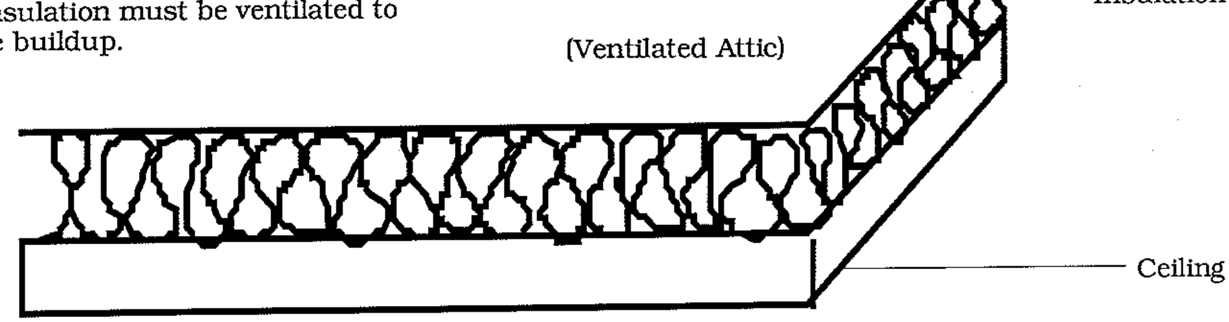


Table 5: Energy Conservation Values for Built Up Roofs

Roof/Ceiling Construction	Currently No Insulation; Add ... 1"	2"	3"	4"
Wood Deck No Ceiling	.0497	.0575	.0608	.0625
Wood Deck With Ceiling or Concrete Deck Without Ceiling	.0239	.0297	.0324	.0340
Concrete Deck With Ceiling	.0143	.0190	.0212	.0226

Roof/Ceiling Construction	Currently 1" of Fiberboard Insulation; Add Another ... 1"	2"	3"
Wood Deck No Ceiling	.0139	.0185	.0207
Wood Deck With Ceiling or Concrete Deck Without Ceiling	.0094	.0130	.0150
Concrete Deck With Ceiling	.0069	.0098	.0114

Roof/Ceiling Construction	Currently 1" of Fiberboard Insulation; Replace With New ... 2"	3"	4"
Wood Deck No Ceiling	.0163	.0197	.0212
Wood Deck With Ceiling or Concrete Deck Without Ceiling	.0113	.0139	.0155
Concrete Deck With Ceiling	.0084	.0106	.0120

Table 6: Energy Conservation Values for Metal Roofs

Currently Uninsulated; Add ...						
Batt Insulation			Spray-on Insulation			
3 1/2"	6 1/2"	8 1/2"	1"	2"	3"	4'
.1372	.1427	.1456	.1200	.1337	.1390	.1418

Currently 1" Spray-on Insulation; Add Another...		
1"	2"	3"
.0137	.0190	.0218

Table 7: Energy Conservation Values for Ceiling Insulation

Ceiling Construction	Currently Uninsulated; Add ... Batt Insulation 3 1/2"	6 1/2"	8 1/2"
Plaster or Drywall	.0677	.0717	.0739
Accoustic Tile	.0378	.0413	.0434

Ceiling Construction	Currently Uninsulated; Add ... Loose-fill Insulation 4"	8"	10"
Plaster or Drywall	.0692	.0734	.0743
Accoustic Tile	.0391	.0429	.0437

Ceiling Construction	Currently 1"- 2" Insulation; Add ...			
	Batt Insulation		Loose-fill Insulation	
	3 1/2"	6 1/2"	4"	8"
Plaster or Drywall	.0153	.0179	.0163	.0181
Accoustic Tile	.0121	.0144	.0129	.0145

Energy Savings From Insulating Roof or Ceiling

WORKSHEET FOUR

Building ______________________ **Area** ______________________

By ______________________ **Date** ______________________

Sketch of Area to be Insulated (with dimensions)

Description of Existing Conditions and Proposed Insulation Project

Existing Conditions:

Proposed Insulation Project:

Energy Savings

Area (sq. ft.)	X	Energy Conservation Value (from Table 5, 6, or 7	X	Heating Correction Factor (Worksheet Two)	=	Energy Savings mBTU/Year

Cost Savings

Energy Savings	X	Fuel Cost/mBTU (Worksheet Two)	=	$ Cost Savings (per year)

Economic Analysis

$ Project Cost (see pg. D-33)	÷	$ Cost Savings	=	Simple Payback in Years

Energy Savings from Insulating Walls

INSTRUCTIONS

Like roof insulation, wall insulation forms a blanket around your building, resisting the loss of heat from the building and keeping the interior warm at less cost.

Frame (wood) walls are usually insulated by blowing loose insulation into the cavities in the wall through small holes. The holes are covered or plugged when the job is finished.

Walls of metal buildings may be insulated by attaching paper or foil-faced batt insulation, using rods or mesh. The lower part of these walls must be covered with wood or drywall to protect the insulation from damage. If there is already an interior wall, then the cavity between that wall and the metal skin may be insulated with poured or blown-in insulation, or batts may be slipped down behind the interior wall if the top is open.

Masonry walls are typically insulated by furring-out the inside walls, adding foam board or batt insulation, and then covering it with drywall. Foam board insulation may also be attached directly to the wall with glue and then the drywall attached to the insulation. The drywall protects the insulation and is required over foam boards for fire safety.

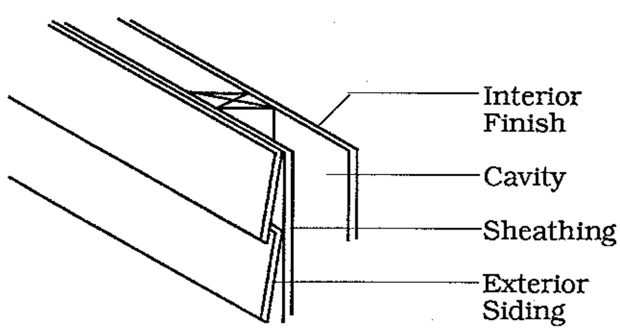
Calculating your savings

The steps for calculating the savings from wall insulation are shown on Worksheet Five.

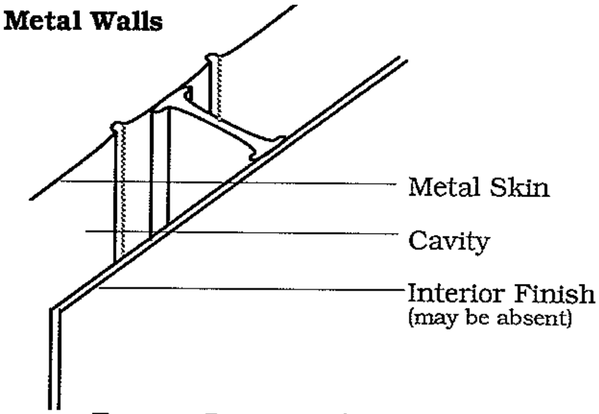
First, measure the actual area of the wall to be insulated, excluding windows and doors, and mark the area, in square feet, in the "Area to be Insulated" box on Worksheet Five.

Locate the correct table for your wall, then find the project which corresponds to the insulation project you want to do. Write its energy conservation value in the box on the worksheet. Follow the calculations to estimate your savings.

Wood Walls



Metal Walls

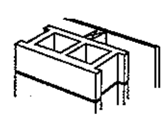
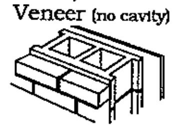
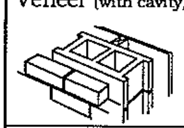


Energy Conservation Values for Wood and Metal Walls

Table 8: Wood and Metal Walls

Wall Type	Insulation Project	Energy Conservation Value
Wood Frame	Blow loose insulation into cavity	.0207
Metal, No Interior Finish	Add R-11 paper or foil-faced batt	.1397
	Add R-19 paper or foil-faced batt	.1442
Metal, Drywall Finish	Fill cavity with loose insulation	.0510

Table 9: Masonry Walls

Description	Features	Add 1" Foam Insulation	Add 3 1/2" Batt Insulation
Block 	Unfinished	.0339	.0405
	Insulated Cores	.0198	.0251
	Drywall Finished	.0105	.0147
Block, Brick Veneer (no cavity) 	Unfinished	.0264	.0324
	Insulated Cores	.0165	.0214
	Drywall Finished	.0092	.0130
Block, Brick Veneer (with cavity) 	Unfinished	.0138	.0186
	Drywall Finished	.0236	.0295
Solid Brick	Unfinished	.0199	.0254

Energy Savings From Insulating Walls

WORKSHEET FIVE

Building ______________________ **Area** ______________________

By ______________________ **Date** ______________________

Sketch of Area to be Insulated (with dimensions)

Description of Existing Conditions and Proposed Insulation Project

Existing Conditions: ______________________

Proposed Insulation Project: ______________________

Energy Savings

Area (sq. ft.)	X	Energy Conservation Value (from Table 8 or 9)	X	Heating Correction Factor (Worksheet Two)	=	Energy Savings mBTU/Year

Cost Savings

Energy Savings	X	Fuel Cost/mBTU (Worksheet Two)	=	$ Cost Savings (per year)

Economic Analysis

$ Project Cost	÷	$ Cost Savings	=	Simple Payback in Years

Energy Savings from Weatherstripping Windows

INSTRUCTIONS

Weatherstripping is an effective method for reducing leakage of cold air (infiltration) around the operable, or moving, parts of windows. Usually, the spring metal type of weatherstrip is the most effective and durable. Nailable felt strips may be used on the sliding surfaces and center of double-hung and slider windows, while plastic V-strip can be used where surfaces meet in compression, such as the sealing surfaces of hinged windows and the bottom of double hung units. Self-adhesive foam tape is not durable enough for most windows, although it may work for some which are rarely opened. It should never be used between sliding surfaces.

Calculate your savings

Measure the length of crack around all operable portions of window units. On hinged windows, this is the distance around the movable unit only. On sliding windows, it is the distance around the pair of movable units when closed plus the distance across the middle, where the movable units meet. Record the total length of crack for all windows in the "Feet of Crack" box on Worksheet Six. Record the appropriate Energy Conservation Value from the "Add Weatherstrip" column of Table 10. For example, if the window fit in your building is, in your opinion, average, but windows are not currently weatherstripped and you plan to add weatherstripping, your Energy Conservation Value is .0215. Complete the calculations on Worksheet Six.

Comments and Cautions

Weatherstrip only reduces air leakage between movable surfaces of the window units. Reset, with fresh putty or gaskets, glass panes that are loose in their sashes and replace broken panes. Hinges and latches should form a tight seal when the window is closed. And, consider caulking the crack around the window frame and caulking or sealing cracks in the frame and sash.

Energy Conservation Vaules for Window Projects
Table 10: Infiltration Savings Calculation

<table>
<tr><th>Window Fit</th><th>Weather-stripped?</th><th>Add Weather-strip</th><th>Add Storm Window</th></tr>
<tr><td rowspan="2">Good</td><td>Yes</td><td>—</td><td>.0036</td></tr>
<tr><td>No</td><td rowspan="2">.0095</td><td rowspan="2">.0095</td></tr>
<tr><td rowspan="2">Average</td><td>Yes</td></tr>
<tr><td>No</td><td rowspan="2">.0215</td><td rowspan="2">.0215</td></tr>
<tr><td rowspan="2">Loose</td><td>Yes</td></tr>
<tr><td>No</td><td>.0664</td><td>.0664</td></tr>
</table>

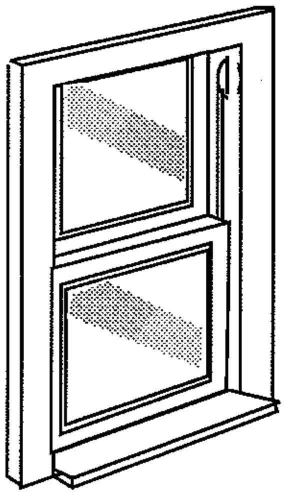
Table 10: Infiltration Savings Calculation (cont.)

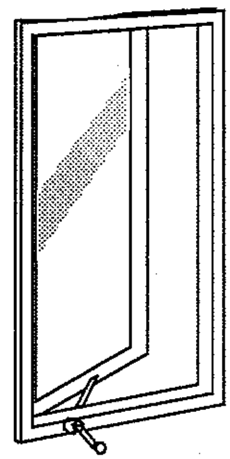
<table>
<tr><th>Window Fit</th><th>Weather-stripped?</th><th>Replace With Panel or Wall</th><th>Replace With New Window</th></tr>
<tr><td rowspan="2">Good</td><td>Yes</td><td>.0072</td><td>.0036</td></tr>
<tr><td>No</td><td rowspan="2">.0215</td><td rowspan="2">.0179</td></tr>
<tr><td rowspan="2">Average</td><td>Yes</td></tr>
<tr><td>No</td><td rowspan="2">.0430</td><td rowspan="2">.0394</td></tr>
<tr><td rowspan="2">Loose</td><td>Yes</td></tr>
<tr><td>No</td><td>.0789</td><td>.0753</td></tr>
</table>

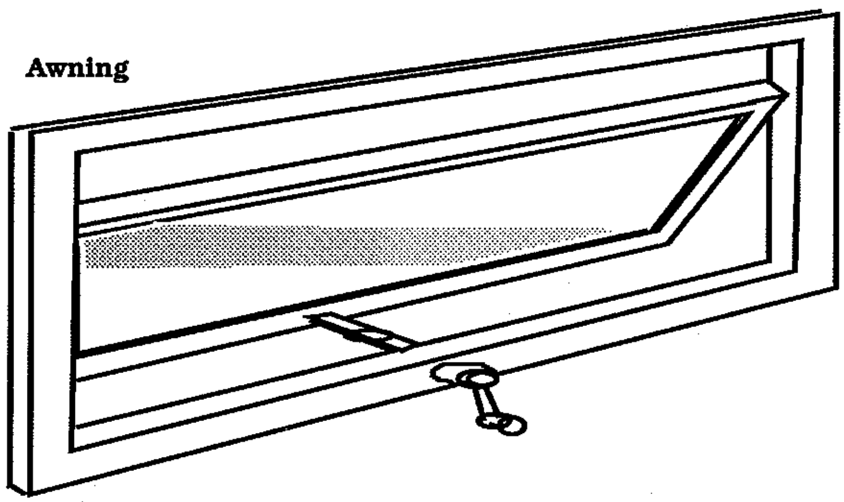
Table 11: Conduction Savings Calculation

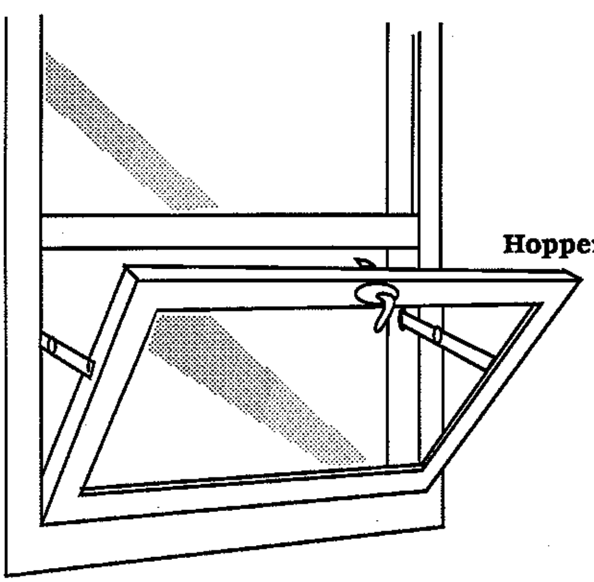
Add Storm Windows	Replace With R-11 Panel or Wall	Replace With New Window
.0755	.1388	.0755

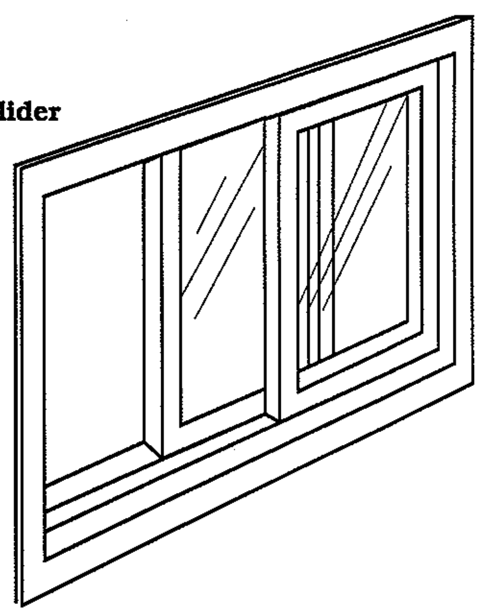
Window Types











Energy Savings From Weatherstripping Windows

WORKSHEET SIX

Building ______________________________ **Area** ______________

By ______________________________ **Date** ______________

Sketch of Window to be Weatherstripped. Highlight the Operable Section (with dimensions)

Description of Existing Conditions and Proposed Insulation Project

Existing Conditions: ______________________________

____

____

____

____

Proposed Insulation Project:

____

____

____

____

Energy Savings

Feet of Crack	x	Energy Conservation Value (from Table 10 or 11)	x	Heating Correction Factor (Worksheet Two)	=	Energy Savings mBTU/Year

Cost Savings

Energy Savings	x	Fuel Cost/mBTU (Worksheet Two)	=	Cost Savings (per year)
				$

Economic Analysis

Project Cost	÷	Cost Savings	=	Simple Payback in Years
$		$		

Energy Savings from Storm Windows

INSTRUCTIONS

Storm windows, like weatherstripping, help reduce the infiltration of cold air around the operable parts of windows. Unlike weatherstrip, they also reduce leakage through cracks in the sash, around loose panes and, depending on their construction, through some cracks in the frame. Also unlike weatherstrip, they add an insulating layer of glass or plastic which reduces heat loss.

Calculate your savings

To estimate conduction savings, measure the area of the entire window, including the sash and frame. You may find it easiest to measure the window in inches, then convert square inches to square feet (divide by 144). Record the result in the box marked "Area of Windows" on Worksheet Seven. Next, locate the Energy Conservation Value corresponding to your proposed project. You'll find this value on Table 10 (page D-14). Now, complete the calculations to estimate your conduction savings.

To estimate your infiltration savings, first measure the length of crack around all operable parts of your window units. On hinged windows, measure the distance around the pair of movable units when they are closed and add the distance across the middle where the movable units meet. Record the result in the box marked "Feet of Crack" on Worksheet Seven. Select the appropriate Energy Conservation Value from Table 10 (page D-14). Complete the calculations on Worksheet Seven to estimate your savings.

Comments and Cautions

If you already have storm windows or primary windows with double-pane glass, don't do this project--it won't pay.

Storm windows are available in many designs. Those with fixed panes permanently mounted in the sash are most effective, but require extra maintenance for removal in the spring and installation in the fall.

Combination storms with a sliding glass panel are more convenient, but do not provide as tight a seal. Be sure to close the glass in the winter or the storm window will be ineffective.

Lightweight plastic sheets taped or stapled over windows are every bit as effective as the traditional storm window. They must be reinstalled each fall, but they may be cheaper than permanent storm windows.

Energy Savings from Storm Windows

WORKSHEET SEVEN

Building ______________________ **Area of Windows** ______________________
(in square feet)

By ______________________ **Date** ______________________

Describe number, size, type and location of proposed storm windows.

Number of Storm Windows: ______________________

____

Size of Storm Windows: ______________________

____

Type of Storm Windows: ______________________

____

Location of Storm Windows: ______________________

____

____

Energy Savings

[ ]	X	[ ]	X	[ ]	=	[ ]
Area of Windows		Energy Conservation Value (from Table 10 or 11)		Heating Correction Factor (Worksheet Two)		Conduction Savings

[ ]	X	[ ]	X	[ ]	=	[ ]
Feet of Crack		Energy Conservation Value (from Table 10 or 11)		Heating Correction Factor (Worksheet Two)		Infiltration Savings

[ ]	+	[ ]	=	[ ]
Conduction Savings		Infiltration Savings		Energy Savings mBTUs/Year

Cost Savings

[ ]	X	[ ]	=	[$]
Energy Savings		Fuel Cost (Worksheet Two)		Cost Savings/year

Economic Analysis

[$]	÷	[$]	=	[ ]
Project Cost (see page D-33)		Cost Savings		Simple Payback in Years

Energy Savings from Replacing Windows

INSTRUCTIONS

Replacing primary windows with new double glazed, tight-sealing windows is extremely expensive, but may be justified for very loose, leaky windows with poor frames and sashes. Usually, a portion of the current window area is eliminated by replacing it with an insulated panel. Then, fewer or smaller new windows need to be purchased. The ability of new windows to enhance a building's appearance and improve security make them a popular project in spite of the cost.

Calculate your savings

Window reduction and replacement are often combined as a total project. However, they are really two separate projects, and can be calculated as such, even though they will typically be done at the same time and by the same crew. See page D-21 for calculation of savings from eliminating windows. The savings from new windows is calculated on Worksheet Eight. If you like, the savings and costs from the two projects can be added and the pair of projects treated as one.

See the calculation section on page D-17 for instructions on measuring the area of windows, and page 12 for instructions on measuring crack length. Use the Energy Conservation values from the appropriate columns in Tables 10 and 11 on page D-14. All these values should be entered in the labeled boxes on Worksheet Eight, which shows you the necessary calculations for this project.

Comments and Cautions

Look for window units with 2 or 3 layers of glass and a tight seal along operable edges. Many manufacturers will provide models to help you judge window suitability. Hinged units often seal more tightly at first, but their mechanisms may not wear as well.

Energy savings will be greater, and costs lower, if you alternate fixed-glass windows with operable windows. Make sure enough operable windows are installed to provide adequate ventilation during mild weather and a means of exit for fire safety. Contact your local fire department or building codes office to determine adequate escape routes.

Energy Savings from Replacing Windows

WORKSHEET EIGHT

Building ______________________ **Area of Windows** ______________________
(in square feet)

By ______________________ **Date** ______________________

Describe the proposed window replacement project. ______________________

____

Sketch Location and Sizes of Windows to be Replaced

Energy Savings

[ ]	X	[ ]	X	[ ]	=	[ ]
Area of Windows		Energy Conservation Value (from Table 10 or 11)		Heating Correction Factor (Worksheet Two)		Conduction Savings

[ ]	X	[ ]	X	[ ]	=	[ ]
Length of Windows		Energy Conservation Value (from Table 10 or 11)		Heating Correction Factor (Worksheet Two)		Infiltration Savings

[ ]	+	[ ]	=	[ ]
Conduction Savings		Infiltration Savings		Energy Savings mBTUs/Year

Cost Savings

[ ]	X	[ ]	=	$
Energy Savings		Fuel Cost (Worksheet Two)		Cost Savings/year

Economic Analysis

$	÷	$	=	[ ]
Project Cost		Cost Savings		Simple Payback in Years

Energy Savings from Eliminating Windows

INSTRUCTIONS

Glass is a very poor insulator, but is used extensively for psychological, aesthetic, safety and health reasons. These benefits are important, but many older buildings have more windows than necessary. It may be advantageous to remove the unnecessary windows and replace them with an insulated (R-11) panel or fill in the opening with an insulated wall. Usually, the panel is chosen if window removal is being done in conjunction with the installation of new windows. An insulated wall is used if the window removal is a project by itself.

South-facing, unshaded windows are a source of solar heating during the winter. Take care in choosing to eliminate them. If the solar heat is good during the winter but causes overheating in the summer, consider keeping the window but adding drapes or blinds. On the other hand, if you have a room which is typically too hot even in cooler weather, you may want to reduce this solar gain by eliminating the window.

Calculate your savings

See pages D-14 and D-17 for instructions on measuring crack length and window area. Note that the window area should be broken into two parts - that which faces south and contributes useful solar heat to the building (written in the box for SOUTH) and all the rest (written in OTHER). Use the Energy Conservation values from the correct columns in Tables 10 and 11 on page D-14. Use Worksheet Nine to calculate your savings.

Comments and Cautions

If your windows currently provide enough daylight that electric lights are unnecessary, their removal will require the use of electric lights. This will reduce your energy savings, although it is not shown in the calculations.

Make certain that enough windows remain to provide adequate ventilation during mild weather and a means of exit for fire safety. You should also consider the effects of a restricted view on building occupants.

Energy Savings from Eliminating Windows

WORKSHEET NINE

Building ______________________ **Area** ______________________

By ______________________ **Date** ______________________

Describe the proposed window elimination project. ______________________

____

Sketch Location and Sizes of Windows to be Eliminated

Energy Savings

[ ] X [ ] X 0.7 X [ ] = [ ]

Area of **South** Windows × Energy Conservation Value (from Table 10 or 11) × 0.7 × Heating Correction Factor (Worksheet Two) = Conduction Savings 1

[ ] X [ ] X [ ] = [ ]

Area of **Other** Windows × Energy Conservation Value (from Table 10 or 11) × Heating Correction Factor (Worksheet Two) = Conduction Savings 2

[ ] X [ ] X [ ] = [ ]

Length of Crack × Energy Conservation Value (from Table 10 or 11) × Heating Correction Factor (Worksheet Two) = Infiltration Savings

[ ] + [ ] + [ ] = [ ]

Conduction Savings 1 + Conduction Savings 2 + Infiltration Savings = Energy Savings mBTUs/Year

Cost Savings

[ ] X [ ] = [$]

Energy Savings × Fuel Cost (Worksheet Two) = Cost Savings/year

Economic Analysis

[$] ÷ [$] = [ ]

Project Cost ÷ Cost Savings = Simple Payback in Years

Energy Savings from Weatherstripping Doors

INSTRUCTIONS

Doors must operate smoothly in all sorts of weather, so it is not surprising that they often do not seal tightly. Common maintenance requirements include checking and adjusting the hinges and latch mechanisms to assure that the door swings easily on its hinges and latches or locks smoothly when closed.

When you have completed this maintenance, you may increase your savings by adding weatherstrip and a threshold, if necessary, to seal cracks around the edges of the door.

Calculate your savings

Since most doors are about the same size, these calculations are based on the number of standard-sized (3'x7') doors to be weatherstripped.

Using your own judgement, select the appropriate value from the table below and record it in the box marked Energy Conservation on Worksheet Ten. Follow the directions on that sheet to calculate your savings.

Table 12: Door Weatherstrip Savings

Tight Fit	Average Fit	Loose Fit
.574	3.44	5.02

Comments and Cautions

Because most doors are used regularly, you should choose a durable weatherstrip material. Spring metal or felt-in-metal are probably your best choices. Plastic V-strip is suitable for lower traffic areas, while self-adhesive foam tape should be applied only on infrequently used doors.

If a door is never needed, consider sealing it shut with tape or caulk to close the crack. This will save more energy than weatherstrip.

To seal under the door, adjust or replace the threshold, or add a sweep--a flexible type of weatherstrip made for this purpose.

Energy Savings from Weatherstripping Doors

WORKSHEET TEN

Building ______________________ **Area** ______________________

By ______________________ **Date** ______________________

Describe number and location of doors and type of weatherstrip proposed.

Number of Doors: ______________________

Type of Weatherstrip: ______________________

____

____

____

____

Energy Savings

[ ]	X	[ ]	X	[ ]	=	[ ]
Number of Doors		Energy Conservation Value (from Table 12)		Heating Correction Factor (Worksheet Two)		Energy Savings mBTUs/Year

Cost Savings

[ ]	X	[ ]	=	[$]
Energy Savings		Fuel Cost (Worksheet Two)		Cost Savings/year

Economic Analysis

[$]	÷	[$]	=	[ ]
Project Cost		Cost Savings		Simple Payback in Years

Energy Savings from Reducing Exhaust Fan Use

INSTRUCTIONS

Many buildings have small exhaust fans which run constantly in the kitchen, restrooms and other areas--even though the fans are needed only when the space is being used. Manually or automatically turning off the exhaust fan when it is not needed saves dollars and energy.

Calculate your savings

Find the fan motor size (in horsepower) on the motor nameplate. Copy the number in the box marked "Fan Size" on Worksheet Eleven. Record the number of hours per week the fan currently runs in the box marked "Current Hours per Week." If the fan runs constantly, use 168 hours per week in this box. Next, record in the box marked "New Hours per Week" the number of hours per week you expect the fan to run after initiating controls. Finish the calculations on Worksheet Eleven to estimate your savings.

Comments and Cautions

If there is a supply fan to move ventilation air into the building, it should be interlocked with the exhaust fan control so that they operate at the same time. Be sure to maintain adequate ventilation and exhaust for health and comfort.

Exhaust fans may be controlled manually by adding a convenient switch, or they may be circuited with the lights so that they operate whenever the lights are on. The most sophisticated controls use a programmable timer to turn the fans off and on at preset times each day. In spaces which are used infrequently, a twist-timer may be installed to turn off the fans after a set amount of time.

Energy Savings from Reducing Exhaust Fan Use

WORKSHEET ELEVEN

Building ________________________ **Area** ________________________

By ________________________ **Date** ________________________

Describe location and use of the exhaust fan and proposed manner of fan control.

Location of Exhaust Fan: ________________________

____

Exhaust Fan Use: ________________________

____

____

____

____

Manner of Exhaust Fan Control: ________________________

____

____

____

____

Energy Savings

[ ] – [ ] = [ ]

Current Hours Per Week – New Hours Per Week = Hours Per Week

[ ] X [ ] X [ ] = [ ]

Fan Size (horse power) X Hours per Week Saved X Weeks Per Year = Electric Savings KWH/Year

Cost Savings

[ ] X [ ] = [$]

Electric Savings X Electric Cost (Worksheet Two) = Cost Savings/year

Economic Analysis

[$] ÷ [$] = [ ]

Project Cost ÷ Cost Savings = Simple Payback in Years

Energy Savings by Replacing Fluorescent Tubes

INSTRUCTIONS

The standard, 4-foot fluorescent tube offers one of the simplest energy conservation opportunities in many buildings. New, energy-saving design fluorescent tubes produce more light for a given amount of energy. The 34-watt energy saver tube uses about 21% less energy but reduces light output by only 14%.

Many areas with fluorescent lighting are more brightly lit than necessary. Here, the existing fluorescent tubes may be replaced with new energy savings tubes to good advantage. If you cannot replace every tube, you can replace every other tube, or replace tubes in some other pattern, and realize savings from every tube you replace.

Calculate your Energy Savings

Worksheet Twelve will guide you through the calculations for this project. The box marked "Annual Hours of Use" should include all the hours that the lights are used in a year.

Comments and Cautions

Don't overlook small opportunities for implementing this project. Because energy savings is proportional to hours of use, you should investigate high-use lights, such as security lights, trophy case lights and lighted signs such as EXIT signs. If you have energy-saving fluorescent tubes on-hand, the cost of installing one here and there is not much more than the per tube cost of changing a whole room.

You have probably been told that turning fluorescent lights off and on wastes energy, so it is better to leave them on. This is not true. However, rapid on-off cycles will shorten lamp life somewhat. Incandescent lights should be shut off whenever possible. Fluorescent tubes should be shut off when they will not be used for 20 minutes or more.

Energy Savings by Replacing Fluorescent Tubes

WORKSHEET TWELVE

Building ______________________ **Area** ______________________

By ______________________ **Date** ______________________

Describe number and location of florescent lamps to be replaced.

Number of Fluorescent Lamps: ______________________

____

Location of Fluorescent Lamps: ______________________

____

____

____

____

____

____

____

____

____

____

____

____

Energy Savings

[ ] X **0.006** X [ ] = [ ]

Number of Tubes to be Replaced; Annual Hours of Use; Energy Savings KWH/Year

Cost Savings

[ ] X [ ] = [$]

Power Savings; Electric Cost (Worksheet Two); Cost Savings/year

Economic Analysis

[$] ÷ [$] = [ ]

Project Cost (see pg. D-33); Cost Savings; Simple Payback in Years

Energy Savings by Replacing Incandescent with Fluorescent Lights

INSTRUCTIONS

Fluorescent lamps (tubes) will produce two to five times as much light for a given electrical input as incandescent lamps--possibly even more, depending on fixture design. Less electric energy is needed to produce the same or even more light, saving you dollars and energy.

Table 13: Energy Conservation Values for Fluorescent Lights

Replace (incandescent)	With (4 ft. energy-saver fluorescent)	Effect on Light Level	Energy Cons. Value
two 60W	one single-tube	40% more	.042
one 100W	one single-tube	40% more	.082
two 100W	one double-tube	40% more	.063
one 200W	one double-tube	20% more	.125
one 300W	one four-tube or two double-tube	50% more	.150
one 60W	one screw-in fluorescent (22W)	no change	.038

Calculate your Energy Savings

See Worksheet Thirteen for these calculations. Hours of use refers to all the hours that the lights are used in a year, including cleaning and unoccupied times.

Comments and Cautions

Fluorescent lamps are typically used in rooms with low or medium ceiling height. If used in gymnasiums, they must be protected from contact with athletic equipment. In cold locations, such as outdoors, and high-moisture areas, such as dressing rooms, special sealed fixtures are needed to protect the tubes.

When installing new lights, it is good practice to review the switching circuits. Lights near windows and doors should be on a separate switch from interior lights so that they can be left off when daylight provides sufficient illumination.

Fluorescent lights in this application have an average life at least twenty times longer than incandescents, which reduces maintenance costs. For other ideas, see "Comments and Cautions" on page D-27.

Energy Savings by Replacing Incandescent with Fluorescent Lights

WORKSHEET THIRTEEN

Building ______________________ **Area** ______________________

By ______________________ **Date** ______________________

Replace Incandescent Lights with Fluorescent Lights

1. Number, size and location of incandescent lights to be removed. ______________________

____

2. Number and type of fluorescent lights to be installed. ______________________

____

Energy Savings

[ ]	X	[ ]	X	[ ]	=	[ ]
Number of Incande-scents removed		Energy Conservation Value (from Table 12)		Annual Hours of Use		Energy Savings KWH/Year

Cost Savings

[ ]	X	[ ]	=	[$]
Energy Savings		Power Cost (Worksheet Two)		Cost Savings/year

Economic Analysis

[$]	÷	[$]	=	[ ]
Project Cost (pg. D-33)		Cost Savings		Simple Payback in Years

Energy Savings by Replacing Incandescent with Metal Halide Lights

INSTRUCTIONS

Metal halide lights, like fluorescents, produce two to five times as much light as a similar wattage incandescent lamp. These lights are only appropriate in medium-to-high ceiling rooms. They have a cool, white light like a fluorescent tube, but have higher light output per lamp, so fewer fixtures are needed in large rooms.

Table 14: Energy Conservation Values for Metal Halide Lights

Replace (incandescent)	With (metal halide)	Effect on Light Level	Energy Conservation Value
one 300W	one 175W	60% more	.100
two 300W	one 250W	25% more	.155
one 500W	one 175W	5% less	.300
	one 250W	50% more	.210
one 750W	one 250W	5% less	.460
	one 400W	50% more	.290

Calculate your Energy Savings

Worksheet Fourteen will guide you through the calculations needed to figure your savings. Hours of use should include all the hours that these lights will be on during a year.

Comments and Cautions

Metal halide lamps require a 2-4 minute warm-up period before they reach full light output, and may require 10 minutes or more to cool down and warm up again if the power is switched off and then on. For this reason, they should be used in rooms where the lights can be turned on and left on all day. Because of the warm-up delay, it is wise to leave several of the old incandescent lamps in place on a separate circuit. These lamps can be switched on for a quick walk-through or look around the room. These will also provide safety lighting in the event of a momentary power outage.

Metal halide lamps, with the proper fixtures, can be used for outdoor applications, such as parking lots and athletic fields.

Energy Savings by Replacing Incandescent with Metal Halide Lights

WORKSHEET FOURTEEN

Building ______________________ **Area** ______________________

By ______________________ **Date** ______________________

Replace Incandescent Lights with Metal Halide Lights

1. Number size and location of incandescent lights to be removed. ______________________

____

____

2. Number and size of metal halide lights to be installed. ______________________

____

____

Energy Savings

[ ] X [ ] X [ ] = [ ]

Number of Incandescents Replaced X Energy Conservation Value (from Table 14) X Annual Hours of Use = Energy Savings KWH/year

Cost Savings

[ ] X [ ] = [$]

Energy Savings X Power Cost (Worksheet Two) = Cost Savings/year

Economic Analysis

[$] ÷ [$] = [ ]

Project Cost (pg. D-33) ÷ Cost Savings = Simple Payback in Years

Figuring out Project Cost

Some energy conservation projects look very attractive until you find that they costmuch more than the savings they will produce. It is impossible to properly evaluate the impact of an energy conservation opportunity without considering cost. Here are a few tips for getting this vital information.

1. Be very clear about exactly what you want to do, or at least what you want the finished project to be. Worksheets Three through Fourteen have been developed to aid in your determination. You can describe your intended project in detail (and even include drawings) at the top of each Worksheet. Then, cover the lower part of the sheet (everything from "Energy and Cost Savings" on down) with a clean sheet of paper and make copies of the entire sheet. These copies can be given to potential contractors to describe what you want. On an informal, "get a few quotes" - type of pricing, they may even submit their quotes on that copy.

2. Allow potential contractors to submit "alternates" if you're not sure exactly how the work should be done. In this way, you gain from their experience in similar projects. Make sure that the contractor clearly specifies the end result.

3. Examine references from all potential contractors, so you can ascertain the quality and acceptability of their work. This is particularly important in evaluating alternate bids.

4. Interview your contractor to be sure that the two of you agree on exactly what is to be done and how it will be accomplished. Let the contractor know of any special situations which might affect the project.

5. Hold down costs by considering projects, or parts of projects which you can do by yourself – possibly with a contractor's guidance. Determine what your time is worth and include it as part of the project cost.

Economic Analysis

Once you have determined the probable cost of an energy conservation project, you can compare its cost and benefits and determine whether it is worth doing - at least in an economic sense.

On the Worksheets we have used the "simple payback" analysis. This is an unsophisticated model which merely predicts how many years the project will take to pay for itself. Theoretically, if the payback time is shorter than the expected life of the project, it is to your economic advantage to do the project. Many groups have added more restrictive criterion, such as indicating that the project will not be implemented unless it pays back in less than a certain number of years – typically 5, 7 or 10. Any project with a payback of one year or less should be implemented immediately, because it can be paid for out of the current year's utility budget and really requires no investment.

Use the current price for fuel or electricity unless you know for certain that a price increase or decrease is coming. If you are certain of an increase or decrease, use the expected price. Depending on your circumstances and abilities, as well as your tax situation, it may be advantageous for you to use a more complex model, such as Life-Cycle Cost, for your economic analysis of these projects.

Where To Get Help

Available Programs and Assistance

Nebraska Energy Office
State Capitol Building
P.O. Box 95085
Lincoln, NE 68509
(402) 471-2867

School Weatherization Program (K-12 schools)

1. Technical Assistance Grants: Up to $2,500 per building for engineering analysis to determine needed cost-effective energy improvements.

2. Energy Efficiency School Loan Program: No-interest loans available to finance energy improvements which demonstrate a payback of seven years or less.

Institutional Conservation Program: Federally funded 50% matching grants available to all schools and hospitals to finance energy improvements.