Agricultural Extension Service
University of Minnesota

Extension Folder 513 — 1981

CONSUMER APPLIANCES:

Energy Labeling and Consumption

Wanda Olson
Extension Household Equipment Specialist

This publication tells how to choose energy efficient appliances[1] (water heaters, dishwashers, clothes washers and dryers, refrigerators, freezers, and cooking appliances) and how to use them efficiently. Home heating/cooling appliances are not included.

Household energy use is about 23 percent of the total energy used in Minnesota. Within the household sector, home heating accounts for 71 percent, water heating 14 percent, clothes drying 4 percent, cooking 4 percent, refrigeration 3 percent, lighting 3 percent, and other appliances 1 percent.[2]

Changes in the dollar amounts of monthly utility bills usually occur with a change in the cost per unit of energy, or changes in the amount of energy used in home heating/cooling or water heating. Shifting the demand from the peak hours (usually 5-9 p.m.) will lower the cost per unit of energy because the capacity required by the electric utility company is based on peak hour usage. Water heating can be delayed by taking baths or showers and doing laundry and dishwashing after peak hours. In some cases, water heating "on cycles" may be controlled by a utility company. It is not as easy to shift the use of food appliances from the peak hours.

As a result of recent legislation, appliance operating costs are listed on the energy labels found on new appliances. These costs are based on laboratory tests designed to approximate typical household usage.

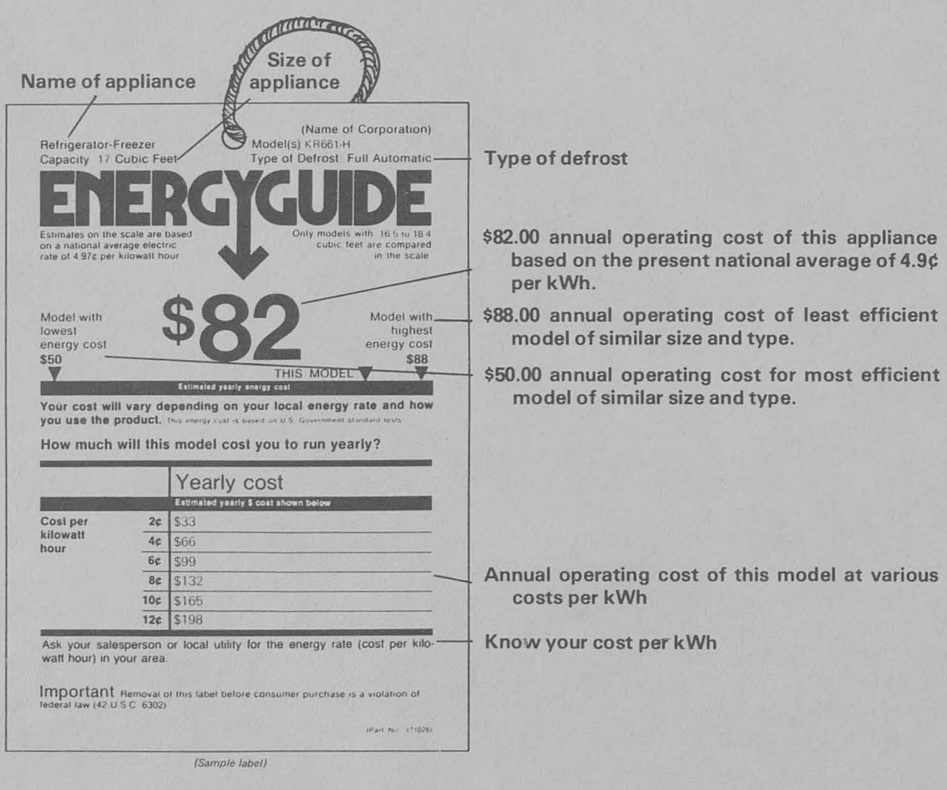
ENERGY LABELS ON NEW APPLIANCES

Operating costs are listed on the energy labels found on new refrigerators, freezers, water heaters, clothes washers, and dishwashers. These costs are for specific models and are given as an estimated annual cost of operation, based on "typical usage." The label also lists the annual operating costs of the most and least efficient model of the same size or type.

While households differ in their use of appliances, the figures can be used to compare the relative costs of models of similar size and/or types when purchase decisions are made.

[1] Energy use is based on appliance operation by consumers. No attempt is made to discuss energy used in the manufacture or distribution of appliances or any savings if appliances are more durable, and have a longer life. The Department of Energy is setting energy efficiency standards which will determine the minimum efficiency of appliances available for sale. This is a requirement of the Energy Policy and Conservation Act (1975) as amended by the National Energy Conservation 1978. The minimum standards for water heaters, refrigerators, freezers, ranges, ovens, and clothes dryers are to be developed by December 1980. Standards for dishwashers and clothes washers are to be developed by November 1981. These standards will apply to new products manufactured after the effective date of the standards.

[2] Data are based on 1975 figures provided by the Minnesota Energy Agency.



(Sample label)

The more efficient appliances usually have higher purchase costs. Two methods, simply pay back and life-cycle costing, may be used to determine whether it is worthwhile to invest in a more efficient appliance (lower operating costs) with a higher purchase cost. Simple pay back will determine the length of time required for lower operating costs to pay back the *higher* initial investment in the higher purchase cost. As an example:

Refrigerator "1" costs $650 and has an estimated annual operating cost of $45.00.
Refrigerator "2" costs $600 and has an estimated annual operating cost of $70.00.

$$\frac{\text{Purchase Cost "1" - Purchase Cost "2"}}{\text{Operating Cost "2" - Operating Cost "1"}} = \text{Simple payback in years}$$

$$\frac{\$650 - \$600}{\$70.00 - \$45.00} = \frac{\$50}{\$25}$$

= 2 years to recover the difference on purchase cost between refrigerator "1" and refrigerator "2". The average life expectancy of a refrigerator is 15 years.

Total cost of ownership is called the life-cycle cost (LCC) and includes purchase and operating costs and service or repair costs. Service or repairs may be estimated at 2 percent of purchase price per year. Changes in the cost of energy vary by fuel type and will affect operating costs. Details of the LCC method and examples are found on page 7.

Some general principles for using the least amount of energy while getting the most from your appliances are:

- use energy efficient appliances
- use only the minimum heat/cold setting or power setting
- operate the appliance with a full load
- operate the appliance under manufacturer's recommended conditions (such as proper air circulation or air conditioner out of direct sun).

APPLIANCES

Water Heaters

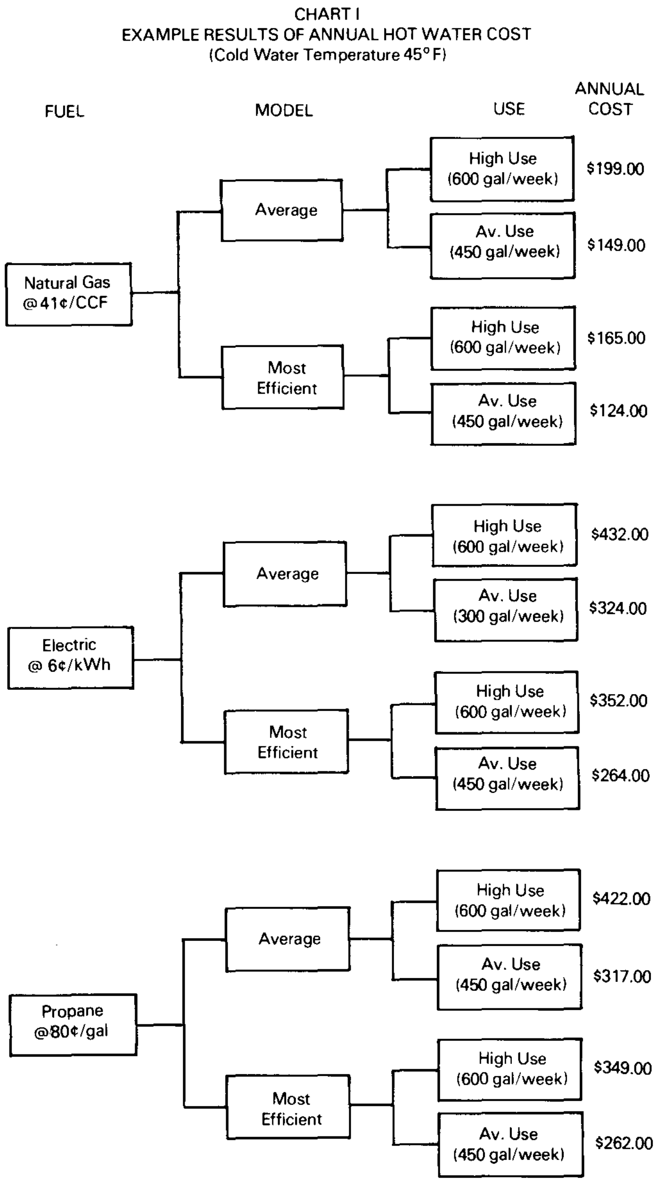
Minnesota Extension Folder 388 — *Hot Water and Your Home Energy Budget* includes a more complete discussion of water heating.

The energy label indicates the estimated operating costs of the specific model. It also lists the lowest and highest operating cost of water heaters that have a similar capacity according to first hour rating which is the amount of water the water heater can heat and make available over the first hour time base.

The amount of energy used depends upon the efficiency of the water heating system, number of persons in the household and water-use habits, street or well water temperature, and the temperature setting of the water heater. A "normal" setting on a new heater is 130°F. rather than 140°F or higher.

Water heaters, if identified as energy saving or energy conserving, must meet or exceed the ASHRAE 90-75 standard for energy efficiency. (American Society of Heating, Refrigerating, and Air Conditioning Engineers) Chart I shows changes in water heating costs due to usage and types of water heaters. Charts II and III give typical amounts of hot water.

Chart I — Example results of annual cost of heating water using typical and energy saver gas and electric water heaters high use and average use for selected prices.



Assume 90°F temperature rise in hot water, e.g., 45°F to 135°F and 8.3 lbs/gallon. "Average" models have the average efficiency of all models sold in 1978: 79% for electric, 48% for gas. Source: Federal Register, June 30, 1980. "Most Efficient" models have the highest efficiency of all models available in January 1980: 97% electric and 58% gas. System efficiency and fuel usage were derived from data in the Federal Register, March 25, 1980.

The amount of hot water used can be reduced by:

- using no more than the minimum amount of heated water needed for each task. Run dishwasher for full loads only. Use appropriate water level in clothes washers. Use flow restrictors in shower heads. Take shorter showers and use less water in tub.
- using lower temperature water when possible. In clothes washing use cold rinse water and warm water for washing clothes that are not heavily soiled.
- reusing heated water whenever possible. Use suds saver feature in clothes washing. The wringer washer is designed to reuse heated water.

Chart II — Volume of hot water per typical washload (gallons)

Clothes washers[1]	Standard	Extra Large	Front Loading
hot wash/warm rinse	27	37	19
hot wash/cold rinse	18	25	9
warm wash/warm rinse	18	25	15
warm wash/cold rinse	9	12	4

[1] *The temperature of the water in your washing machine when using the warm setting is usually the result of an equal mix of hot and cold water. Equal amounts of hot (135°F) and cold water (45°F), will give warm water about 90°F. The actual temperature of water in your washing machine is determined by the water heating setting, its rate of recovery, and the temperature drop of the hot water between the water heater and the washing machine.*

Dishwashers and Clothes Washers

Most of the energy used by dishwashers and clothes washers is in the heating of water. The energy label on these appliances lists different operating costs when water is heated by electricity or natural gas. The comparison on the label for clothes washers is among compact (less than 16 gal.) models or among standard (16 gal. or more) models. Standard includes what we normally call extra large. Costs are based on a percentage of loads done in hot, warm, and cold water, and warm and cold rinses. Comparisons are most accurate when made between machines with the same number of temperature settings.

A dishwasher requires water at 130°-140°F for good operation. Energy saving dishwashers have the option to air dry rather than heat dry; air drying will save about 1/2 kWh per cycle. Some models have eliminated one rinse in the total wash cycle; if your water is heated electrically, this will save about 1/2 kWh per cycle.

To use a dishwasher efficiently:

- run full loads.
- use shorter cycle (fewer fills of water), if available, for lightly soiled dishes.
- eliminate or use shorter drying cycle.

Chart III — Hot water use by purpose

	Events per week (average household)	Temperature in °F	Volume of water per event (gallons)	Volume of hot water at 130°F per event (gallons)[1]	Volume of hot water at 140°F per event (gallons)[2]
6-10 min. shower or 1/2 fill bath	14	105°F (typical)	30	21	19
3-5 min. shower or 1/4 fill bath			15	10-1/2	9-1/2
Sink (hands, face, shaving, food preparation, and hand dishwashing)	100	105°F	1-1/2	1 (no different due to rounding)	1
Automatic dishwasher	4	130-140°F (minimum)	11-15	11-15 no mixing is used)	11-15

[1] *Assumes cold water at 45°F.*

[2] *The total amount of hot water drawn from the heater is increased when the temperature setting is lowered. This is due to the greater proportion of hot water needed each time the shower, bath, or sink are used, since cold water is mixed with hot water. Hot water draw is increased when the setting is lowered from 140o to 130°F, but the overall cost is less. The savings result from less heat added to the water used in non-mixed uses.*

About 5 kWh or .30 CCF of gas are used to heat water for a laundry load using hot wash and cold rinse[3]. A warm wash/cold rinse uses about half as much energy because warm is usually the result of an equal mix of hot and cold water.

Cold water clothes washing uses little energy; however, hot water removes more soil, particularly oily soil, than warm or cold water. Hot water does more than warm or cold water to reduce bacteria in laundry items; however, chlorine bleach sanitizes in any temperature water. Energy saving washing machines use a cold water rinse. According to tests conducted by the Whirlpool Corporation, machine drying a load of clothes rinsed in cold water may take up to 1/2 kWh more than a load rinsed in warm water.[4]

On any washer, adjust the water level when it is not possible to run full loads. A wringer washing machine allows you to reuse the heated wash water. The suds saver feature on automatic washing machines reuses all but about three gallons of the heated water from the previous load.

Normal or fast spin removes more water than the slow spin found in delicate cycles and some perma-press cycles. A slower spin results in less wrinkling of durable press items but will require more energy in machine drying.

[3] 18 gallons of water heated 90°F and assuming an efficiency of electric heaters of 79 percent and gas 48 percent.

[4] Soap and Detergent Conference Proceedings, San Francisco, April 10, 1980.

Clothes Dryers

Clothes dryers use about 2-1/2 kWh of electricity or .10 CCF of gas to dry a load of clothes.

To use a dryer efficiently:

- remove more water in washing by using a normal rather than a slow spin.
- avoid over drying of clothes; this is more of a problem when using the timed dry rather than automatic dry cycle or when loads combine synthetics with little water and heavy cotton that holds a lot of water.
- keep the lint screen and the outside exhaust clean.

Refrigerators and Freezers

The energy label indicates the estimated operating costs of the specific model. It also lists the lowest and highest operating costs of models in the same size category and of the same type. The operating costs of similar sized refrigeration appliances differ by:

- Interior temperature to be maintained:
  - 0°F in freezer or freezer compartment of refrigerator-freezer.
  - 15°F in freezer compartment of refrigerator.
  - 33-38°F in fresh food compartment of refrigerator-freezers.
- Type of defrost system: manual, partial, or automatic.
- Type and amount of insulation: The insulation efficiency of one inch of urethane foam plastic is about the same as two inches of fiberglas. Energy efficient models may have 2-2½ inches of urethane foam plastic insulation.
- Room temperature where the refrigerator or freezer is located: Refrigerators operating in areas where the temperature is 90°F will require at least one-third more energy than at 70°F. Refrigerators and freezers are operating in very warm areas when located next to ranges, heat vents, or pushed into very tight spots. Install refrigerators and freezers only where there is plenty of room for good air circulation. This is essential for those models with the condenser coils on the back, as well as for some new models with the condenser at the bottom.
- Operator use: Ice making, food freezing and cooling, and the number and length of time of door openings all affect energy use. For efficient use of the refrigerator and freezer:
  - Avoid unnecessary ice making — make only what you need.
  - Operate freezer compartment full — this is as important as selecting the proper size of freezer. It takes the same amount of energy to maintain 0°F in a half-filled as in a full freezer. Heat entering the freezer will cause air temperature to rise quickly and make the motor run more often. Don't operate freezer with only a few items in it; make room for these items in the freezer compartment of the refrigerator.
  - Thaw frozen foods in the refrigerator if you need to thaw them before cooking or serving. In thawing, the frozen foods will absorb heat, reduce running time of the refrigerator, and save electricity.
  - Avoid placing hot foods in your refrigerator. This increases refrigerator operating time greatly and warms up foods already there. Quickly lower the temperature of perishable foods in a pan of water, then refrigerate the food for further cooling.
  - Reduce the number of door openings. This is more critical with refrigerators and upright freezers. When the lid of a chest freezer is open, there is little exchange of air because hot air rises. When the door of an upright opens, cool air moves out and toward the floor and is replaced by warm air causing the temperature to rise and the unit to run.
- Operator maintenance:
  - Clean condenser fins and coils regularly. They are

located either at the back or bottom front of the refrigerator. Remove grill at bottom to gain access. Dust with a brush or use a vacuum cleaner attachment.

- Check tightness of door gaskets. These should be replaced if they are not tight (check hinges and latch first). Polyvinyl chloride gaskets are used today, and they do not deteriorate as fast as rubber gaskets.
- If the refrigerator has an energy saver switch, turn it off when the humidity is low and sweating is not a problem. Unplug the refrigerator when not in use. Remove all items and clean.
- If a refrigerator is excessively noisy, have it checked.

[5]According to the Department of Energy's (DOE) preliminary determinations of maximum technologies **feasible**, Federal Register, Vol. 44 No. 1, January 2, 1979. The efficiency level of refrigerator-freezers with an automatic defrost is 1/3 lower than the efficiency levels of refrigerator-freezer with partial defrost or a manually defrosting refrigerator; and the efficiency level of automatic defrost upright freezer is only 1/2 of the manual defrost chest freezer.

Cooking Appliances

There are no energy labels on new ranges. According to the Federal Trade Commission (FTC), it would not be economically feasible to require labels for ranges and ovens because the energy used in cooking varies mostly with operator use and less with the efficiency of the appliances.[6] Any energy changes made by the manufacturer or distributor must be based on DOE tests. New gas ranges will have electric ignition in place of pilot lights.[7] Ovens in efficient gas or electric ranges will have increased insulation, a feature that is always present in ovens that self-clean by the high temperature method. This self-cleaning process takes about 3-4 kWh of electricity or 24-38 cu. ft. of gas (this is as much energy as used in operating the oven for one hour at 375° F 4-6 times).

Some ranges have convection ovens with forced hot air currents; these speed up the transfer of heat into the food. In these ovens, preheating is usually not needed and the baking is usually done at lower temperatures and for a shorter period of time than used in conventional ovens.

Surface units on electric ranges are conventional, smooth top thermostatically controlled, or smooth top non-thermostatically controlled units; energy and time comparisons are given in Chart IV. Data given are taken from a study involving meals for a family of four for one week.

The operator must decide whether cooking is to be done on top of the range, in the oven, or in a portable appliance. The top of the range uses less energy than the oven unless you are using the oven for more than one item. The energy used for each additional food item placed in the oven is small; it may not add more than 10 percent.

Portable appliances, including the microwave oven, are used frequently in food preparation. Because of the ECPA (Energy Conservation and Policy Act) restrictions there are few energy saving claims in the microwave manufacturer's literature. The greatest savings with the microwave oven occur when it is used in place of the range oven, or in place of the surface unit for small amounts (2 cups or less). Chart V shows the energy savings when the microwave oven is used in conjunction with an electric range. Charts VI and VII show the energy and time used in preparing meat products using the range and selected portable appliances. Gas appliances use less energy than electric appliances when one includes the energy used in production and transmission of electricity.

[6]The FTC reported maximum energy savings $6-7 per year with efficient appliances.

[7]All new gas ranges sold in Minnesota after January 1, 1979 have electric ignition.

To operate the range efficiently:

- bake several items at one time or one following the other. Energy used in heating up the oven is a considerable part of the energy for total baking, and this is eliminated when foods are baked after each other. Heating the oven to 325°F takes about .2-.3 kWh of electricity or .02-.03 CCF of gas. Operating the oven at 325°F for one hour including preheat takes about .7-.8 kWh, or .05-.08 CCF; at 400°F it takes about 1 kWh or .10 CCF. If your oven has the high temp (pyrolytic) cleaning features, run it, when necessary, immediately after the oven is used for baking. This will save much of the energy needed to reach the cleaning temperature.
- for top of the range cooking, turn heat settings down to a low setting or use thermostatic units to maintain temperature. The amount saved depends on the actual simmer or boiling. For example, cooking six medium, whole potatoes in 1/2 cup of water in a covered saucepan takes about three times as much energy on a constant high setting as using a high setting to get a boil and low setting to maintain a boil. On electric ranges small surface units use about 1100-1500 watts on high and the large units use 1800-2600 watts. Low settings that maintain boil use about one-fourth as much electricity as high settings. Low settings that maintain a simmer, 185°-205° F or below bubbling, use about one-tenth as much as a high setting. Ranges with infinite heat settings continuously cycle off and on at full wattage, but at a low setting that will maintain a low boil they are on only about one-sixth or one-fourth of the time, and on the very low, keep warm settings, on less than one-tenth of the time. On gas ranges comparable savings are made by turning burners to lowest settings to maintain desired temperature. Small gas burners

use about 8000 Btu per hour on high; the larger gas burners 12,000 Btu on high; pilots burning continuously use about 175 Btu an hour.

- use pan size that matches the size of surface element or burner.
- use smallest amount of water for food being cooked.

Chart IV — Energy and time used in surface cooking for family of four for one week[1]

Range	kWh	Time
Conventional	6.5	8 hrs. 8 min.
Smooth top thermostatically controlled	6.5	9 hrs. 21 min.
Smooth top non-thermostatically controlled	9.4	10 hrs. 50 min.

[1] *Lovingwood, Rebecca P. and Goss, Rosemary C. "Electric Energy Used by Major Cooking Appliances," Home Economics Research Journal Volume 8, Number 4, 1980.*

Chart V — Energy and time savings when microwave oven used in conjunction with conventional electric range[1]

	Energy savings as a percentage of range alone	Time savings as a percentage of range alone
Microwave and conventional range	24%	47%
Microwave and conventional oven	42	53
Microwave and surface unit	5	21

[1] *Lovingwood, Rebecca P. and Goss, Rosemary C. "Electric Energy Used by Major Cooking Appliances," Home Economics Research Journal Volume 8, Number 4, 1980.*

Chart VI — Energy (kWh, cubic feet) and time in preparing four beef patties and meat loaf in selected appliances[1]

Appliance	kWh electricity	Cu. ft. gas	Time (minutes)
Beef patties			
Microwave oven	.1		5
Frypan on surface	.19	.92	10
Electric skillet	.19		10
Broiler in portable oven-broiler	.27		12
Broiler in 30 inch oven	.47[2]	3.73	10
Meat loaf			
Microwave oven	.39		17
Dutch oven on surface	.31	1.80	28
Electric skillet (212°F setting)	.22		26
Slow cooker (low setting)	.36		298
Oven in portable oven-broiler	.77		91
Oven in 30 inch range (325°F)	.82	8.77	67

[1] *Drew and Rhee, "Fuel Consumption by Cooking Appliances," Journal of the American Dietetic Assoc. Volume 72, p. 1, January 1978.*

[2] *Data used are for one patty.*

Chart VII — Energy (kWh) and Time in Preparing a Beef Roast and an Entire Meal in Selected Appliances[1]

2# beef blade roast	kWh of electricity	Time (min.)
microwave oven	.60	60
el. pressure saucepan	.66	53
pressure saucepan/surface unit	.80	55
saucepan/surface unit	.42	155
conventional oven	1.50	111
meal for two: chicken, brussel sprouts and potatoes	**kWh of electricity**	**Time (min.)**
microwave oven	.44	28
el. pressure saucepan	.10	23
pressure saucepan/surface unit	.64	23
saucepan/surface unit	.42	65
conventional oven	1.90	62

The conventional oven used significantly more energy than any other appliance for all products. The electric pressure saucepan used significantly less energy than any other appliance for the meat.

[1] *Wilson, "Time & Energy Comparison of Five Cooking Appliances," Research Report, Stout State University Foundation, Inc., 1980.*

COMPUTING LIFE CYCLE COSTS

The life cycle costing method can be used to determine the cost of owning an appliance or any net benefit from buying a more energy efficient appliance with a higher purchase cost. To compute net benefits multiply the annual benefit by an energy factor and then subtract the difference in repair costs and in purchase costs. Examples for refrigerator and water heater follow:

Refrigerator "1" costs $650 and has an estimated annual operating cost of $45.00.

Refrigerator "2" costs $600 and has an estimated annual operating cost of $70.00.

The following estimates are used:

a) refrigerator life expectancy of 15 years

b) yearly repair costs of 2 percent of purchase price

c) an energy factor of 10.42. Factor selected from Table 1 for 15 years and assumes energy costs will rise .06 percent faster than general inflation and calculated at the present value of money. Factor can also be derived from the formula at the bottom of Table 1.

Annual benefit from refrigerator "1" compared to refrigerator "2":

annual energy cost difference (benefits)

$70.00 - $45.00 = $25.00

annual benefits x energy factor ($25.00 x 10.42)

— difference in repair costs x years ($1.00 x 15 years)

— difference in costs[1] ($50.00)

= Net Life Cycle Benefit

$260.50
- 65.00

= $195.50 net benefit from buying refrigerator "1"

[1] *If you wish to include opportunity costs — money that could have been earned if the difference in purchase cost had been invested for the selected time period, multiply the difference in cost by a factor from the following table and use this number for the difference in costs.*

Table I — Compound interest for amount deposited and held for X years

Year (X)	Interest rates 5%	6%	8%	10%	15%
1	1.0500	1.0600	1.0800	1.1000	1.1500
3	1.1576	1.1910	1.2597	1.3310	1.5209
5	1.2763	1.3382	1.4693	1.6105	2.0114
10	1.6289	1.7908	2.1589	2.5937	4.0456
15	2.0789	2.3966	3.1722	4.1772	8.1371
20	2.6533	3.2071	4.6610	6.7275	16.3665

Table II — Present value of lifetime energy costs

Years	Factor Electricity	Natural Gas	Propane & Distillates
1	.95	1.07	.99
3	2.73	3.10	2.93
5	4.34	5.25	4.84
10	7.75	10.93	9.41
15	10.42	17.08	13.73

[1] *Derived from data from 1981-1996 in MEA Forecasting, 12-9-80. Future energy costs are inflated at their projected rate of increase above the general level of inflation (electricity +.06 percent, natural gas +6.69 percent, and propane and distillates +3.83 percent) and are discounted at a 5 percent annual rate to allow for the time value of money. If you wish to select other rates use the following formula as illustrated.*

$$\sum_{t=1}^{n} \frac{(1+g)^t}{(1+r)^t} =$$

Example:

when g = .0669, r = .05, and n = 10 years

$$\sum_{t=1}^{n} \frac{(1+.0669)^t}{(1+.05)^t} = 10.93$$

Water heater — 52 gal. electric with 55 gal. 1st/hour recovery rate

Water heater — 40 gal. gas with 70 gal. and a 69 gal. 1st/hour recovery rate

Electric:	Natural Gas:
Water heater: "1" costs $235.00 and has an annual estimated operating cost of $286.00 per yr.	Water heater "1" costs $230.00 and has an annual estimated operating cost of $117.00 per yr.
Water heater: "2" costs $155.00 and has an annual estimated operating cost of $309.00 per yr.	Water heater "2" costs $150.00 and has an annual estimated operating cost of $136.00 per yr.

The following estimates were used:

a) water heater life expectancy of 10 years.

b) no repair costs — repairs usually require replacement.

c) energy factor of 7.75 for electric and 10.93 for gas. Factor selected from Table 1 for 10 years and assumes electric costs to rise .06 percent faster than inflation and natural gas cost to rise 6.69 percent faster than inflation.

Annual benefit from water heater "1" compared to water heater "2".

Electric

Annual benefits X energy factor ($23 x 7.75)

- difference in cost ($80)

= net life cycle cost benefit

$178.25
-80.00

$ 98.25 net benefit from buying water heater "1"

Gas

Annual benefits X energy factor ($19 x 10.93)

- difference in cost ($80)

= Net life cycle cost benefit

$207.67
-80.00

$127.67 net benefit from buying water heater "1"

To compare appliances using different fuels, determine the benefits for the selected time period by multiplying the annual energy cost of each appliance by the appropriate energy factor and then subtract to get the energy cost difference (benefit).

Water Heater "1 electric" and water heater "1 gas"

($286 x 7.75) - ($117 x 10.93) = $937.69

Changing fuels may require an investment, gas appliances require gas fuel lines, electric water heaters operate on 220-240 circuit.

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