Consumers are key elements in national patterns and levels of energy usage, both directly in the energy they use and indirectly in the energy used to produce food, goods and services for them. Industries have learned that energy efficiency is worthwhile. For example, commercial canners report that changes in equipment to reduce heat wastes in food processing paid for themselves in as little as one year.

Energy conservation actions in individual households may have less dramatic results than in large scale manufacturing operations, but small amounts multiplied by millions of households can result in substantial savings overall.

**Direct** use of energy for food for the family includes gasoline for auto trips to buy food; electric power for refrigerating food; and gas, electricity or other fuel for cooking and for water heating for dishwashing. Consumers have control over their direct uses of energy.

From the consumer's standpoint, energy used to produce food and the appliances for food preparation in homes is **indirect** energy. Consumers have control to some extent over indirect energy usage by their purchasing decisions — for example, whether to buy dried, fresh, canned or frozen foods; what cooking appliances to buy; whether to buy beverages in glass or plastic bottles or aluminum cans.

Careful management in use of a car for shopping trips and in use of appliances that burn fuel (such as gas, wood, or coal) results in corresponding savings in fuel.

Saving energy in use of electricity is somewhat more complex. Use of only the amount of fuel or electric power needed and avoiding wasteful practices are desirable in any case.

Avoiding heavy usage of high wattage electric equipment at times of day when the demand on the local utility company for power is highest helps to reduce the amount of scarce fuels the utility

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company must use to assure uninterrupted, stable power service. In rural areas, demand tends to be highest in late afternoons and early evenings, especially during winter months, at about the time dinner preparation and dishwashing are generally being done.

Energy use in the food system in the United States is estimated to account for 12 to 17 percent of total U.S. energy consumption. Of that amount, about 2.9 percent goes for agricultural production of food, 4.8 percent for food processing, 4.3 percent for home preparation of food, 2.8 percent for quantity food service operations, 0.5 percent for wholesale trade, and 0.8 percent for retailing.

<table>
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<tr>
<th>Farm Production Input Vs. Output</th>
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<td>For farm production of food, energy inputs for each unit of output varies with the type of food. One way to evaluate the return on energy investment in food production is to compare yield of energy (calories) and protein (grams) from foods in relation to units of cultural energy; that is, energy used in crop production.</td>
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Field crops such as oats, soybeans and wheat require relatively low amounts of cultural energy per unit of production. Deciduous fruits are intermediate. Vegetables and small fruits are the most energy intensive of the plant crops because of difference in cultivation, pest control, and harvesting requirements.

Production of meat animals and related animal products, on the other hand, is considerably more energy intensive than the growing of plants because animals must feed on plant materials and are not efficient in converting what they eat to energy or body mass.

Yield of protein from soybeans is fairly high per unit of cultural energy. Grains (wheat, oats, corn) yield lower amounts of protein per unit of energy input. Animal protein is highly energy intensive. Protein yield from legumes per unit of energy used in production is estimated at about 60 times greater than from beef or pork and 15 times greater than from chicken. Differences in quality of protein from different sources are not accounted for in such estimates.

If Americans obtained their food energy and protein entirely from grains and legumes, energy costs of food production for human consumption might be reduced to some extent.

This kind of analysis, however, overlooks at least three major factors: 1) the importance of other nutrients essential for human growth and health.
which are supplied in fruits, vegetables and animal products; 2) low acceptance of vegetarian diets; and 3) energy costs of converting such foods as soybeans to edible forms having familiar textures, appearance and flavors.

The more precooking and processing, special packaging and refrigeration a food requires, the higher the energy input is. For example, average energy requirements for slaughter of beef and pork are estimated at 910 and 1,750 Btu per pound of live weight, respectively. But processing (such as making weiners, bologna, smoked ham and bacon) increases energy costs by 5 to 10 times, adding as much as 7,000 Btu (more than 2 kilowatt-hours) per pound processed. It should be mentioned here that, with processing, some increase in carcass utilization is possible.

Although processing adds greatly to the energy required in production of meat, some of the products are consumed without further heating. In such cases, energy input in home preparation of the food is lessened and the extra energy used in production may tend to be equalized in the food chain from farm to table.

Fruits, vegetables, fruit and vegetable juices, and tomato sauces and catsup make up the bulk of food processed in the canning industry. In the making of catsup and tomato sauces, a major factor in energy use is the amount of water removed by evaporation. Sterilization by processing with steam is the major energy user in canning operations.

Energy requirements for commercial canning of tomatoes, fruits and vegetables in 1974 were calculated at about 1,600, 1,800 and 2,150 Btu per pound of fresh weight, respectively. Vegetables require longer processing than fruit and tomatoes to assure sterilization, and the longer food must be processed, the more energy is required.

The amount of energy required for sterilization in canning is affected not only by composition and acidity of the food but also by container size and shape. The food industry is searching for ways to reduce energy costs, including possibilities offered by new types of containers.

Food pouches made of a layer of aluminum foil sandwiched between two layers of heat-resistant plastic film are among container innovations considered by food canners.

The flat package permits more rapid heat transfer to food throughout the package than is possible in the cylindrical can. Shorter processing times are then needed and the fresh flavor and
texture of foods are reported to be retained well. Further, the pouches can be stored at room temperature.

An important drawback to the pouch is that more energy is required to make the pouch than to heat sterilize the food it contains.

Alternatives to commercial food preservation are home canning and freezing. Information on energy requirements in home preservation of food is more limited than for commercial operations at present and more difficult to determine as well.

However, for canning 7 quarts of tomatoes by the water bath method, 2.43 kWh of electrical energy were estimated by one source to be needed to bring the water bath and jars of food to a boil and to process them for 45 minutes. The energy input for this part of the canning job would amount to about 545 Btu per pound of canned tomatoes.

Energy for manufacture of canning jars and equipment and for heating water to clean the jars and peel the tomatoes is not accounted for. These factors, coupled with inefficiencies of home equipment and homemakers’ procedures, could easily amount to more energy than that needed for processing the food in an energy efficient commercial cannery.

Pressure canning fruits and vegetables by recommended procedures requires less energy than the water bath method because less time is required for heat processing. Perhaps more important, pressure canning helps assure safety of vegetables and low acid foods by permitting use of temperatures above 212° F.

Frozen foods, from the standpoint of total energy inputs from field to table, would be considered luxury foods. The initial energy costs of freezing alone are relatively low compared to energy costs of storage.

In general, about 0.1 kWh (314 Btu) of electrical energy is reported to be required to freeze a one-pound package of food and drop its temperature to 0° F. This figure does not include energy costs for preparing foods before freezing, such as the blanching of vegetables, nor for packaging materials.

Average energy consumption for food freezer operation per day — disregarding size, type and other factors — is reported to be about 3.3 kWh in cold months and 4.1 kWh in warm months. If a family kept 100 pounds of frozen food in the freezer on the average, the energy cost would amount to about 102 to 130 Btu per day per pound. The longer a package of food is held in the freezer, the higher would be the energy cost for its storage.
Much of our food is not locally grown and must be transported long distances. The average distance for moving food in the United States is reported to be 765 miles. Citrus fruits and juice, for example, are produced primarily in Florida and California and grains are grown and processed into animal feed, cereals and flour in the Midwest. Where the food is grown and processed in relation to where it is consumed affects transportation energy inputs correspondingly.

Two other important factors besides distance enter into energy consumption for food transportation: temperature requirements and weight. Refrigerated transport naturally requires more energy than nonrefrigerated, and the lower the temperature needed, the higher the energy input. As for weight, the lower the water content, the less transportation energy required. Thus less energy is required for hauling dried beans than canned baked beans or the like.

In some cases, energy inputs for producing and transporting foods over long distances may be less than for growing them locally. Production of vine-ripened tomatoes out of season is an example. As much as 40 times more energy may be required to grow tomatoes in northern greenhouses for local consumption than to truck field-grown tomatoes from Florida. No comparisons are made here of eating quality, nutrient content, or dollar costs.

The bulk of the food that families use is purchased. Food shopping trips generally require use of a car; consequently a part of transportation energy costs in households is chargeable to providing food for the family. Energy inputs for transportation are related to the energy efficiency of the auto, the distance of the residence from the shopping center, distances between stores shopped, and frequency of shopping trips.

In weekly trips with shopping for lowest prices in up to four food markets separated by a total distance of less than 5 miles, savings of as much as 14 percent have been reported over dollar costs of the same items purchased in a single store.

Energy for cooking in homes has been estimated at 1.1 percent of the total energy used in the United States. Most food preparation is done with the range, although American families own a number of portable appliances which can be used as substitutes for parts of the kitchen range — egg cookers, coffeemakers, countertop ovens, electric skillets, slow cookers and the like.
Some Cooks
Great, Others
Don't Rate

Work habits of the “cook” are a major factor in energy consumed in food preparation. Energy usage has been shown to vary by as much as 50 percent among women doing identical meal preparation tasks with the same kitchen range.

How can such variability among range users occur? With surface units on an electric range, 70 percent of the heat produced is estimated to go into the food in a utensil which fits and rests on the unit properly. The remainder of the energy goes to heat the element (10 percent) and losses to room air (20 percent). Additional losses can occur if utensils used are smaller than the heated area of the element and if heat settings are not appropriate for the cooking job.

As an example of the effect of heat settings on energy consumption with an electric range, consider the cooking of potatoes in a 2-quart covered saucepan. A 6-inch unit at the high setting would be used to quickly start the boiling. Once boiling has begun, the cooking temperature can be maintained with a low setting for about 20 minutes. If medium low is used instead, 100 percent more energy will be used than actually needed.

Use of a utensil with a fitted cover during cooking with water is worthwhile. The lid prevents loss of heat from the pan by evaporation. Six times more energy is required to change water to steam than to bring it to a boil. In addition, small amounts of cooking liquid can be used in a covered pan without burning food if heat settings are controlled, cooking time is shortened, and uniformity of cooking is improved. Further, nutrients and flavor of foods are conserved.

Range ovens are less efficient in energy use than surface units and burners. Only 14 percent of the heat produced during cooking in an electric range oven is estimated to enter the food. Of the remaining 86 percent of the energy, 46 percent goes for heating the oven lining, 25 percent is lost through oven walls and 15 percent is lost through the oven vent.

Efficiency of gas range ovens is poorer than for electric ranges. Only 6 percent of the heat produced is estimated to penetrate the food load, 20 percent heats the materials of the oven structure, 11 percent is lost through the oven walls, and 63 percent is lost through the vent. Greater movement of air through the gas oven than through electric ovens is needed in order to provide oxygen for the flame and to remove moisture vapor produced in combustion of the gas and evaporated from the food.

It should be pointed out in comparisons of gas
and electricity consumption that about 10,500 Btu input is required to produce and deliver one kilowatt-hour (3,413 Btu) of electric energy.

**Keep That Oven Door Closed**

With both electric and gas range ovens, door openings cause additional heat losses and further reduce the energy efficiency of the ovens. Suggestions to time oven cooking and to avoid frequent or lengthy door openings during oven uses should be heeded.

If basting of a food is necessary or items are added to food already cooking in the oven, the food might well be removed from the oven for attention in order to avoid wasting heat through prolonged opening of the door.

Heat losses in cooking contribute to the heat load and cost of home air-conditioning in summer. In winter, the wasted heat from cooking contributes toward home heating but is an inefficient method of comfort conditioning.

Planning food preparation to do several cooking jobs while the oven is heated improves efficiency in energy use. An oven meal when meat or a pie is to be cooked in the oven, for example, takes advantage of available heat.

Many foods lend themselves well to oven-cooking. Potatoes may be oven-cooked in several ways besides baking. Fruit and vegetables can be steamed in covered baking dishes. And a variety of desserts are appropriate choices for oven preparation.

The additional food load for an oven meal causes some increase in energy needed, but not nearly as much as reheating the oven a time or two or heating additional surface units to complete a meal.

Recipes requiring use of ovens often call for preheating. Some revision of traditional practices may be appropriate in view of claims that oven preheating wastes energy, that preheating may increase energy usage by as much as 25 percent or more, and that cold oven starts in modern ovens yield acceptable products.

Items that need to be cooked for half an hour or more and non-critical items such as roasts, baked potatoes and casseroles should not require a preheated oven unless an old model range is used in which the broiler unit comes on during preheating. With modern ranges, preheating occurs quickly, usually in less than 10 minutes, and some heating of foods occurs as the oven heats if preheating is eliminated. Quick-cooking items such as biscuits
may require as much as 30 percent additional baking time in absence of preheating the oven in order to get desired browning and thorough cooking.

In comparisons of energy usage in cooking with portable appliances and conventional ranges, portable appliances usually are slightly more energy efficient. The differences are attributed to the smaller mass to be heated, lower wattage rating, and better contact between the food container and the heating element in the portable appliance than for a saucepan or skillet on a range.

In cooking jobs normally requiring long slow cooking, such as navy bean soup, a pressure saucepan on a conventional range may be more energy efficient than a covered saucepan or a slow cooker.

As much as 16 percent less energy may be required with the pressure saucepan than with the slow cooker, and 40 percent less energy with the pressure saucepan than with the regular saucepan. Percentages of savings vary greatly with cooking times involved.

Purchase of portable cooking appliances with the expectation of reducing the drain on U.S. energy resources may be counter-productive. Energy savings in use of the appliances may be small and involve very long payback periods. Further, energy required to produce the appliance may far exceed energy saved by its use. If portable appliances are owned or acquired for whatever reasons, however, they certainly should be used when possible.

With the microwave ovens, only 40 to 50 percent of the energy input is absorbed by food loads. This explains why a table model microwave oven may have a wattage input rating of 1,450 W and an output (cooking power) rating of only 650 W.

Less energy is generally required for cooking or heating small quantities of food in a microwave oven than with an electric range. For cooking complete family meals, however, a microwave oven does not use significantly less energy than an electric range when appropriate procedures are followed.

**Dishwashers**

Energy usage associated with food for the family doesn't stop with acquiring the food, storage, and cooking. Energy is used also in cleaning the dishes and cooking utensils. About 43 percent of American homes wired for electricity were equipped with mechanical dishwashers as of December, 1979.

Energy used in automatic dishwashing includes electricity for operating the motor and a heating element during the process. A typical dishwasher
model on the market today requires about 0.6 kilowatt-hour of electrical energy each time it is used on a "regular" setting, including both wash and dry phases. The energy usage is cut about in half if the dishes are air-dried without heat.

Some dishwasher models have a heat/no heat drying option. Similar energy savings can be accomplished in older models by stopping the dishwasher operation after the last rinse and drain, leaving the door slightly ajar, and letting the dishes dry by evaporation.

Average energy usage per day in households for operation of mechanical dishwashers is about 0.4 kWh. Families are apparently drying dishes without heat or are waiting to wash them until they have a full dishwasher load.

Dishwashing water must be at least 140° F to effectively soften and remove fatty soils such as beef fat from surfaces of dishes and cookware and to cause water to evaporate during drying, particularly when the no-heat drying option is used.

For people who want clean dishes but also want the temperature of their household water supply lower than 140° F, dishwasher models are now available which will heat the water to the appropriate temperature after the dishwasher fills with water but before dishwashing action begins. Energy losses associated with storage of hot water in the household hot water system may thus be minimized, but use of the feature increases total time needed for dishwashing because of the initial delay while the water heats.

Use of hot or warm water to prerinse dishes before loading them into the dishwasher wastes energy. Most dishwashers are designed to thoroughly clean dishes with food materials simply shaken off or scraped lightly and not pre-rinsed.

Dishes washed mechanically and handled appropriately are generally more sanitary than those washed by hand unless particular care is given in the handwashing process. A procedure for bacterially clean dishes by hand includes scraping, washing in hot detergent solution (120° F), rinsing by pouring boiling water over them, and allowing them to air dry in a clean environment.

Hand washing of dishes may require as little as 2 gallons of water or much more per time, depending upon whether water at the faucet is allowed to run continuously throughout the dishwashing. At the least, 1 kWh of energy would be required to heat 2 gallons of cold tap water.
Mechanical dishwashers typically use 12 to 14 gallons of water, all of which is as hot as the household water heating system provides, for a complete cycle at the "regular" wash setting. Heating 12 gallons of cold water to 150°F in order that the water entering the dishwasher may be at least 140°F requires about 3.2 kWh of electricity or 10.4 cubic feet of natural gas in winter, and 2.6 kWh or 8.5 cubic feet in summer in northern climates (assuming tap water temperatures of 40°F in winter and 60°F in summer). Thus 4 to 5 times more energy is required for heating water than for operating the dishwasher itself.

About the same amount of hot water is used in mechanical dishwashing, whether a few items or a full load is washed. More energy will be conserved by accumulating a full load before washing than by drying the dishes without heat.

Energy management in providing food for the family is a highly complex matter without easy answers. At present, much more information is needed in order for us to feel comfortable with our decisions about how to be good stewards of the resources available to us.