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THE DOLLAR, ENERGY, AND EMPLOYMENT IMPACTS OF CERTAIN CONSUMER OPTIONS, VOL. I

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ABSTRACT

Impacts are compared for a spectrum of home consumption options, such as home vs. laundromat washing, hand vs. machine dishwashing, fresh vs. frozen vs. canned food, returnable vs. throwaway beverage containers, and various sets of kitchen appliances.

SUMMARY

We have compared different consumer activities or products which provide comparable services with respect to their dollar, energy and labor (DEL) cost. Dollar cost is measured in consumer prices and includes all purchases which support the service under consideration (see Table 1.1). Energy cost is the total primary energy required by the U. S. economy to provide the service to the consumer, and includes contributions from all aspects of mining - manufacturing - processing - sales. Labor cost is the total man years of labor required, and likewise includes all steps. (However, home labor, such as for washing dishes, is not included.)

This is done for nine product groups. The methodology uses energy and labor input-output techniques and additional analysis. DEL costs are given in annualized form; the service lifetime of devices have been accounted for (unless otherwise stated). Results apply to the year 1971 unless otherwise stated.

In comparing options, we should also consider the effects of alternative spending of the money saved if the consumer chooses the less expensive option. We have provided a method by which the energy and labor cost of this spending may be obtained for comparison.

In general, we found that the multiplicity of mini-options (for example, is the water heater electric or gas?) greatly complicated results. We can, however, summarize as follows:

1. The DEL costs of 25 kitchen appliances are obtained, and the costs of three sample kitchens - Spartan, moderate, and fully appointed - are compared.
2. Gas or electric clothes dryers are at least 8 times as expensive, 34 times as energy intensive, and 8 times as labor intensive as outdoor drying.
3. Washing and drying clothes at a laundromat rather than at home is more expensive and energy intensive except for the most costly home option (such as electric water heat and electric dryer). The laundromat is also less labor intensive per load than all except the most spartan home option (gas water heater, cool rinse, no dryer), which is approximately its equal. This does not include transportation to the laundromat; when this is included, laundromats increase rapidly in dollar and energy cost.

4. Paper towels are more expensive, less energy intensive, and less labor intensive than cloth. The energy result is highly dependent on the hot water to wash the cloth towels, and can be reversed by schemes to conserve hot water.
5. Disposable diapers are more expensive than cloth. Whether they are more energy intensive depends on the home laundry options used. Disposables are more labor intensive than cloth.
6. Disposable paper plates and cups are at least 6 times as expensive, 1.7 times as energy intensive, and 7 times as labor intensive as earthenware dishes (i.e., "inexpensive china").
7. Dishwashers are rather efficient in their use of hot water. Since hand dishwashing habits vary so much, we cannot draw a definite conclusion on relative DEL costs. (Results are presented so that the reader can compute his own DEL costs.)
8. Fresh, frozen, and canned fruits and vegetables are compared. In increasing order, the costs (for 1963) are:

   Dollars: Canned and frozen (equal), fresh

   Energy: Canned, frozen and fresh (equal)

   Labor: Canned and frozen (equal), fresh
9. Metal household furniture is less expensive, more energy intensive, and less labor intensive than wood household furniture. (This refers to manufacturing and purchase only, and includes no consideration of relative durability.)

I. INTRODUCTION

1.1 The basic question

When providing a particular service or product to consumers, are there two (or more) ways to do so which differ significantly in their total energy impact? In other words, are there less energy intensive product choices which provide equivalent levels of comfort and convenience? If so, what would be the costs--first, in dollars to the consumer, and second, in employment--of moving toward the less-energy intensive alternatives? These are the questions addressed by our research on product groups.

We have analyzed nine groups, sometimes pairs, of consumer products for their dollar, energy, and labor (DEL) costs. (They are listed in Section II of the table of contents.) The dollar cost is that paid by the consumer for all activities supporting ownership and use of the product. Energy cost is the total primary energy required, labor cost is the total man years of employment.* To obtain total energy (or dollars or labor), one must be attentive to indirect aspects as well as direct. When you consume anything, you are consuming energy. For example, the manufacture of an automobile, including the mining and processing of ores, transportation of materials, fabrication of parts, assembly, etc., requires as much energy as the car burns in one year's driving. And, of this energy, only about 6 percent is used directly by the automobile industry.

We have dealt with indirect costs, but this causes problems of its own. For example, does the energy to manufacture home water pipes contribute to the energy impact of the dishwasher? We would say yes, except that they would probably be there anyway--so that the incremental energy impact of the dishwasher would not include the pipes. On questions like this, we have had to make several arbitrary decisions on where to truncate the search for indirect contributions. Such decisions are noted when made.

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*Throughout this report labor cost does not include home labor.

1.2 Methodology

Almost all indirect energy and labor impact has been evaluated through use of input-output (I/O) coefficients developed for 1963. This is discussed in Appendix B. We have converted this to 1971 using approximations (Appendix A). The development, applications, and limitations of the coefficients is described in reference 1 (energy) and reference 2 (labor).

The general model for DEL cost adds the impacts of all contributing factors on an annual basis. The total cost is given by:

capital cost + maintenance cost + disposal cost + operating cost

where each is expressed on a per-year basis. (To annualize we have had to obtain lifetimes of devices, or number of uses during the lifetime.) Energy is expressed in British thermal units (Btu) and labor in man-years.

Dollar cost is computed similarly; this means the assumed interest rate is zero. In Appendix V we discuss the reason for this choice, and the potential errors resulting.

1.2.1 The savings reinvestment question

In comparing any pair of alternatives for their energy and labor cost, we must also ask how the money saved would be spent instead. (If it's spent on gasoline, the energy savings probably are negated.) After much discussion, we conclude that it would be incorrect to assume that the consumer will spend the savings in a predictable manner (based on our (i.e., the author's) meager knowledge of human behavior) [3]. Hence we have provided, in Appendix W, a list of consumer activities with their energy and labor intensity (Btu and man years per dollar expended). This appendix is included in both volumes of this report.

The interested reader can determine the energy impact of his own alternative spending of money saved. If he wants to save energy, then he would choose an activity lower in energy intensity than the one he has given up.

1.2.2 Wood energy cost

Wood, if not committed to make things, could conceivably be burned productively. We have decided to include this energy as a part of the total energy cost of the appropriate items. (We have done this for oil or natural gas based products, such as plastics, as a matter of course.) On the other hand, we have not accounted for potential recovery of energy from productive burning of the final product. This results from the practical observation

that today, little garbage is burned productively (see Appendix F).

1.2.3 What kinds of answers are provided

First, we provide the DEL cost of the consumer products and services, measured in 1971. Second, with adequate qualifications we can predict the DEL consequences of changes in consumption. Qualifiers include 1) basic limitations of I/O analysis; see ref. 1; 2) a need for a long adjustment period. For example, we have annualized the cost of many large appliances over 14 years. Hence the statement that "X amount of energy will be saved by a shift from frost-free to conventional refrigerators by Y people or Z number of jobs will be produced " would be true only after something like 14 years, if technology stayed constant.

Most of the choices within a product group are not completely substitutable; often one is less convenient or more time consuming, and some difference in lifestyle is implied. This difference may be weighed by the consumer against the dollar, energy, and labor costs which we have obtained.

1.2.4 Format

The report is divided into a relatively short descriptive section, and a lengthy set of computational appendices. The appendices are bound separately.

2. Results

Before discussing each product group, let us state four general points.

First, we conclude that if there is one general rule for energy conservation in the home (after dealing with space heating and cooling), it is: conserve hot water. We found that water heating energy was by far the dominant factor in several of our product groups.

Second, there is a great spectrum of options even within a product group. We have tried to simplify, but often could not because we would have glossed over what seem to be worthwhile options. For example, for washing, even if we assume an automatic washer, we still have these questions: 1) electric or gas water heat, 2) warm or cool rinse, 3) electric, gas or no dryer, which already yields 12 different possibilities. This complicates our presentation, but it seems unavoidable.

Third, we have had to make arbitrary, but hopefully reasonable, assumptions on "equivalence" of products. For example, what's the cloth equivalent

of one 170 sheet roll of paper towel? (We concluded it is 14 hand-sized towels and two "rags.") In some cases we felt so unsure that we provide enough information for the reader to use his own equivalence. This requires considerable effort on the reader's part, however.

Fourth, we have obtained some results which indicate that the minimum energy does not always imply minimum environmental impact. For some home washing options, we find that paper towels are <u>less</u> energy intensive than cloth. One must, therefore, weigh the question of forest use against energy reserves depletion to resolve the question of total environmental impact.

2.1 DEL costs of kitchen appliances

We have obtained the DEL costs of 25 kitchen appliances. From these results one can build up the energy and labor impact of his own set of appliances. To illustrate we have compared three sample kitchens.

We have accounted for the energy and labor to make and maintain appliances as well as to operate them. We found it useful to define a ratio, "Q."

$$Q = \frac{\text{capital energy + maintenance energy + disposal energy}^{*}}{\text{annual operation energy}} \qquad (1)$$

All energies are in primary terms. From reference 1, operation energies used in the home are delivered with these efficiencies:

electricity - 25.8%

gas - 85.5%

Data on operational energies and purchase prices come from industry associations [4,5,6] and represent averages for typical use. Here we are not investigating the effect of reducing use of a given appliance; we take an "all or nothing" approach. Manufacturing, sales, and maintenance energy were evaluated using I/O coefficients; see Appendix A. Maintenance costs were difficult to obtain and were estimated according to the following scheme: if the appliance cost less than $20, it was assumed to last 8 years and be retired without maintenance. If it cost more than $20, it was assumed to last 14 years and receive a total lifetime maintenance bill equaling one

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* Disposal energy is negligible for appliances. We did not place maintenance energy in the denominator since maintenance is often sporadic; hence often "ε_{op}" is the only perceived yearly cost.

half the purchase price. Exception: (water heaters were assumed to fall in the first category). (See Appendix B.)

The annualized total energy cost, ε_{tot}, is then

$$\varepsilon_{tot} = (1 + Q/\tau)\varepsilon_{op} \qquad (2)$$

where τ is the lifetime in years.

The ratio Q/τ expresses the importance of the indirect energy requirements. Appliances which provide heating or cooling tend to have low Q's (e.g., a clothes dryer; Q = 2), while those which produce only mechanical motion have higher Q's (e.g., an electric mixer; Q = 7). For high Q appliances, ε_{tot} is quite sensitive to changes in lifetime; for low Q, it is not. This leads to the observation that prolonging the lifetime of low Q appliances through increased durability will effect relatively little energy savings.

In Table 2.1.1 are listed the DEL costs for 25 appliances. An arbitrary kitchen may be constructed from these. As an example, we have looked at three kitchens, from rather Spartan to full. The results are presented in Table 2.1.2 and Figure 2.1.1.

From Table 2.1.1, we see that the full set (including frostless refrigerator and freezer, washer and dryer, and dishwasher) has a yearly energy impact of about 120×10^6 Btu (gas) and 150×10^6 Btu (electric). This is the equivalent of five or six tons of coal.

The "moderate" kitchen differs from the full in its substitution of conventional freezer and refrigerator for frostless models where possible, its absence of a dishwasher and many smaller appliances (blender, can opener, disposal, exhaust fan, electric frying pan, hot plate, electric knife, and waffle iron). Its energy impact is about 4/5 that of the full kitchen. Many of the rejected appliances are small energy users.

The Spartan kitchen retains only four basic appliances: range, clotheswasher, water heater*, and refrigerator (not frostless). Here, the energy cost is about 55 percent of the full kitchen. Thus, these four appliances

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*We have not computed the reduced use of the water heater due to a lack of a dishwasher. Roughly speaking, hand and machine dishwashing require the same amount of hot water.

are responsible for over half of the energy required by the full kitchen set of about 20.

As expected, electric options increase energy use and expense. The additional annual energy cost of an all-electric full kitchen is about 28 x 10^6 Btu, or one ton of coal equivalent, an increase of 23 percent over the all-gas option. The additional cost is $86, an increase of 26 percent over the all-gas option.

In spite of all the attention we have paid to manufacturing--maintenance energy cost, operational energy (in primary terms) accounts for over 90 percent of the total energy impact. Those appliances which have a high Q consume little energy, and hence contribute little to the total.

Additional information is found in Appendix C.

2.2 DEL costs of mechanical and outdoor clothes drying

We compare an electric-pilot gas dryer, or an all electric, with a clothesline-pole combination. The dryers are assumed to have a lifetime of 4000-39 minute cycles, and the outdoor equipment to last for 4000 hangings of a similar load. (See Appendix J.)

Table 2.2.1 breaks down the total energy and labor impact of the dryer. This is compared with the outdoor drying option in Table 2.2.2, and shown graphically in Figure 2.2.1.

Conclusions:*

The gas dryer is 8 times as expensive as outdoor drying (12 times for an electric dryer).

The gas dryer is 34 times as energy intensive as outdoor drying (70 times for an electric dryer).

The gas and electric dryers are 8 and 9 times as labor intensive respectively, as outdoor drying.

2.3 DEL cost of home laundry vs. laundromat

Two questions arise in this product group. First, are there DEL economies of scale in laundromat operation which overbalance the added DEL costs

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*We note again:

1. Home labor is not included.
2. We have not accounted for possible spending of money saved.

of constructing, lighting, and space conditioning a building built expressly as a laundromat? Second, how significant is transportation to the laundromat?

To obtain the DEL costs of home laundry operation, we had to consider several sub-problems, such as the DEL costs of hot water. We found it necessary to keep distinct a large number of home laundry options, depending on presence or absence of a dryer, type (electric or gas) of water heater, etc. (See Appendix D.)

For the laundromat data, on the other hand, we used an actual case study of three local laundromats in which actual energy bills were obtained. We assumed that the space conditioning and lighting energy of the building was a part of the energy cost of laundromat laundering, whereas at home no correction was needed. (See Appendix U.)

It was necessary to obtain a definition of a "load." This is not universally accepted, but depends on standards of cleanliness, type of fabric, etc. We did find, however, that for washing, commercial and home machines do handle equivalent loads [7,8].

A few additional aspects of laundromat laundering should be mentioned. First, laundromats almost always use gas for all their heating needs. Second, a laundromat user often "must" use the dryer, as he has no place to hang the wash. (For our laundromat case studies we could not separate energy used for washing from that used for drying; our laundromat energies represent an empirical average of customer behavior.) Third, while the laundromat machines may be more durable (they have a heavier drive mechanism), they are subjected to harder use. Also, since (Appendix D) capital and maintenance energies total only about 10% of the total energy cost of home laundering, differences in machine durability would have a very small effect on total energy cost.

Results are given in Table 2.3.1 and Figures 2.3.1, 2 and 3.

The additional DEL costs of automobile transportation are based on an average American automobile and include all automobile associated costs (see Appendix J).

Conclusions:

For all but the most expensive home options (such as electric water heater and dryer), the laundromat is a more expensive way to wash clothes, assuming no driving. If automobile transportation is included, the laundromat is almost surely more expensive.

For most of the home laundry options, the laundromat uses more energy. Adding auto transportation makes it almost surely so.

The laundromat option uses less labor than all but the most spartan home option, but a few miles of driving increases the labor impact to equality.

Let us compare DEL costs for a specific home option - gas water heater, warm rinse, electric dryer. (This is the most common arrangement for households who have dryers - even though today only 30% of households do [6]). For this case, the laundromat is about 20% more expensive, 15% more energy intensive, and 50% less labor intensive than home laundering. The use of auto transportation will increase the energy difference, and decrease the labor difference.

2.4 DEL costs of paper and cloth towels

We found a wide range of opinions on the substitutability of paper and cloth towels [9]. To allow the reader to make his own choice, we compute the DEL costs for a roll of paper towels (170 sheets) and one clean 15" x 27" towel. We also make a comparison for a reasonable substitution.

The dominant factor in the energy cost of a cloth towel is the washing and drying. The towels are assumed to last 300 washings; (the full computation is in Appendix E). In all cases an automatic washer is assumed. As discussed in Appendices F and G, the energy content of the paper is included.

Table 2.4.1 lists the DEL costs for a single towel; for comparison the reader should multiply the entry times the number of towels (letting a "rag" for cleaning spills equal one towel) he feels would substitute for a roll of paper towels.

We felt that a reasonable equivalent of a roll of paper towels is 14 towels and 2 rags. In Table 2.4.2 and Figures 2.4.1, 2, 3 we compare DEL costs.

Conclusions: (These apply to our choice of cloth-paper equivalence only)

Cloth towels are less expensive than paper towels. Even if the energy content of the paper is included, the cloth towel option is more energy intensive, by up to a factor of 2.3. Cloth towels are less labor intensive than paper.

2.5 DEL costs of disposable vs. cloth diapers

We compare a gauze prefolded (cloth) diaper with associated waterproof

pants and a disposable diaper.* Both were selected from the 1963 Sears Roebuck and Company catalog. We have assumed that cloth diapers are home washed in an automatic washer, but that plastic pants (one change of pants to every two cloth diaper changes) are washed by hand. Details are in Appendix R.

Table 2.5.1, and Figures 2.5.1, 2, 3 list the DEL costs.

Conclusions:

Disposables are more expensive, by at least a factor of 2.5.

Disposables (including the paper energy content) are more energy intensive than half of the cloth diaper options, and less energy intensive for the remainder.

Disposables are more energy intensive than any cloth option. (Note again that this does not include home labor.)

2.6 DEL costs of disposable paper and earthenware dishes

We compare the DEL costs of an earthenware cup and plate vs. a paper cup and plate. "Earthenware" is "inexpensive china"; it is strictly defined as "low-fired clay, which is slightly porous and opaque and covered with a non-porous glaze."** We chose a "nicer" paper plate and cup: a 9 inch plastic coated plate and a 7 ounce plastic coated hot cup.

We assumed the china dishes to last two years at two uses per day (Appendix Q) and that a plate and cup constituted 2/50 of a dishwasher load. Due to difficulty in determining good average figures for hand dishwashing DEL costs (see Section 2.7), we assumed a mechanical dishwasher. As is typical with items that are washed often in their lifetimes, the capital energy contribution was relatively small, so that the actual choice of lifetime is quite unimportant to the energy conclusions we obtain.

Results are in Table 2.6.1.

Conclusions:

Disposable paper dishes are at least 6 times as expensive as earthenware.

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*Cloth: Prefolded, 8 larger center, 4 larger edge, 14"x21". Disposables: 14"x19", flat.

**Compare "china": "a hand-fired ceramic ware with a dense, vitrified, but opaque, body."

Disposable paper dishes are 3 times as energy intensive (gas water heater) or 1.7 times (electric water heater) as earthenware. Disposable paper dishes are at least 7 times as labor intensive as earthenware.

2.7 DEL costs of washing dishes by hand and in a dishwasher

For this comparison we have encountered such a wide spread of hand dish-washing techniques that we can give no definite answer as to relative DEL costs. The reader will have to determine his own habits and compute the energy and labor impact from the information we provide.

A typical automatic dishwasher can handle 10 place settings - the dishes used by a family of four in one day. The largest contributor to the energy cost is the hot water used (see Table 2.7.1). The next largest factor is the operational energy; this is relatively large because a dishwasher often contains a heater to heat the input water, and, sometimes, another to dry the dishes after washing.

We assumed that hand washing has a modest requirement for capital goods (dishpan, rack, brush, clean dish towel, etc.) and that hand and machine washing use the same amount of detergent per article washed. (See Appendix P.) Hot water's energy contribution again dominated. We have therefore expressed hand dishwashing results as a function of hot water used in Figures 2.7.1, 2, 3. We list volume of hot water in gallons, or "sinkfulls." A 15" x 14" x 8" sink filled to a depth of 6" requires 5.4 gallons. Thus a sinkfull of "hot" requires 5.4 gallons of hot (140 degree) water; a sinkfull of warm (115 degree) requires 3.9 gallons of hot (140 degree) water. (Cold water has essentially zero DEL cost compared with hot.)

Conclusions:

The dishwasher uses 14 gallons of hot water to do a family's dirty dishes, or 2.6 sinkfulls of hot water. It appears that dishwashers are quite efficient in their use of water, and that it would take some effort to hand wash these dishes with that little hot water.

If hand washing did use 14 gallons of hot water, we could conclude:

Hand washing is 20 to 30 percent less expensive.

Hand washing is 20 to 25 percent less energy intensive.

Hand washing is 30 to 40 percent less labor intensive.

(Again: Home labor is not included.)

2.8 DEL costs of fresh, frozen, and canned fruits and vegetables, 1963*

We compare the DEL costs of equal servings of a selection of fresh, frozen, and canned fruits and vegetables. Home refrigeration is a significant contributor to the energy cost and is included.† We have studied those fruits and vegetables which are available in all three forms; we have not considered the full spectrum of perishables.

Table 2.8.1 shows that on a per-dollar basis, in producer's prices, canned and frozen fruits and vegetables are about 75% more energy intensive than fresh. When converted to purchaser's prices (see Appendix T), the difference drops to about 20%, which is still significant. The question then becomes: how do they differ in price? Two problems complicate the answer: first, the difficulty of normalizing to an equivalent serving [10]; second, the difficulty of obtaining representative price data (fresh food prices fluctuate seasonally, locally, etc.).

We found only one price source which offered consistent data over the whole "triplet" (fresh, frozen, and canned) for a spread of products [11]; we used it. The data were collected for a twelve month period for four cities - Oakland, Milwaukee, New Orleans, and Philadelphia. The base year was 1959-60, a potential problem, since our I/O results are for 1963, but we used the prices without modification, as listed in Table 2.8.2.

Given the problems mentioned, we feel we can try only to answer this question: if one buys only fresh, only frozen, or only canned fruits and vegetables where there is a choice, which policy is least energy intensive.

Since we do not know what percentage of the average home refrigerator's space is allocated to our selection of fruits and vegetables, we have plotted DEL costs as a function of this fraction (α) in Figures 2.8.1, 2, 3.

From Table 2.8.2, we see that for the "average" purchase pattern for fruits and vegetables, the cost of frozen foods is 83% of that for equivalent fresh produce. Canned foods cost 77% as much as the equivalent fresh.

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*Because of relatively rapid price changes we do not feel that the 1963 results can be extended to 1971 with confidence.

†About 45% of the average family's food bill is spent for perishables other than baked goods. In 1963 this amounted to about \$900/family (Statistical Abstract of the United States, 1971, Tables 538, 542). The energy impact is approximately \$900 x 50,000 Btu/\$ = 45×10^6 Btu. From Table 2.1.1, a refrigerator had an energy impact of about 8×10^6 Btu/yr., or about one fifth of that of the food stored within.

(Note that these ratios don't apply to all fruits and vegetables, since several are available in only one form, e.g., lettuce.) While the choice of α depends on personal habit, we feel that $\alpha \leq 0.1$. (We are concerned here with only $1.93 fresh-equivalent of food per week, in 1960 prices.)

Conclusions:

If we assume $\alpha = 0.1$, and note that costs that differences of less than 10% are not statistically significant, we find in increasing order of cost:

Dollars: Canned and frozen (equal), fresh.

Energy: Canned, frozen and fresh (equal)

Labor: Canned and frozen (equal), fresh.

2.9. DEL cost of wood and metal household furniture

These two categories are sectors in the I/O table (22.01 and 22.03); in theory comparison should be easy. However, obtaining representative furniture prices is a bit difficult, since some furniture is a low volume, high profit product [12]. We again used the Sears Roebuck and Company catalog. We made our own, hopefully reasonable, decisions on choice of products, and made no attempt to evaluate relative durability (see Table 2.9.1). Hence our results will yield only the energy and labor impact of the purchase, and will not be normalized per year of service. (In most of the other product groups we have included lifetimes.) Our results are for 1963. We found little wood furniture available for 1971. In that time period the economy has been evolving toward metal furniture. As we found, this was the more energy-intensive option.

For 1963, the energy intensity per dollar of metal furniture is 1.97 times that of wood furniture, in producer's prices [1]; when converted to purchaser's prices the fraction is reduced to 1.59 (66,400 Btu/$ to 41,800 Btu/$), still a significant difference. The higher energy intensity for metal furniture is based in large part on the energy intensity of metals production [14]. Table 2.9.2 gives the final energy and labor costs. (Details are in Appendix S.)

Conclusions:

From Table 2.9.1, we see that for the selection of furniture we chose, metal is never more expensive, and is usually less so than wood furniture.

However, because of metal furniture's relatively high energy intensity

per dollar, for all furniture selected the metal option has a higher energy cost than the wood.

Metal furniture is less labor intensive than wood.

APPENDIX V. THE EFFECT OF INTEREST RATES ON DOLLAR COST

In the draft report we did not use an interest rate in computing dollar costs. We adhere to that inclination because of the difficulty of determining 1) how, or if, the purchase is financed; 2) the maintenance payment schedule. In this appendix we compute examples of cost increases if we were to include an interest rate.

The question we ask is this: What annual payment (assumed equal for each year) must we make to be sure all payments (initial cost, maintenance, operation) will be covered as they become due? The assumption is that if we have "overpaid," we will receive an interest rate r on our money; if we have "underpaid" we will pay an interest rate r on the negative balance.

Let:

C(n) = payments due in year n

p = annualized yearly payment we must make

N = lifetime of device.

At the beginning of year n, we have a principal = P(n-1). At the end of year end, we have left

$$P(n) = P(n-1)(1+r) + p - C(n)$$

We assume zero principal for n=1; i.e., at the beginning, and we assume that the principal is again zero for year N. Thus

$$P(N) = 0 =$$

$$[(p - C(1))(1 + r) + p - C(2)]\ (1 + r) + p - C(3)\ \ (1 + r) + p - CN)] \ldots$$

$$+ p - C(N)$$

$$= p[(1 + r)^{N-1} + (1 + r)^{N-2} + \ldots .\ 1] - [C(1)(1 + r)^{N-1} + C(2)(1 + r)^{N-2}]$$

$$+ \ldots C(N)$$

$$= p\ (\frac{(1 + r)^{N-1}}{r}) - \sum_{n=1}^{N} C(n)(1 + r)^{N-1}$$

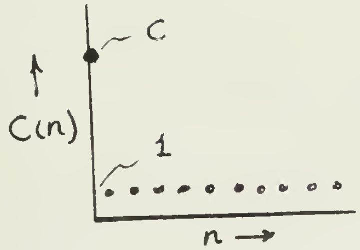
$$p = \frac{r}{(1 + r)^{N} - 1} \sum_{n=1}^{N} C(n)\ (1 + r)^{N-1} \qquad (3)$$

If r = 0,

$$p_0 = \frac{1}{N} \sum_{n=1}^{N} C(n) \qquad (4)$$

We need eq. (4) to compute dollar cost. Let us compare p_0 and p for different values of r and different payment schedules.

Case 1



Down payment of value C and unity yearly costs

In this case eq. (3) can be written

$$p = \frac{r}{(1+r)^N-1} C(1 + r)^{N-1} + 1$$

while

$$p_0 = 1 + \frac{C}{N}$$

Thus $p = 1 + \beta \frac{C}{N}$, where $\beta = \frac{Nr(1+r)^{N-1}}{(1+r)^N-1}$

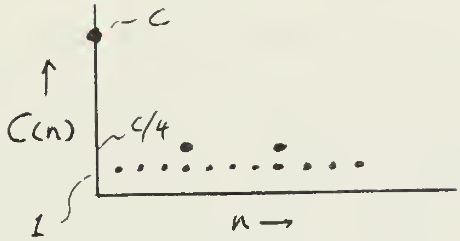
We compute values of β for case 1.*

r =	.06	.18
N = 5	1.12	1.35
10	1.28	1.89
15	1.46	2.49

We see that the effect of the interest rate is to as much as double the effective dollar cost contribution from the original purchase. $\frac{C}{N}$ is large (it might be of order one for a refrigerator), the ratio p/p_0 could be around 1.5; i.e., a 50% error.

*6% is the best bank interest rate; 18% is a typical credit card rate. Of course, we have simplified reality by assuming the same rate applies to borrowing or lending.

Case 2



Down payment of value C, two maintenance payments of $\frac{1}{4}$ C at $n = \frac{N}{3}, \frac{2N}{3}$, and yearly costs of unity.

For this case we expect the effect of the interest rate to be less pronounced.

$p_0 = 1 + \frac{3}{2}\frac{C}{N}$. If we write $p = 1 + \beta \frac{3}{2}\frac{C}{N}$, we find, for N = 15,

$\beta = 1.29$ for $r = 0.06$

1.93 for $r = 0.18$

The effect is indeed less, but still of order two, leading to errors of order 50% in dollar cost.

These errors are thus implicit in all dollar results in this report, if one believes that the interest rate should be included.

Note that if we include interest effects in dollar cost, there is then the question of energy cost of banking, etc., which we have also ignored.

APPENDIX W. ENERGY INTENSITIES OF PERSONAL CONSUMPTION ACTIVITIES

The U. S. Department of Commerce has published a detailed study of personal consumption [1]. 83 "activities" (e.g., purchased meals and beverages) are broken down into their component expenditures by input-output sector. In this form they are easily converted to energy. Table W-1 lists the results, which have been scaled from 1963 to 1971 using published deflators [2].

The dollar breakdown is a national average, and undoubtedly incorporates many arbitrary assumptions. If you never buy hot dogs when you go to a ball game, your energy intensity for activity 71, "spectator sports," is probably not average. Nonetheless, Table W-1 offers some guidance on how to direct your spending if you desire decreased energy impact.

Note that the average of all personal consumption expenditures in 1971 was 70,000 Btu/$. Only 16 of the 83 activities were more energy intensive.

Table W-1
Energy intensities of personal consumption activities

ENERGY INTENSITY RANKED SECTOR TABLE (1971)

RANK	ACTIVITY	TITLE	ENERGY COEFFICIENT BTUS/$
1	29	GAS	986048.
2	31	OTHER FUEL & ICE	631064.
3	28	ELECTRICITY	504899.
4	52	GASOLINE & OIL	480070.
5	60	AIRLINE TRANSPORTATION	130918.
6	30	WATER & OTHER SANITARY SERVICES	78819.
7	26	CLEANING PREPARATIONS	78035.
8	61	OTHER INTERCITY TRANSPORTATION	69520.
9	53	BRIDGE & ROAD TOLLS	65781.
10	59	INTERCITY BUS TRANSPORTATION	63975.
11	50	TIRES, TUBES & PARTS	62375.
12	58	RAILWAY & SLEEPING CAR	59621.
13	22	KITCHEN & HOUSEHOLD APPLIANCES	58896.
14	15	TOILET ARTICLES	57646.
15	56	TAXICAB TRANSPORTATION	57381.
16	49	NEW & USED CARS	55696.
17	27	STATIONERY, WRITING SUPPLIES	55620.
18	10	CLOTHING ISSUED TO MILITARY	54403.
19	55	STREET & LOCAL BUS TRANSPORT	53833.
20	35	DRUG PREP & SUNDRIES	52498.
21	25	SEMIDURABLE HOUSE FURNISHINGS	51497.
22	23	CHINA, GLASSWARE, TABLEWARE	51151.
23	57	RAILWAY (COMMUTER) TRANSPORT	48841.
24	65	DURABLE TOYS & SPORT EQUIPMENT	47802.
25	64	NONDURABLE TOYS & SPORTS EQUIP	45480.
26	24	OTHER DURABLE HOUSE FURNISHINGS	45475.
27	3	FOOD FURNISHED TO GOVT	44707.
28	4	FOOD PROD & CONSUMP ON FARM	43946.
29	66	RADIO & TV RECEIVERS	43423.
30	63	MAGAZINES & NEWSPAPERS	42171.
31	1	FOOD PURCH FOR OFF PREM CONSUMP	41100.
32	21	FURNITURE	36693.
33	7	SHOE CLEANING & REPAIR	36074.
34	34	OTHER HOUSEHOLD OPERAT EXPEND	35287.
35	77	PRIVATE ELEM & SECOND SCHOOL	34852.
36	76	PRIVATE HIGHER EDUCATION	34832.
37	62	BOOKS AND MAPS	34662.
38	20	OTHER HOUSING	33868.
39	68	FLOWERS, SEEDS, PLANTS	33310.
40	8	WOMEN & CHILDRENS CLOTHING	33126.
41	78	OTHER PRIVATE EDUCATION	32715.
42	2	PURCHASED MEALS AND BEVERAGES	32444.

← 70000 Avge. personal consump.

RANK	ACTIVITY	TITLE	ENERGY COEFFICIENT BTUS/$
43	13	JEWELRY & WATCHES	31738.
44	39	OTHER PROF MEDICAL SERVICES	31651.
45	36	OPHTHALMIC & ORTHOPED PROD	31315.
46	9	MEN & BOYS CLOTHING	31193.
47	14	OTHER CLOTHING & ACCESSORIES	31035.
48	12	LAUNDERING IN ESTABLISHMENT	29537.
49	11	GARMENT CLEANING, REPAIR	29537.
50	67	RADIO & TV REPAIR	28137.
51	6	SHOES AND FOOTWEAR	28006.
52	72	CLUBS AND FRATERNAL ORGANIZATION	27779.
53	79	RELIG & WELFARE ACTIVITIES	27779.
54	47	FUNERAL & BURIAL EXP	26403.
55	48	OTHER PERSONAL BUSINESS	26254.
56	40	PRIVATE HOSPITALS	25105.
57	51	AUTOMOBILE REPAIR & MAINTENANCE	23551.
58	54	AUTOMOBILE INSURANCE	22025.
59	41	HEALTH INSURANCE	22025.
60	45	LIFE INSUR HANDLING EXP	21[illegible].
61	44	FINANCIAL INTERMEDIARIES	21[illegible]4.
62	75	OTHER RECREATIONAL EXP	21205.
63	5	TOBACCO PRODUCTS	19733.
64	32	TELEPHONE & TELEGRAPH	18953.
65	73	COMMERCIAL AMUSEMENTS	18715.
66	46	LEGAL SERVICES	18555.
67	18	TENANT OCC NONFARM DWELLING	18399.
68	42	BROKERAGE CHARGES	18103.
69	74	PARIMUTUEL NET RECEIPTS	17920.
70	80	FOREIGN TRAVEL BY US RES	16655.
71	69	MOTION PICTURE THEATERS	16033.
72	71	SPECTATOR SPORTS	15475.
73	70	THEATERS AND OPERA	15378.
74	16	BARBER, BEAUTY SHOPS	15037.
75	43	BANK SERVICE CHARGES	13452.
76	38	DENTISTS	10922.
77	37	PHYSICIANS	103[illegible]5.
78	17	OWNER OCC NONFARM DWELLING	8235.
79	19	RENTAL VALUE OF FARMHOUSE	8168.
80	81	EXPEND ABROAD BY US GOVT	5238.
81	33	DOMESTIC SERVICE	0.
82	82	EXPEND IN US BY FOREIGNERS	0.
83	83	PERSONAL REMIT TO FOREIGNERS	0.

REFERENCES

1. "An Energy Input-Output Matrix for the United States, 1963: User's Guide," Herendeen, R. A., CAC Document No. 69, Center for Advanced Computation, University of Illinois, Urbana, Illinois 61801.

2. "An Energy, Pollution and Employment Policy Model," Folk, Hugh and Bruce Hannon, CAC Document No. 68, Center for Advanced Computation, University of Illinois, Urbana, Illinois 61801.

3. In the first draft of this work we assumed that saved money would be spent with energy and labor intensities equal to the average for all personal consumption expenditures. We now feel that was too simplistic.

4. "Annual Energy Requirements of Electric Household Appliances," Electric Energy Association, New York, 1971.

5. "Use of Gas by Residential Appliances," American Gas Association, Arlington, Virginia, November, 1972.

6. Merchandising Week, New York, 1972 statistical issue.

7. Telephone conversation with Mr. Warren Barren of the Whirlpool Corporation, Benton Harbor, Michigan, June 1973.

8. Telephone conversation with Mr. James Thayer of the Speedqueen Corporation, Ripon, Wisconsin, July 1973.

9. Discussions with Jacqueline Anderson, Department of Home Economics, University of Illinois, and four individuals locally.

10. Canned foods contain much water. See "Why Net Weight Spells Nonsense on Canned Food Labels." Consumer Reports, October, 1972.

11. "Comparative Costs to Consumers of Convenience Foods and Home-Prepared Foods." Marketing Research Report no. 609, Marketing Economics Division, U. S. Department of Agriculture, June 1963. The data are for 1959-60.

12. M. Rieber, personal communication.

13. Sears Roebuck and Company catalog. Fall and Winter, 1963.

14. "Energy Use in the Commercial and Industrial Sectors of the U. S. Economy, 1963," Bullard, Clark and Robert Herendeen, CAC Document No. 105, Center for Advanced Computation, University of Illinois, Urbana, Illinois 61801.

Table 1.1 Product groups

1. Kitchen appliances
2. Mechanical vs. outdoor drying
3. Home laundry vs. laundromat
4. Paper and cloth towels
5. Disposable vs. cloth diapers
6. Disposable paper dishes vs. earthenware
7. Mechanical vs. hand dishwashing
8. Fresh, frozen, and canned fruits
9. Wood vs. metal household furniture

Table 2.1.1

DEL Costs of 25 Appliances

Appliance	Appliance Complement: Spartan G	Spartan E	Moderate G	Moderate E	Full G	Full E	Operational Energy[(a)] (10^5 Btu/yr)	Q (years)	τ (years)	Q/τ	Total energy (10^5 Btu/yr)	Total dollars (per year)	Total jobs (10^4 man-yr/yr)
Blender						x	2.0	7.2	14	0.51	3.0	2.58	2.60
Can opener						x	0.66	10.5	8	1.32	1.5	1.73	1.85
Clothes washer		x		x		x	13.6	13.6	14	0.97	26.9	28.00	25.9
Clothes dryer, gas			x		x		70.2	2.2	14	0.15	81.0	27.60	22.6
Clothes dryer, electric				x		x	131	0.97	14	0.07	140	39.40	26.5
Coffeemaker				x		x	14	0.61	8	0.08	15.1	4.32	3.22
Dishwasher						x	48	3.7	14	0.26	60.6	31.40	26.0
Disposer						x	4.0	12	14	0.87	7.4	7.09	6.46
Exhaust fan						x	5.7	2.5	14	0.18	6.7	3.19	2.87
Freezer, conv., 15 cu. ft.				x			158	1.1	14	0.08	170	49.40	33.8
Freezer, frostless, 15 cu. ft.						x	233	0.73	14	0.05	245	61.80	39.2
Frying pan						x	24.6	0.82	14	0.06	26.0	7.29	5.28
Hot plate						x	11.9	0.54	8	0.07	12.7	3.47	2.52
Iron				x		x	19.0	0.48	8	0.06	20.2	5.28	3.72
Electric knife						x	1.06	13	14	0.96	2.07	2.43	2.54
Mixer				x		x	1.72	7.5	14	0.53	2.6	2.32	2.35
Range, gas	x		x		x		123	1.3	14	0.09	134	33.50	25.8
Range, electric		x		x		x	155	1.2	14	0.08	168	50.70	35.9
Refrigerator, conv., 12 cu. ft.		x		x			96.3	2.2	14	0.16	111	45.00	35.0
Refrigerator, frostless, 12 cu. ft.						x	161	1.3	14	0.09	176	55.70	39.6
Toaster				x		x	5.2	1.9	8	0.23	6.4	3.10	2.87
Vacuum cleaner				x		x	6.1	6.4	14	0.45	8.8	7.97	6.99
Water heater, gas	x		x		x		370	0.15	8	0.02	377	46.00	22.2
Water heater, electric		x		x		x	558	0.11	8	0.01	565	104.00	50.2
Waffle iron						x	2.91	3.1	8	0.39	4.1	2.61	2.57

G = gas appliance

E = electrical appliance

(a) Converted to primary energy terms.

Table 2.1.2

DEL Costs of three sets of appliances

	Spartan	Moderate	Full
Dollars/yr.			
gas	152.50 (.451)[a]	252.49 (.747)	337.88 (1)
electric	227.70 (.537)	339.49 (.800)	424.38 (1)
Energy (10^5 Btu/yr.)			
gas	649 (.542)	953 (.796)	1170 (1)
electric	871 (.589)	1234 (.835)	1478 (1)
Labor (10^{-4} man yr./yr)			
gas	108.9 (.441)	184.7 (.748)	247.1 (1)
electric	147.0 (.509)	226.5 (.784)	289.1 (1)

[a] Number in parentheses is fraction of total for full appliance set.

Table 2.2.1

DEL cost of drying clothes mechanically

(one 39 minute cycle)

ction	Dryer type	Cost (Cents/cycle)	Primary energy (Btu/cycle)	Labor[b] (Man. yr./cycle)
ufacture and le of dryer	gas	4.88	3090	4.50×10^{-6}
	electric	4.13	2614	3.81×10^{-6}
ntenance	gas	2.44	682	2.60×10^{-6}
	electric	2.07	577	2.20×10^{-6}
ration	gas	1.59	15403 (12144 direct)[a]	5.35×10^{-7}
	electric	7.12	42081 (11092 direct)[a]	3.08×10^{-6}
otal	gas	8.91	19175	7.60×10^{-6}
	electric	13.32	46172	9.09×10^{-6}
atio	(gas/electric)	0.67	0.42	0.85
comparison:				
loor drying		1.15	658	1.01×10^{-6}

)
Direct energy actually applied to unit.

Does not include homeowner's labor.

Table 2.2.2

DEL costs of clothesdryer vs. clothesline

(All quantities per 39 minute cycle)

Option	Cost (Cents)	Energy (Btu)	Labor (Man yr.)
Gas dryer, electric pilot	8.91 (.669)	19175 (.415)	7.69×10^{-6} (.846)
Electric dryer	13.32 (1)	46172 (1)	9.09×10^{-6} (1)
Outdoor drying	1.15 (.086)	658 (.014)	1.01×10^{-6} (.111)

Table 2.3.1

DEL costs of laundromat washing[a]

Component	Dollar (Cents/load)	Energy (Btu/load)	Labor (10^{-6} man yr/million loads)
Direct(cleaning and operation)			3.40
Facilities construction		1086	1.41
Washer and dryer		1585	1.74
Gas and electricity:			
Air conditioned	42.0	111029	3.33
Not air conditioned		103000	
Water		2693	1.63
Maintenance		433	1.65
Detergent	6.2	5005	4.37
Total	48.2	114072 without a/c 122101 with a/c	17.53

(a) Excluding transportation

Table 2.4.1

DEL costs of 1 cloth hand towel[a]

ater heater	Washer rinse	Dryer	Cost (Cents)	Primary Energy (Btu)	Labor (Man yr.)
gas	cool	no	1.27	1687	$.648 \times 10^{-6}$
gas	cool	gas	1.53	2304	.871
gas	cool	electric	1.68	3204	.917
gas	warm	no	1.34	2134	.685
gas	warm	gas	1.60	2751	.908
gas	warm	electric	1.74	3651	.954
electric	cool	no	1.55	2866	.785
electric	cool	gas	1.81	3483	1.01
electric	cool	electric	1.96	4383	1.06
electric	warm	no	1.75	3875	.888
electric	warm	gas	2.01	4492	1.11
electric	warm	electric	2.15	5292	1.16

For comparison:

		Cost	Primary Energy	Labor
One roll paper towels[3] (including disposal)		39	27000	2.6×10^{-5}
Energy content of paper towels		-	10100	-
	Total		37100	

[a] 15" x 27", approximate weight, 4oz.

Table 2.4.2

DEL costs of "equivalent" paper and cloth towels

Water heater	Washer rinse	Dryer	Cost (Cents)	Primary Energy (Btu)	Labor (Man yr.)
gas	cool	no	20.32	26992	10.37×10^{-6}
gas	cool	gas	24.48	36864	13.94
gas	cool	electric	26.88	51264	14.67
gas	warm	no	21.44	34144	10.96
gas	warm	gas	25.60	44016	14.53
gas	warm	electric	27.84	58416	15.26
electric	cool	no	24.80	45856	12.56
electric	cool	gas	28.96	55728	16.16
electric	cool	electric	31.36	70128	16.96
electric	warm	no	28.00	62000	14.21
electric	warm	gas	32.16	71872	17.76
electric	warm	electric	34.4	84672	18.56
For comparison, using an electric wringer washer[(a)]					
gas	cool	no	15.02	13359	6.56
One roll of paper towels, including disposal			39.00	27000	26×10^{-6}
Wood energy			---	10100	----
Total, paper towels			39.00	37100	26×10^{-6}

(a) Based on a single local case study; see Appendix I.

Table 2.5.1

DEL costs of disposable vs. cloth diapers

			Cost (cents/change)	Primary Energy (Btu/change)	Labor (10^{-6} man yr/change)
Disposable diapers			4.439	2720	2.789
Cloth diapers					
Water heater	Washer rinse	Dryer			
gas	cool	no	.9838	1563	1.288
gas	cool	gas	1.2031	2078	1.474
gas	cool	elect	1.3231	2828	1.513
gas	warm	no	1.0371	1936	1.319
gas	warm	gas	1.2531	2451	1.505
gas	warm	elect	1.3731	3201	1.544
elect	cool	no	1.2792	2828	1.692
elect	cool	gas	1.4992	3342.	1.878
elect	cool	elect	1.6192	4092	1.917
elect	warm	no	1.4492	3669	1.779
elect	warm	gas	1.6592	4183	1.964
elect	warm	elect	1.7792	4933	2.003

Note: the above cloth diaper totals include the following manufacturing and hand plastic pants laundry DEL costs:

	Cost (cents/change)	Primary Energy (Btu/change)	Labor (10^{-6} man yr/change)
Manufacturing (diaper, pins and plastic pants)	.2283	78	.220
Plastic pants laundry (hand option)			
gas water heater	.0931	274	.568
electric water heater	.1592	556	.858

Table 2.6.1

DEL costs of paper vs. earthenware plates

	D(Cents)	E(Btu) w/o savings reinvestment	$L(10^{-6}$ man yr) w/o savings reinvestment
Earthenware			
manufacturing	.092	51	.10
washing - gas*	.476	1346	.32
elect*	.696	2289	.44
Total - gas	.568	1397	.42
elect	.788	2340	.54
Disposables	4.89	3392	3.82
Wood energy		650	--
Total	4.89	4042	3.82

*Water heater type

Table 2.7.1

DEL costs of a dishwasher load

Function		Cost (Cents/load)	Primary Energy (Btu/load)	Labor (Man yr/load)
ital Cost		3.13	1943	2.84×10^{-6}
ntenance		1.57	438	1.67×10^{-6}
ration				
1) Water (14 gal)		0.94	772	4.68×10^{-7}
2) Water heat	gas water heater	1.83	18774	1.39×10^{-6}
	electric water heater	8.71	42308	5.18×10^{-6}
3) Soap		1.94	1781	1.56×10^{-6}
4) Electricity		1.64	9919	7.09×10^{-7}
Total	gas heater	11.9	33627	8.62×10^{-6}
	electric heater	17.4	57161	11.00×10^{-6}

Table 2.8.1

Energy and labor coefficients for fresh, frozen, and canned foods, 1963

Sector	Energy Coefficients, 1963, Btu/$			Labor Coefficient (10^{-4} man-yr/$)	
	Producer's Price	Purchaser's Price	Modified (1)	Producer's Price	Purchaser's Price
Fruit and tree nuts (2.04)	38700	40900	51900	1.94	1.64
Vegetables, sugar, and miscellaneous crops (2.05)	40573	42100	53900	1.30	1.37
Frozen fruit and vegetables (14.13)	68688	57800	66300	1.20	1.29
Canned fruit and vegetables (14.09)	72250	61800	61800	1.18	1.30

(1) Modified to account for refrigeration of perishables; see Appendix T.

Table 2.8.2

Comparative retail costs for fresh, frozen, and canned fruits and vegetables--1959-60[a]

	Serving (oz)	Weighting Factor[b]	Cost/serving (cents) Fresh	Frozen	Canned	Cost Ratio Frozen/Fresh	Canned/Fresh
Vegetables							
corn, cut	2.9	.68	7.4	5.9	6.2	.80	.84
peas	2.8	1.13	13.0	6.0	5.0	.46	.38
spinach	3.4	.20	12.1	7.9	7.0	.65	.58
lima beans	2.9	.17	12.0	7.1	7.7	.59	.64
asparagus	2.1	.17	9.5	9.7	8.3	1.02	.87
beets	3.2	.072	4.4	---	4.4	---	1.00
green beans	2.3	.45	4.3	5.7	5.4	1.33	1.26
broccoli spears	3.3	.056	6.1	9.0	---	1.48	----
brussels sprouts	2.7	.035	7.4	8.1	10.8	1.10	1.40
carrots	2.8	.02	3.0	5.2	4.3	1.73	1.43
				Average for vegetables		0.76	0.72
Fruit							
orange juice	4.4	1.59	7.6	3.7	4.1	.49	.54
peaches, drained	3.7	.40	5.8	13.8	9.3	2.38	1.60
peaches and liquids	4.4		---	10.0	6.3	---	---
grapefruit, drained	3.4	---	6.2	10.7	7.5	1.73	1.21
grapefruit and liquids	4.3	---	6.5	7.9	5.6	1.22	.86
pineapple, drained	3.2	.24	7.1	11.4	8.0	1.61	1.13
pineapple and liquids	4.2		---	8.9	6.8	---	---
cherries, drained	3.9	.35	17.1	9.6	7.8	.56	.46
cherries and liquids	4.9		---	6.7	6.0	---	---
strawberries	3.5	.156	12.1	18.3	23.3	1.51	1.93
			Average for fruit			0.93	0.80
			Average without orange juice			1.54	1.17
			Average for all fruits and vegetables			0.83	0.77

(a) "Comparative Costs to Consumers of Convenience Foods and Home Prepared Foods." Marketing Research Report No. 609, U.S. Department of Agriculture, June, 1963

(b) Weighting factor: from above document, pp. 8,12. This is the dollar price for the fresh equivalent of all canned and for frozen product bought per hundred dollars of food expenditures. Thus, for example, the average consumer bought canned and frozen cut corn which would have cost 60 cents if he had bought it fresh, per hundred dollars spent on food. This is not the cost of the fresh product he actually bought.

Table 2.8.3
DEL costs of fresh, frozen, and canned food

	Fresh (I/O 2.04, 2.05)	Frozen (14.13)	Canned (14.09)
Normalized cost	1	0.83	0.77
Normalized energy intensity[(a)]	1	1.25	1.17
Normalized labor intensity[(b)]	1	0.85	0.86
Normalized energy impact	1	1.04	0.90
Normalized labor impact	1	0.71	0.66
Normalized energy impact with savings respent	1	1.32	1.27
Normalized labor impact with savings respent	1	0.83	0.83

[(a)] From Table 2.8.1; these figures are modified for commercial refrigeration.

[(b)] No refrigeration correction was made for labor.

Table 2.9.1

Furniture pricing data

	Wood (22.01)			Metal (22.03)		
	Weight[a] Factor	Page[b]	Price ($)	Weight[a] Factor	Page[b]	Price ($)
Dinette set (table and 4 chairs)	7.1	1467	119.95	115	1464	99.00
Playpen	5.0	578	16.00	26.0	579	16.00[c]
High chair		580	14.00[d]		580	13.33[d]
Sink cabinet (66")		1242	85.00[e]		1243	64.95
Wall cabinet (30"h x 36"w)	203.1	1248	38.00[e]	45.7	1245	26.00
Base cabinet (30"w)		1248	47.00[e]		1245	37.00

(a) From Census of Manufacturers, 1963; this is dollar ($$10^6$) production (producers') price for this specific class. Sector 22.01 had a total output of $$1943 \times 10^6$; sector 22.03, $$578 \times 10^6$.

(b) Sears, Roebuck Catalog, Fall and Winter, 1963.

(c) Price of pad subracted.

(d) Average of two chairs.

(e) Assembled, birch.

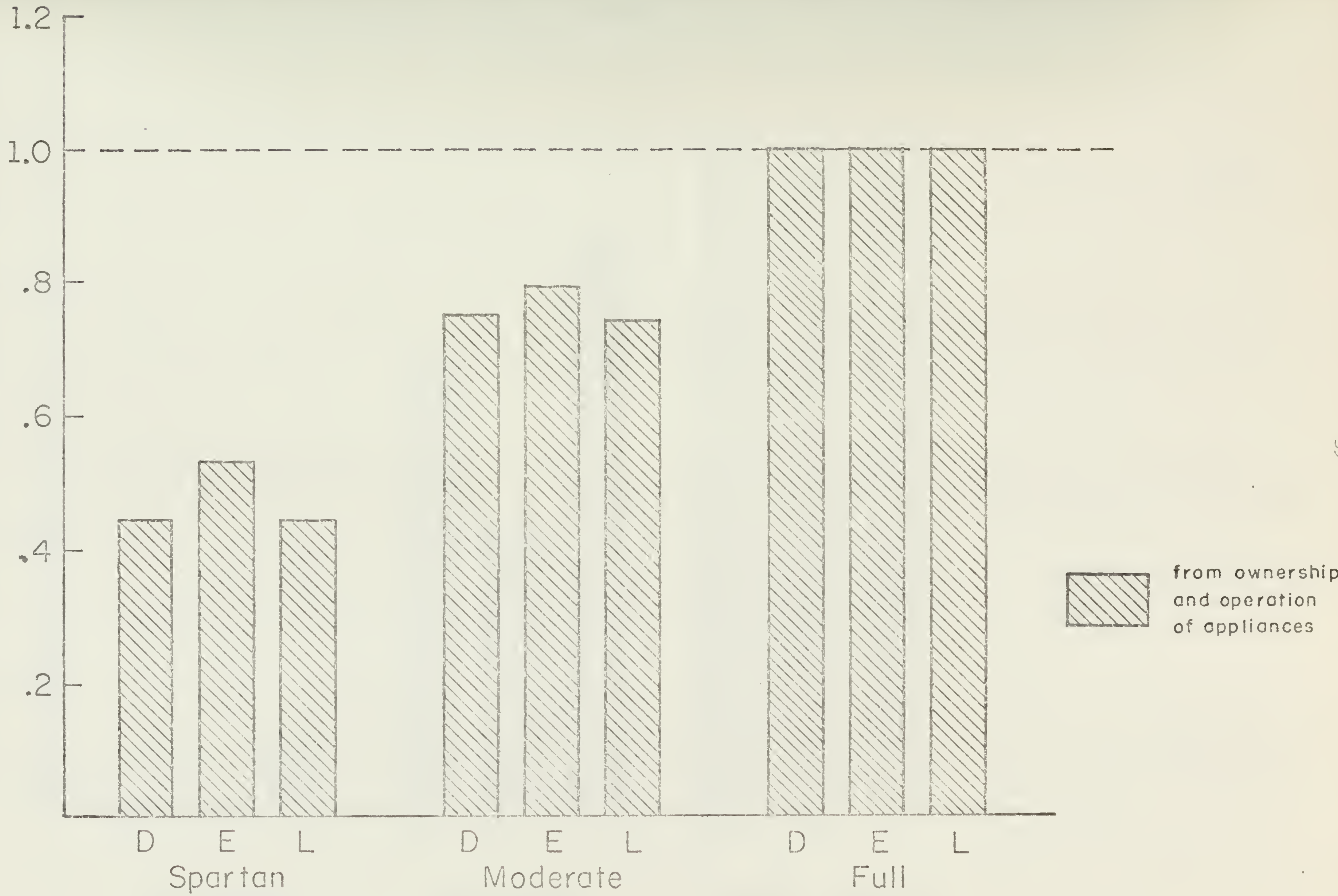
Table 2.9.2

DEL costs (normalized) of wood vs. metal household furniture, 1963[a]

Product	Dollars		Energy		Labor	
	Wood	Metal	Wood	Metal	Wood	Metal
Dinette set	1	.83	1	1.31 (1.09)[b]	1	0.75
Playpen	1	1.00	1	1.59 (1.18)	1	0.91
High chair	1	.95	1	1.51 (1.18)	1	0.87
Sink cabinet	1	.76	1	1.21 (0.98)	1	0.70
Wall cabinet	1	.68	1	1.09 (0.91)	1	0.62
Base cabinet	1	.79	1	1.25 (1.06)	1	0.72

[a] See Appendix S. These figures are for purchase only; no lifetime effects are included.

[b] Figures in parentheses include a correction for the energy content of the wood. See Appendix S.


1.2
1.0
.8
.6
.4
.2
D E L
Spartan
D E L
Moderate
D E L
Full
from ownership
and operation
of appliances

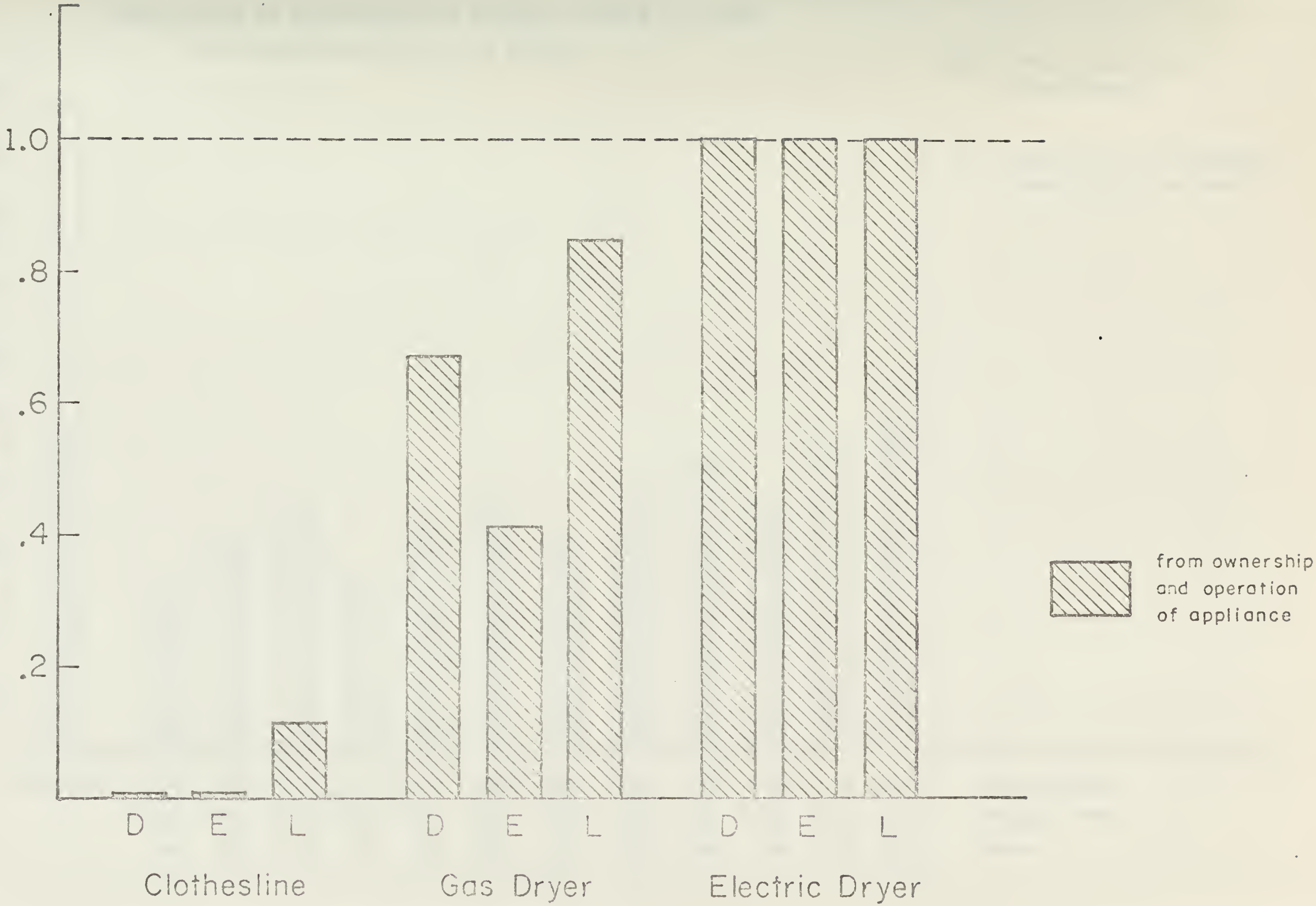

1.0
.8
.6
.4
.2
D
E
L
D
E
L
D
E
L
Clothesline
Gas Dryer
Electric Dryer
from ownership
and operation
of appliance

Figure 2.3.1

Dollar cost of washing and drying a load of wash in a laundromat vs. at home

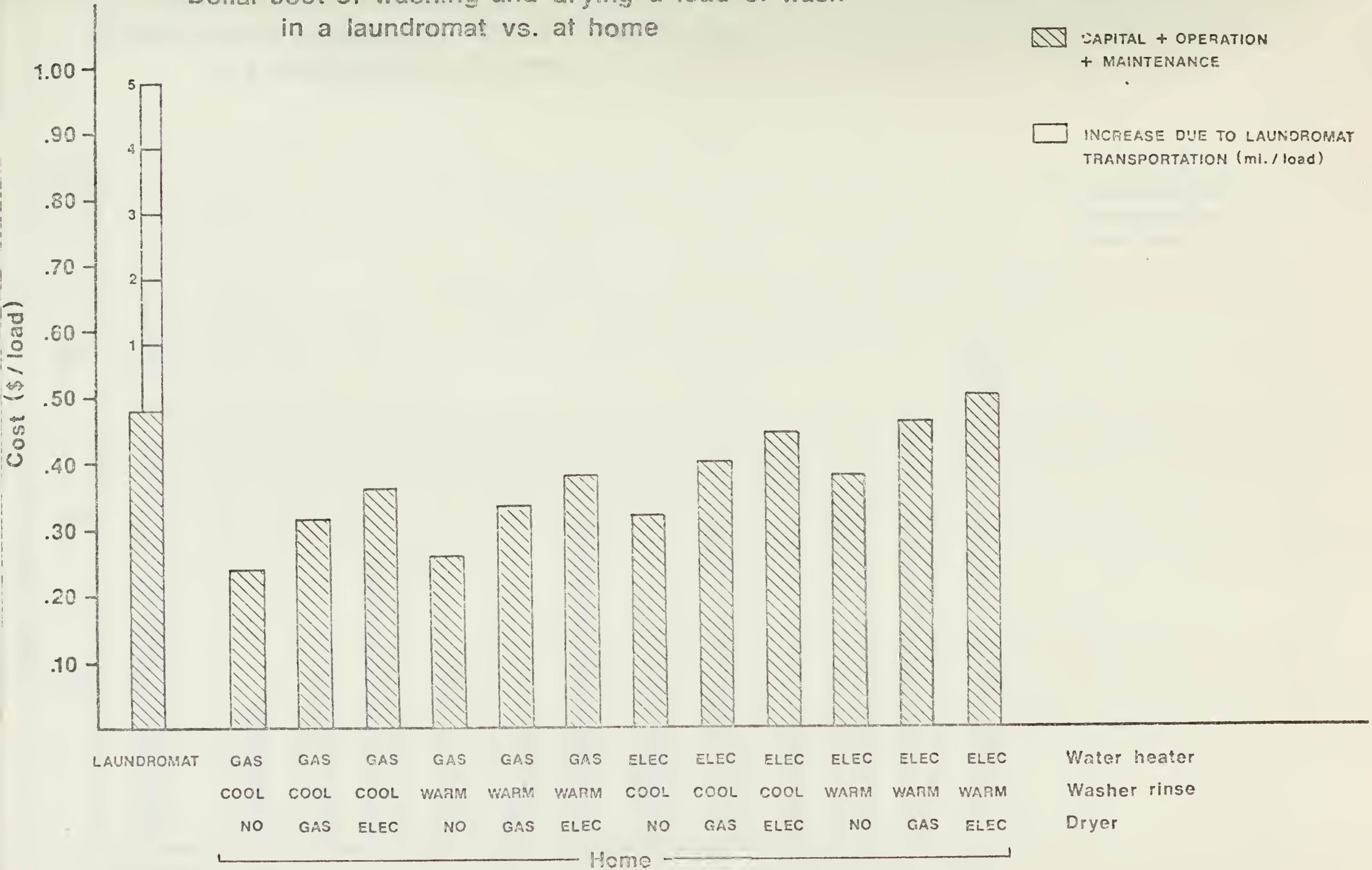
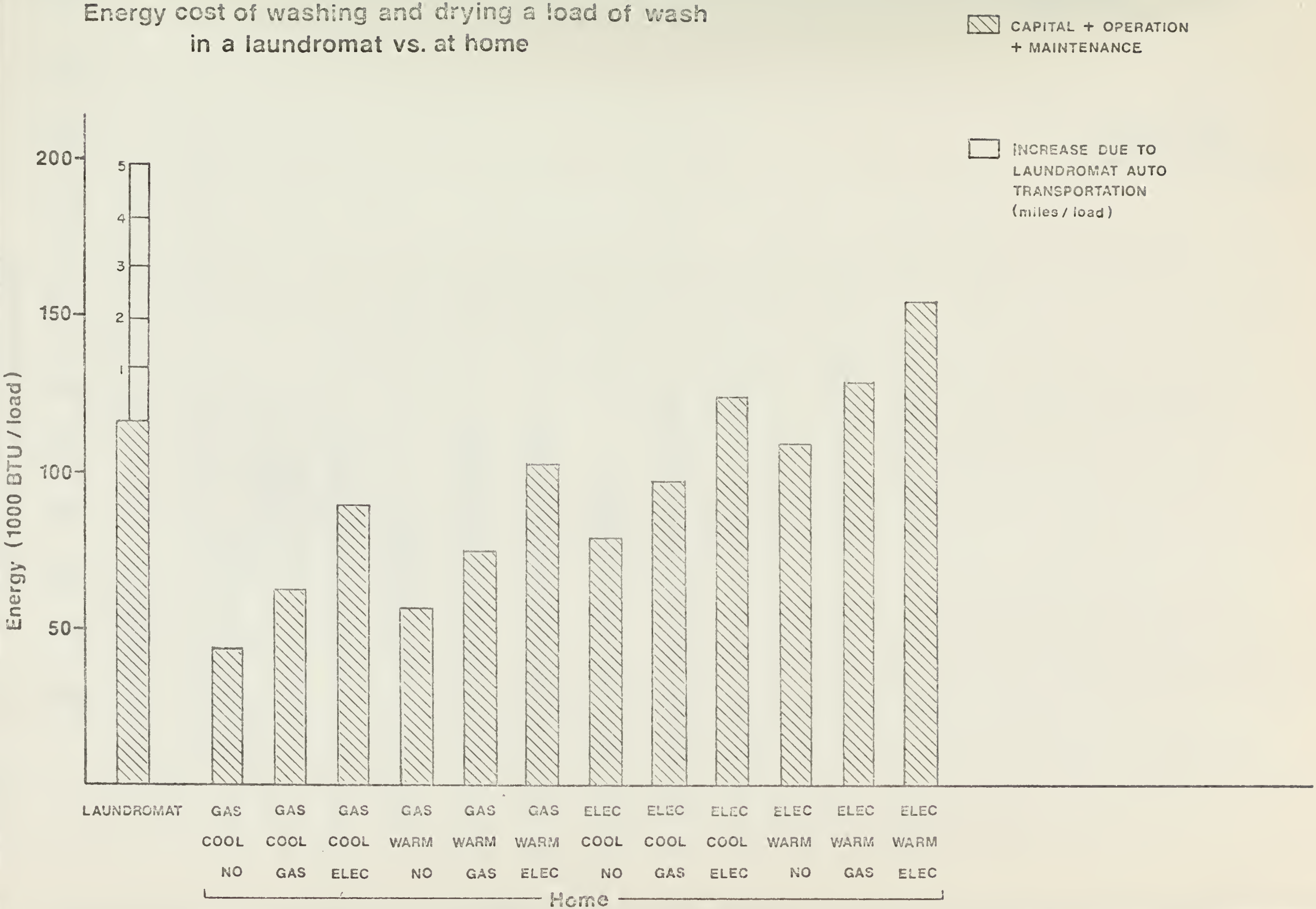


Figure 2.3.2

Energy cost of washing and drying a load of wash in a laundromat vs. at home



vs. at home,

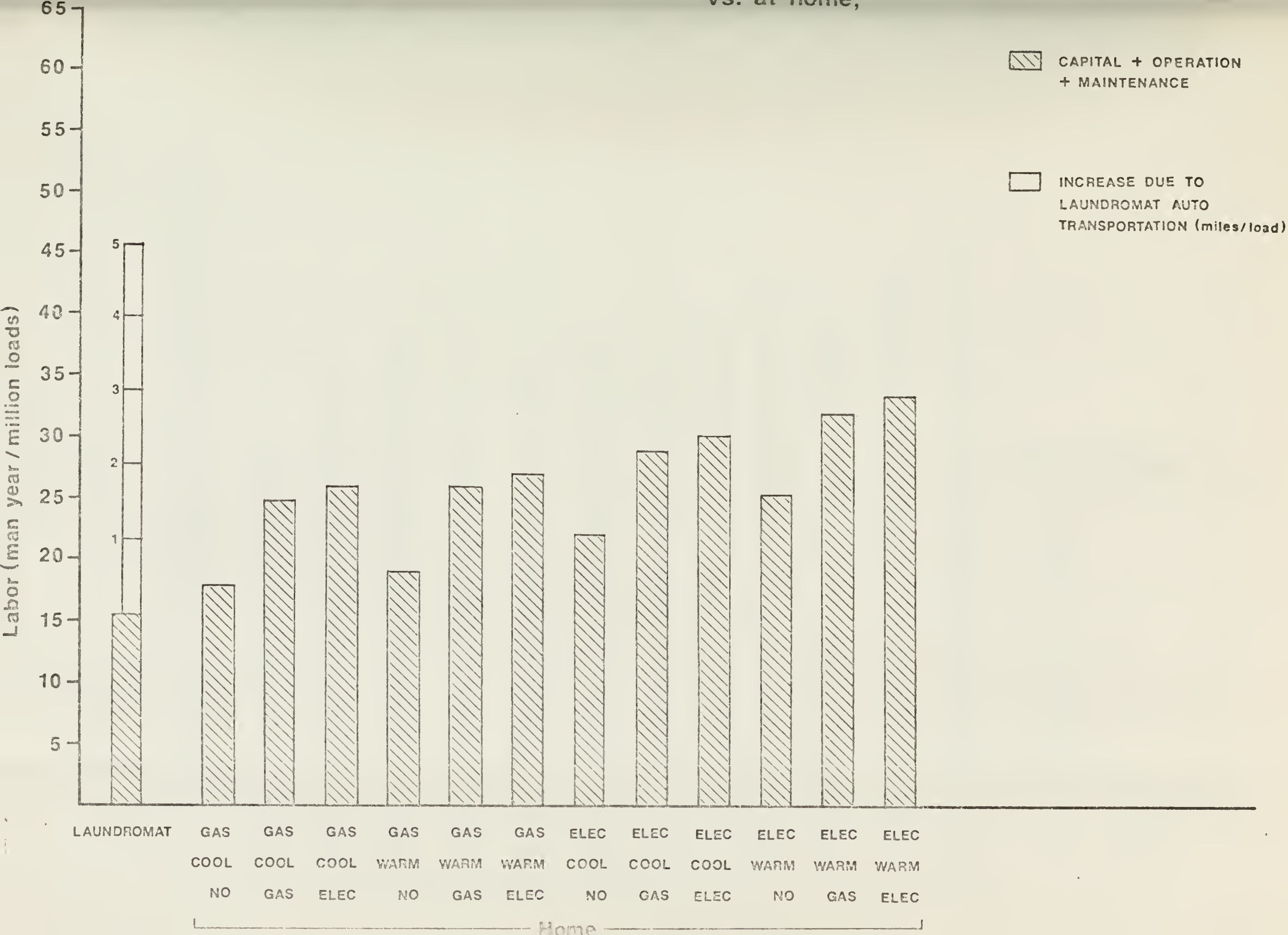

CAPITAL + OPERATION + MAINTENANCE
INCREASE DUE TO LAUNDROMAT AUTO TRANSPORTATION (miles/load)
Labor (man year / million loads)
65
60
55
50
45
40
35
30
25
20
15
10
5
1
2
3
4
5
LAUNDROMAT
GAS COOL NO
GAS COOL GAS
GAS COOL ELEC
GAS WARM NO
GAS WARM GAS
GAS WARM ELEC
ELEC COOL NO
ELEC COOL GAS
ELEC COOL ELEC
ELEC WARM NO
ELEC WARM GAS
ELEC WARM ELEC
Home

Figure 2-4-1 Dollar cost of paper vs cloth towels (16 cloth towels, 1 roll paper)

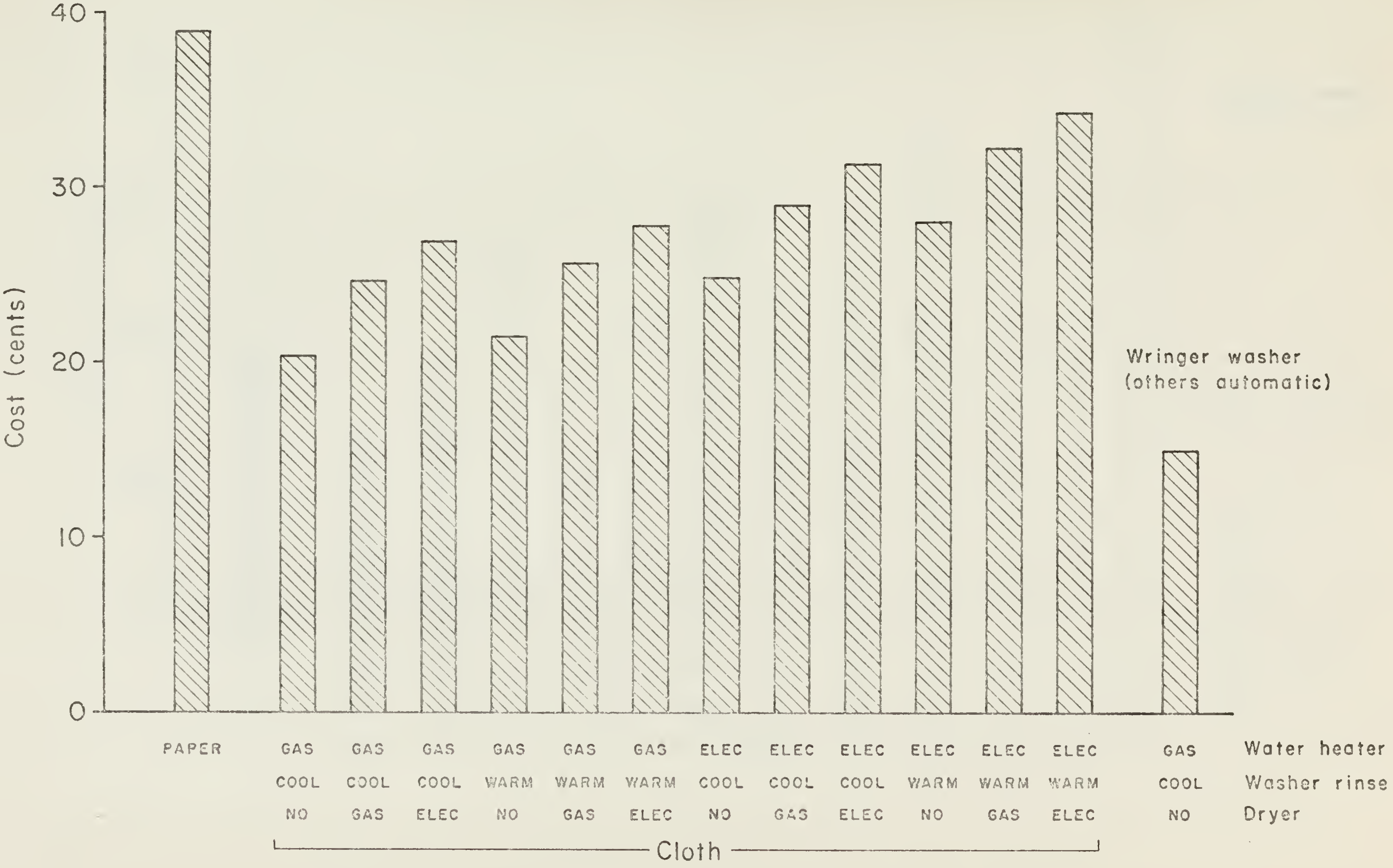


Figure 2.4.2 Energy cost of paper vs cloth towels (16 cloth towels, 1 roll paper)

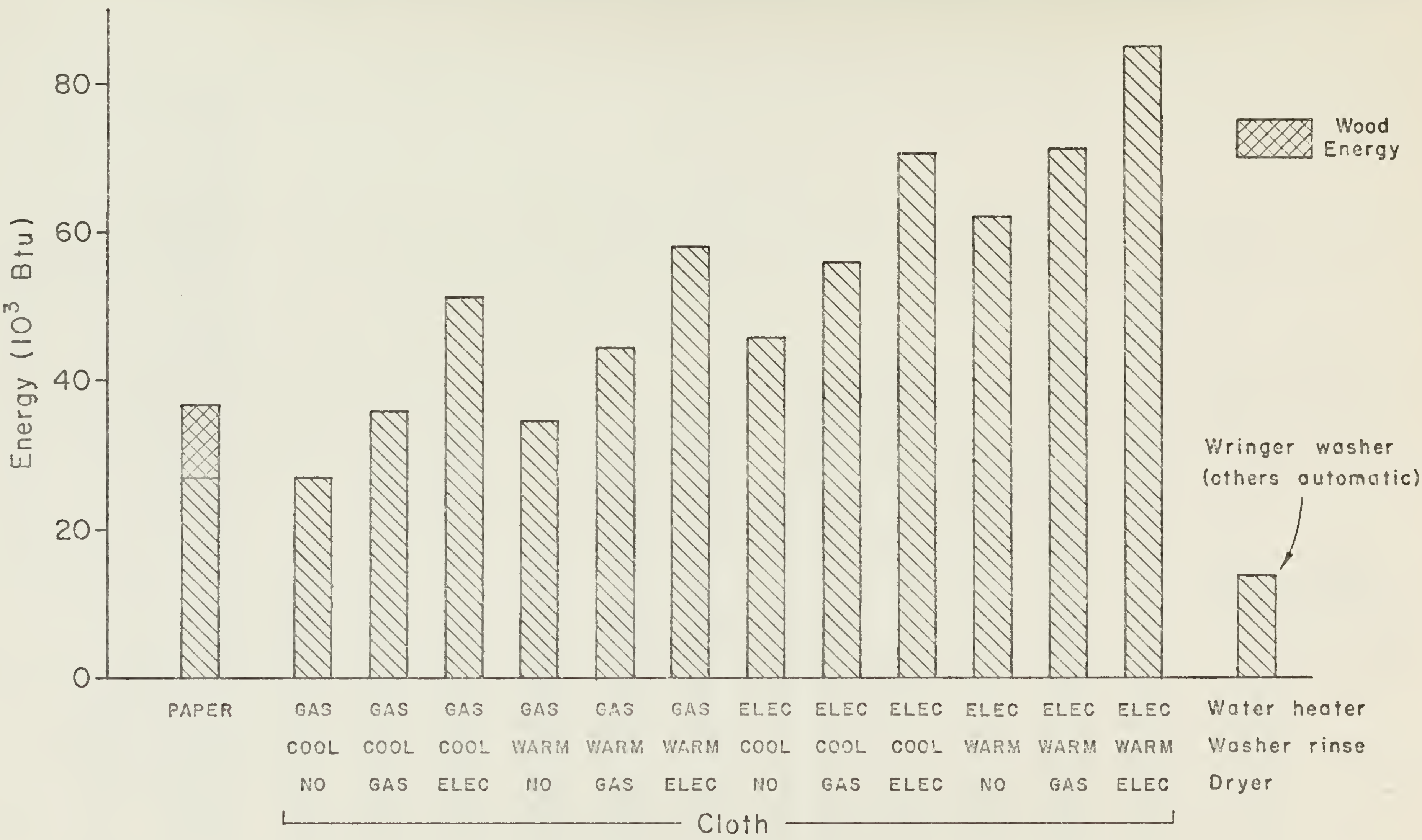


Figure 2.4.3 Labor cost of paper vs cloth towels (16 cloth towels, 1 roll paper)

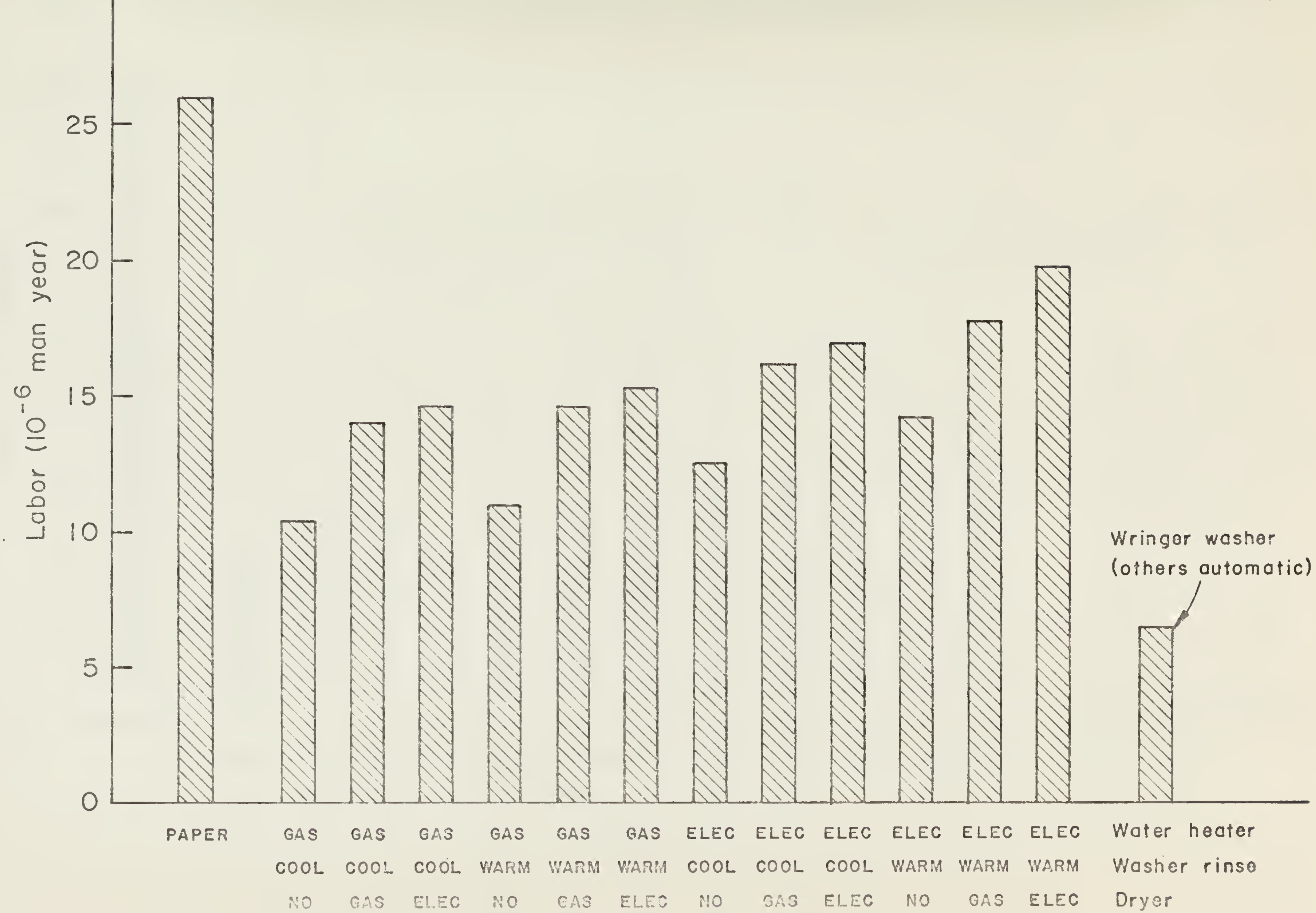


Figure 2.5.1 Dollar cost disposable vs. cloth diapers

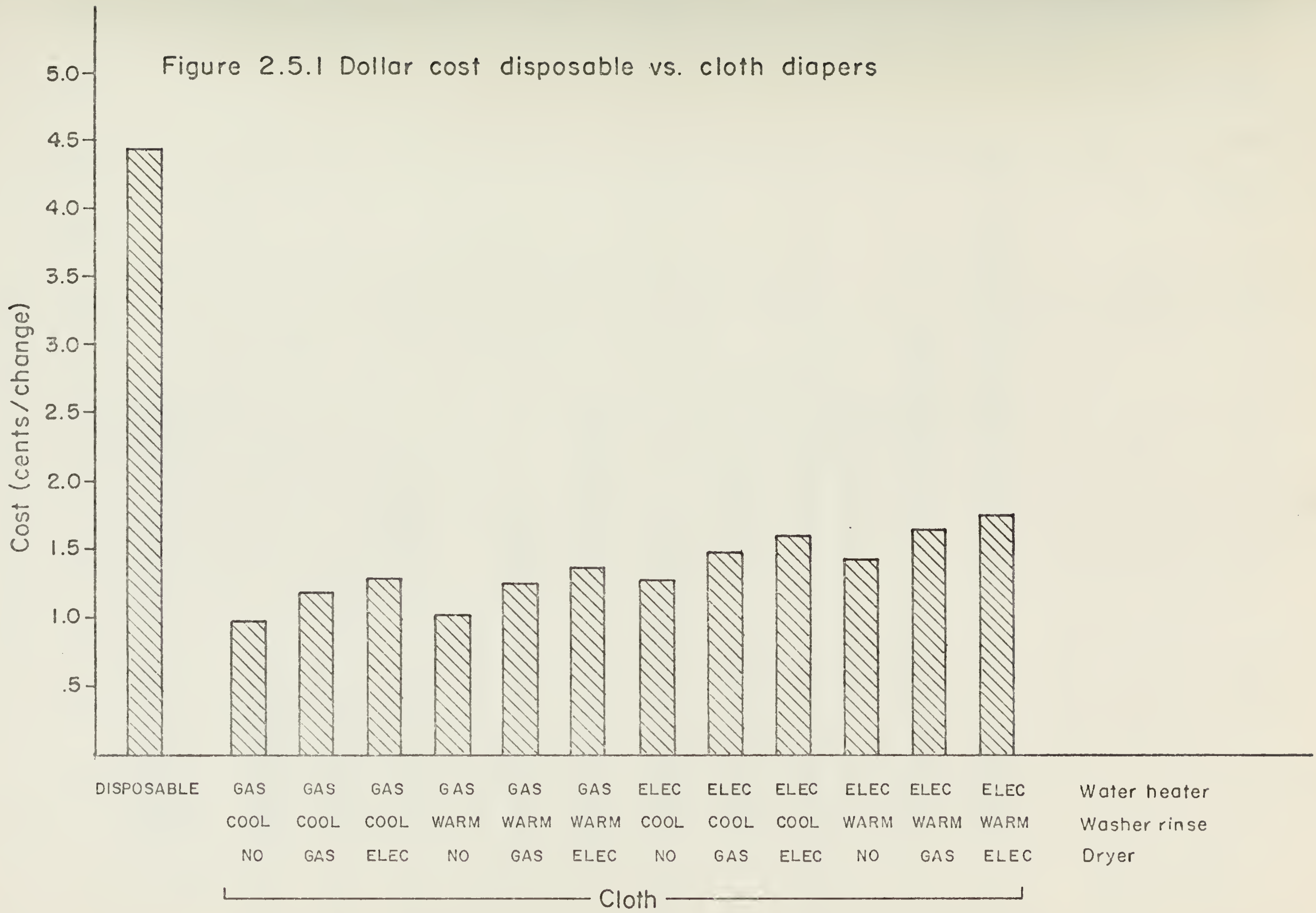


Figure 2.5.2 Energy cost disposable vs. cloth diapers

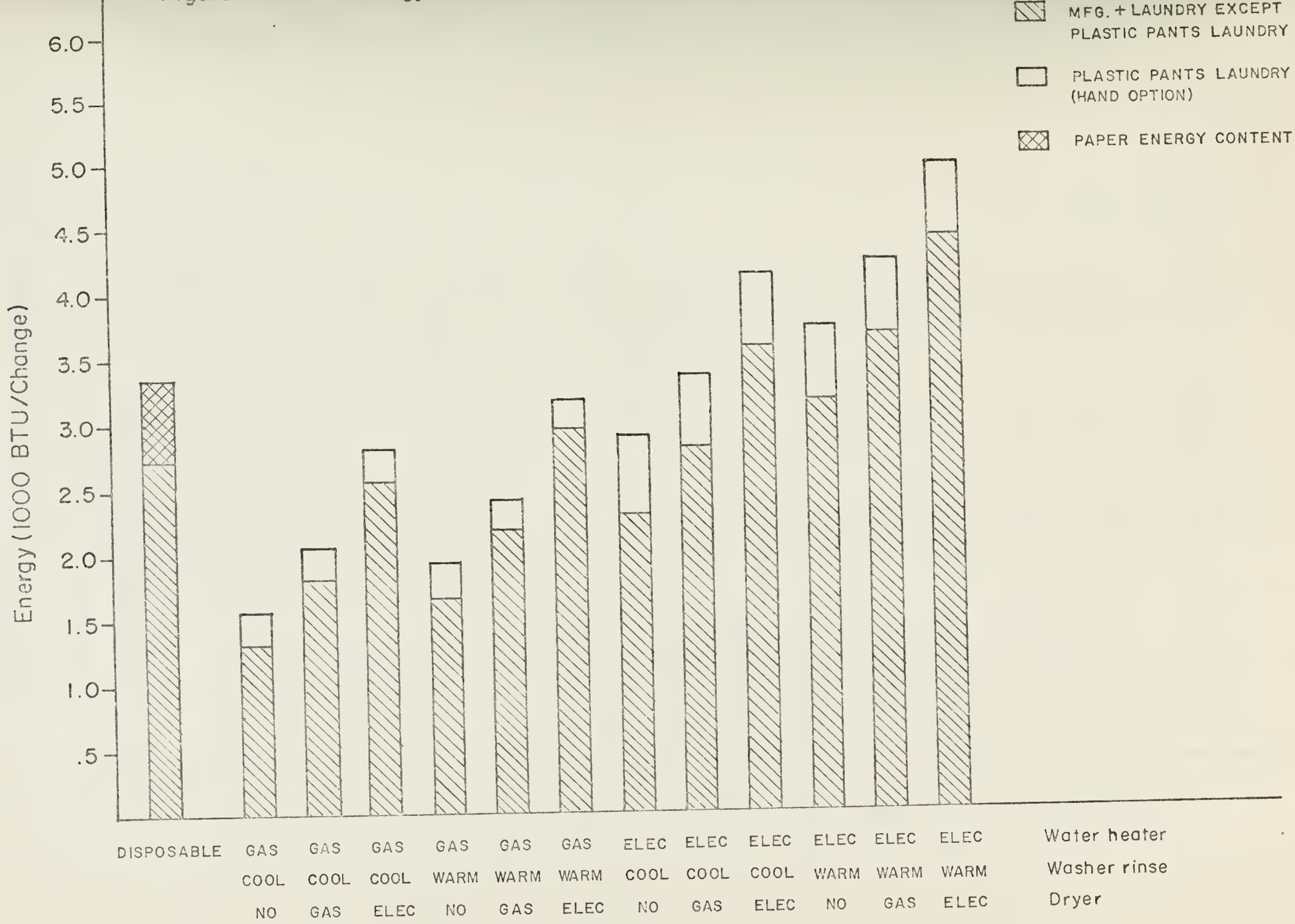


Figure 2.5.3 Labor cost of disposable vs. cloth diapers

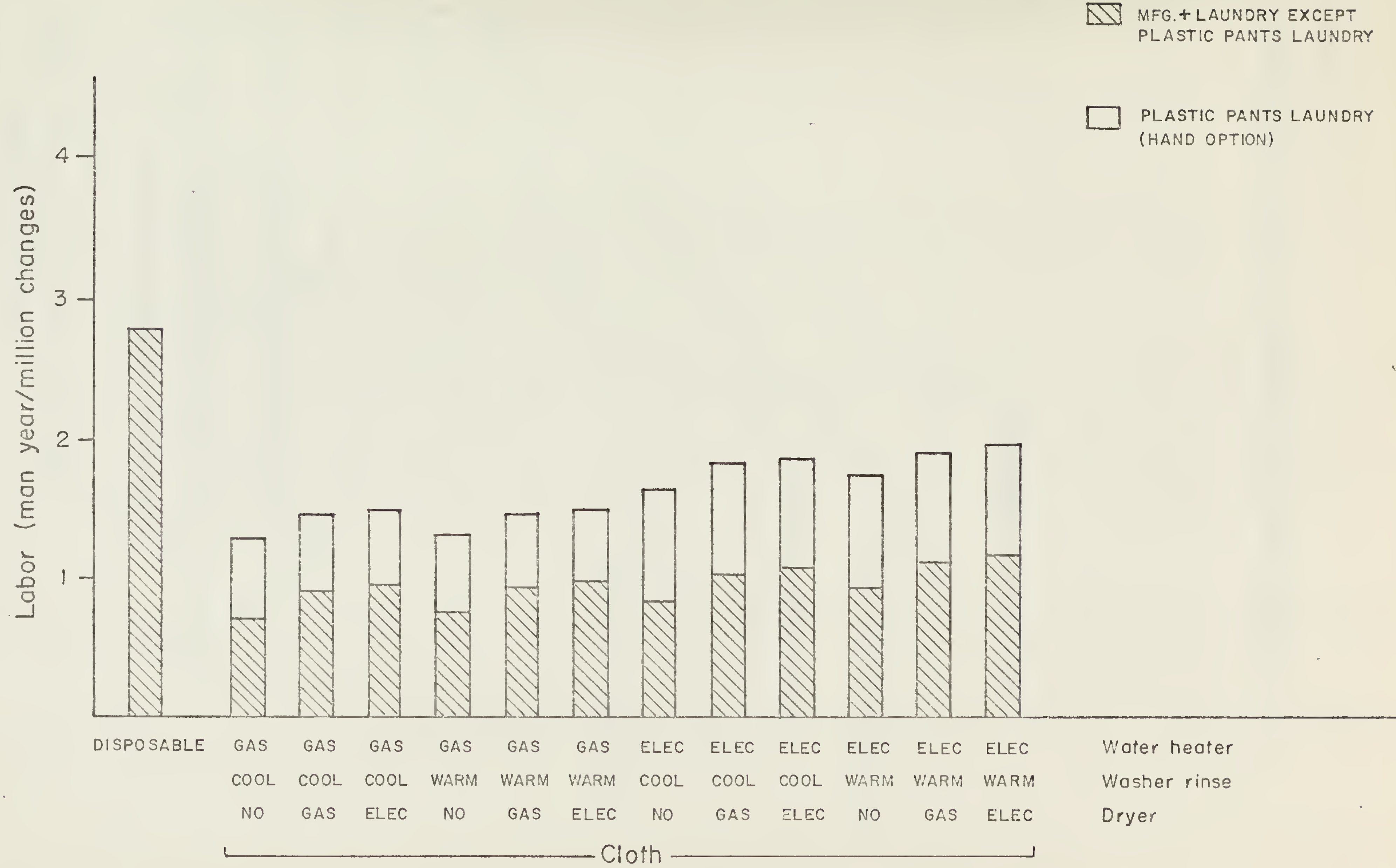
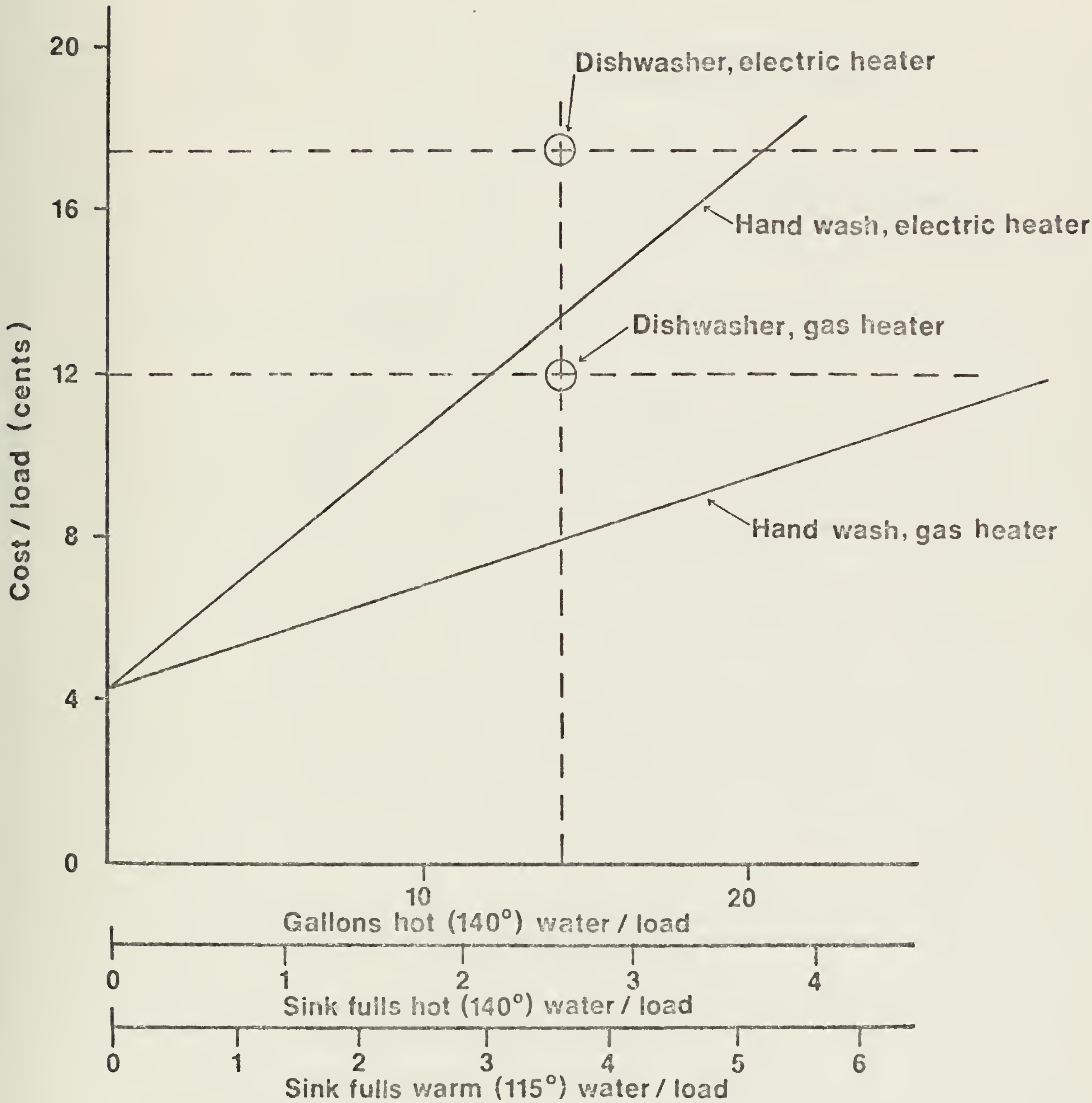


Figure 2.7.1

Dollar cost of hand vs mechanical dishwashing

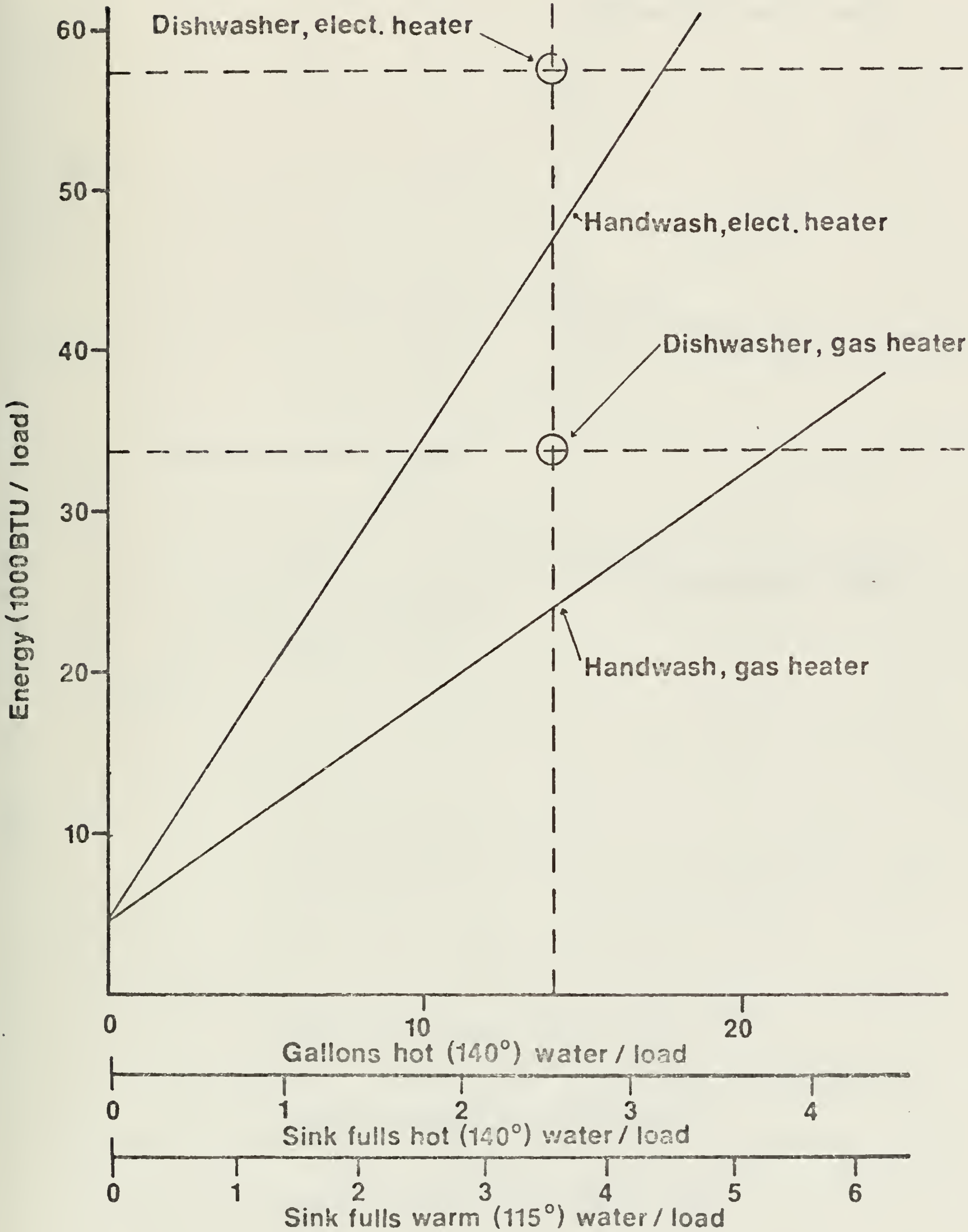


Notes: 1 load = 10 place settings ≈ 1 days dishes

1 sink full = 5.4 gallons

Figure 2.7.2

Energy cost of hand vs mechanical dishwashing

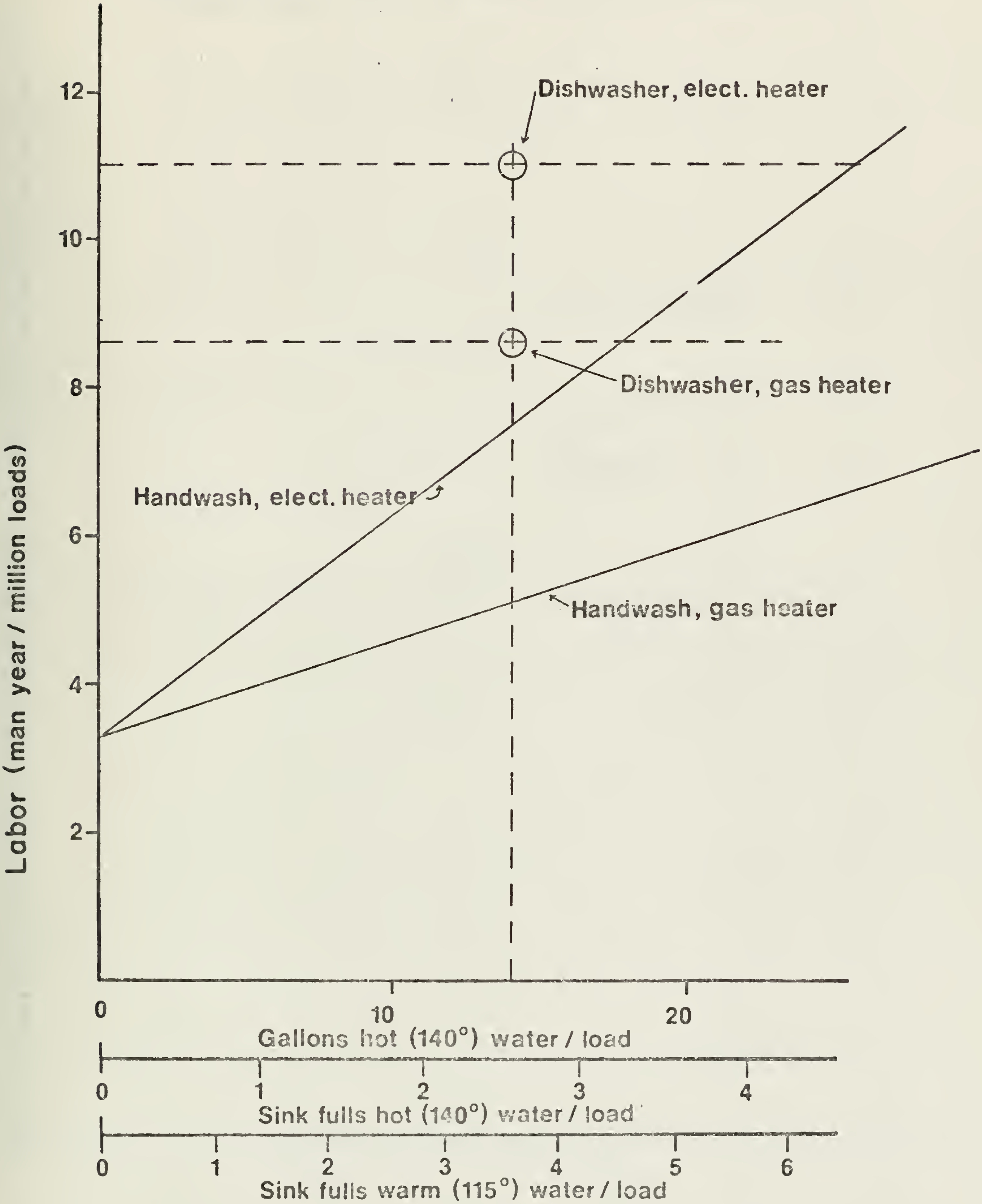


Notes: 1 load = 10 place settings ≈ 1 days dishes

1 sink full = 5.4 gallons

Figure 2.7.3

Labor cost of hand vs mechanical dishwashing



Notes: 1 load = 10 place settings ≈ 1 days dishes

1 sink full = 5.4 gallons

Figure 2.8.1

Dollar cost of fresh, frozen, and canned fruits and vegetables

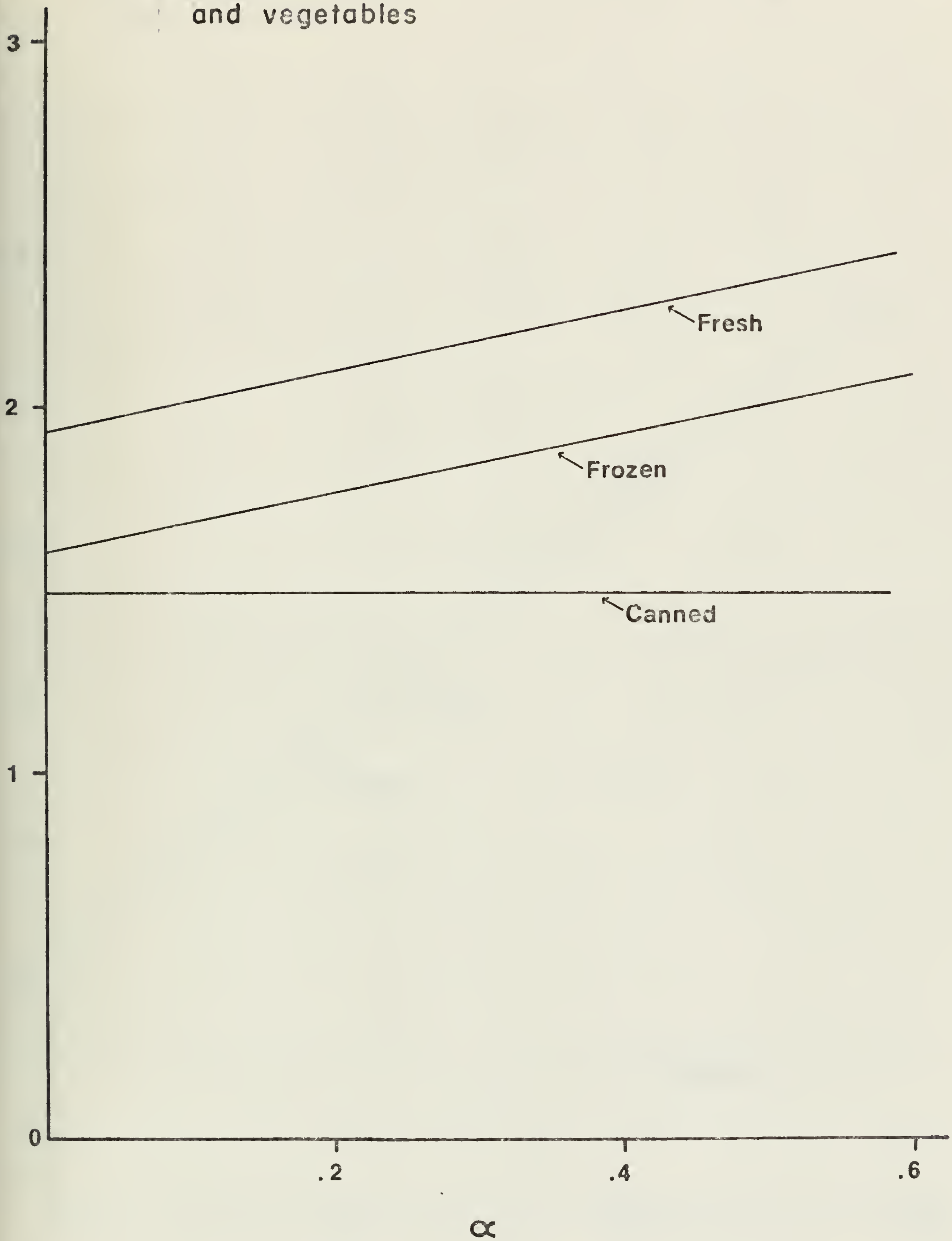


Figure 2.8.2

Energy cost of fresh, frozen, and canned fruits and vegetables

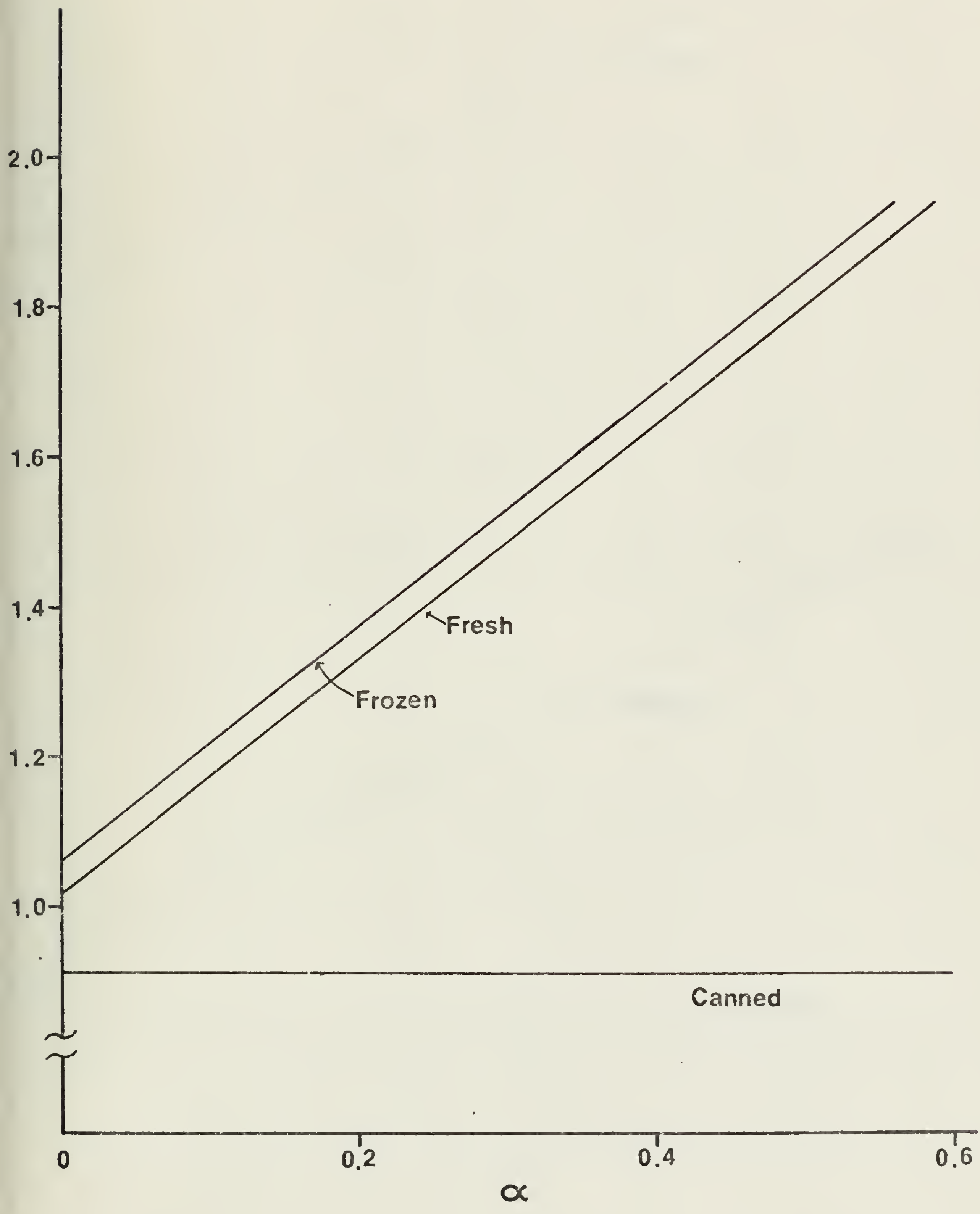


Figure 2.8.3

Labor cost of fresh, frozen, and canned fruits and vegetables