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This paper documents actual energy inputs for selected agricultural products for all activities from production to home consumption. It then estimates the potential food cost impacts of several alternative energy pricing schemes. The findings of this analysis indicate that modest energy price changes are unlikely to have significant impacts on food costs, contrary to some beliefs.

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INTRODUCTION

The 1973-74 energy crisis brought numerous studies in energy-related problems. This paper relates the findings of a recent study which measured energy use in the food system for some major agricultural commodities produced in Washington State. More specifically, the study measured the total energy inputs into the production, processing, transporting, marketing, and home uses (preservation and preparation) of wheat, apples, potatoes, sugar beets, green peas, and dairy products. These data then provide the basis for estimating the impacts of higher energy costs on Washington agriculture and food consumers.

ENERGY USE IN THE FOOD SYSTEM

Table 1 shows information related to energy use and costs in producing and consuming frozen peas. The data shown in this table are an example of similar data collected for 18 final food products.[1/]

Total energy inputs required to produce, process, and consume one ton of peas as frozen peas[2/] amounted to 16.4 million BTU's. More than one-third of the total energy is used for refrigeration after processing and prior to consumption. This requirement for refrigeration appears in marketing, transportation, and the home.

1/ Similar information for other products can be found in (9).

2/ The data presented here are in terms of one ton of farm weight product. As commodities are processed into alternative forms, however, the final product weight may be quite different from the original. One ton of green peas, for example, will produce 1.37 tons of canned peas or .92 tons of frozen peas. Products which are dehydrated will lose up to 90% of fresh weight.

Table 1. Energy and cost data for one ton of green peas processed as frozen peas.[a/]

Item	Unit	Production	Processing	Transport	Wholesale and Retail Trade	Home Storage	Home Preparation	Total
Electricity	KWH		106.80		1,656.00	355.20	855.00	2,973.00
Gasoline	Gal	5.85	3.81					9.66
Diesel	Gal	5.64	.72	11.70[b/]	2.70			20.76
Natural Gas	Therm	2.71[c/]	12.14				4.36	19.21
L-P Gas	Gal		.23					.23
Fuel Oil	Gal	2.51[c/]						2.51
BTU	1,000	2,073.20	2,158.20	1,585.30	6,016.40	1,212.30	3,354.10	16,399.50
BTU/Total BTU	%	12.60	13.20	9.70	36.70	7.30	20.50	100.00
Total Energy Cost	$	5.66	4.57	3.39	14.08	7.10	17.84	52.64
Total Cost	$	95.61	140.00[d/]	48.07	205.50	15.70	35.89	540.77
Energy$/Total$	%	5.90	3.30	7.00	6.90	45.20	49.70	9.70

[a/] One ton of farm weight green peas produces .92 ton of frozen peas or 2,944 ten ounce packages.

[b/] Does not include local distribution which is accounted for in the trade sector.

[c/] Used for fertilizer production.

[d/] Does not include raw green pea costs.

Energy used for home cooking accounted for 20.5% of total requirements while production and processing accounted for 12.6% and 13.2%, respectively.

Total energy costs for all activities were $52.64 at early 1975 price levels. One-third of the total energy cost is accounted for by home cooking though cooking used only 20.5% of total energy. Household electricity is the highest cost form of energy compared on a BTU basis. Petroleum products and natural gas, accounting for most of the energy used in production, processing and transportation activities, are much cheaper forms of energy. Also note that about one-half the consumer's cost of storage and cooking is composed of energy inputs while the ratios of energy costs to total costs are less than 10% for production, processing, transportation, and trade.

To establish a basis for estimating energy impacts on food costs, the current energy costs for each food related activity are summarized in Table 2. This table shows present energy costs calculated for a typical marketing unit of each commodity. The current cost of disembodied energy in a 17-ounce can of peas, for example, is shown to be $.0148. Thus, we begin to see the potential effect on food costs that may be affected by changing energy costs. The distribution of these costs among industries such as processing or transportation also may be estimated. For example, energy costs in the transportation industry could be doubled with the effect of increasing the cost of a can of peas by about $.002, if all other costs were held constant. Similarly, doubling only food processing energy costs would increase the cost of a can of peas by $.0034.

Table 3 shows the current total energy cost for each commodity and the energy cost under alternative pricing policies. The current retail value of these food items provides a comparison for the magnitude of energy costs. For example, a 17 oz. can of peas has a retail value of $.46 while 10 lbs. of potatoes sell for $1.09. These retail food values were determined in January 1975 and are, therefore, subject to change over time.

Table 2. Total energy cost per unit of final product by activity at present energy prices.

Item	Unit of Final Product	Energy cost per unit of final product: Production	Processing	Transport	Wholesale & Retail Trade	Home Preservation	Home Preparation	Total[a]
		dollars						
Canned peas	17 oz.	.0021	.0034	.0019	.0010		.0064	.0148
Frozen peas	10 oz.	.0019	.0015	.0011	.0047	.0024	.0061	.0178
Fresh potatoes	10 lbs.	.0091		.0211	.0009		.0850	.1162
Frozen fries	1 lbs.	.0023	.0100	.0034	.0033	.0031	.0069	.0290
Dehydrated potatoes	1 lbs.	.0064	.0358	.0031	.0013		.0172	.0639
Sugar	5 lbs.	.0191	.0671	.0107	.0048			.1018
Flour	10 lbs.	.0251	.0219	.0092	.0010		.1230	.1801
Fresh apples	1.5 lbs.	.0080		.0109	.0009	.0072		.0271
Apple juice	46 oz.	.0133	.0025	.0064	.0010	.0083		.0315
Applesauce	2 pts.	.0088	.0073	.0092	.0010			.0263
Dehydrated apples	1 lbs.	.0222	.0134	.0046	.0010			.0413
Fluid milk	1 gal.	.0159	.0081	.0044	.0088	.0227		.0600
Cheese	1 lbs.	.0149	.0015	.0020	.0084	.0029		.0296
Cottage cheese	1 lbs.	.0097	.0030	.0024	.0083	.0028		.0263
Butter	1 lbs.	.0103	.0067	.0016	.0081	.0028		.0296
Ice-cream	½ gal.	.0141	.0074	.0009	.0082	.0216		.0523
Dehydrated milk	1 lbs.	.0110	.0138	.0012	.0009			.0269

[a] Row sum may not equal the total due to rounding.

Table 3. Total energy costs for each commodity under policies A-D.

Item	Unit of final Product	Current Market Price	Current Energy Costs [a]	Energy Cost / Market Price [a]	Current Energy Costs [b]	Energy cost / Market Price [b]	Energy cost under policy: [a] A	B	C	D
Canned peas	17 oz.	.46	.0148	3.22	.0085	1.85	.0200	.0221	.0172	.0296
Frozen peas	10 oz.	.33	.0178	5.39	.0094	2.85	.0218	.0309	.0188	.0356
Fresh potatoes	10 lbs.	1.09	.1162	10.66	.0312	2.86	.1428	.2001	.1215	.2324
Frozen fries	1 lbs.	.49	.0290	5.92	.0190	3.88	.0365	.0443	.0353	.0580
Dehydrated potatoes	1 lbs.	1.03	.0639	6.20	.0467	4.53	.0763	.0867	.0913	.1278
Sugar	5 lbs.	2.72	.1018	3.74	.1018	3.74	.1291	.1102	.1679	.2036
Flour	10 lbs.	2.09	.1801	8.62	.0571	2.73	.2094	.3060	.2051	.3602
Fresh apples	2.5 lbs.	.75	.0271	3.61	.0199	2.65	.0441	.0367	.0276	.0542
Apple juice	46 oz.	.63	.0315	5.00	.0232	3.68	.0499	.0434	.0329	.0630
Applesauce	2 pts.	.69	.0263	3.81	.0263	3.81	.0433	.0300	.0319	.0526
Dried apples	1 lbs.	1.98	.0413	2.09	.0413	2.09	.0743	.0472	.0437	.0826
Fluid milk	1 gal.	1.60	.0600	3.75	.0371	2.31	.0772	.0987	.0637	.1198
Cheese	1 lbs.	1.75	.0296	1.69	.0267	1.53	.0439	.0445	.0300	.0590
Cottage cheese	1 lbs.	.90	.0263	2.92	.0235	2.61	.0375	.0399	.0280	.0526
Butter	1 lbs.	.81	.0296	3.65	.0270	3.33	.0412	.0439	.0331	.0594
Ice-cream	½ gal.	1.09	.0523	4.80	.0307	2.81	.0652	.0880	.0559	.1046
Dehydrated milk	1 lbs.	1.04	.0269	2.59	.0269	2.59	.0393	.0317	.0368	.0538

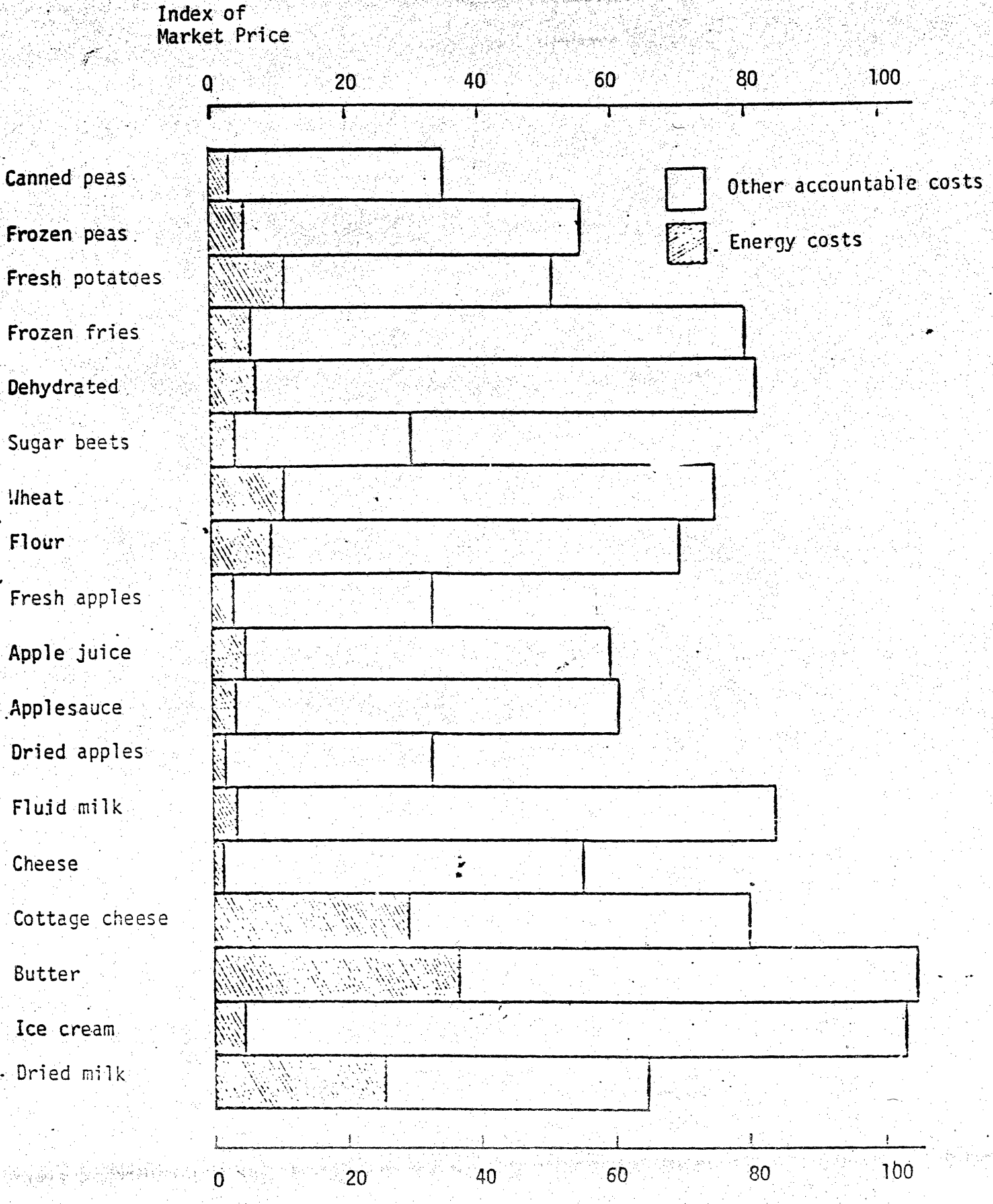
[a] Including home energy use

[b] Excluding home energy use

Similarly, the current cost of energy was established in the period December 1974 - January 1975. The energy costs are also changing but probably more slowly or with less variation than the prices of food. The third data column in Table 3 shows current energy costs for each final product and the data in the fourth column shows the percentage of the consumer's food cost currently contributed by energy inputs. These values range from as low as 1.7% for cheese to more than 10% for fresh potatoes. That is, more than 10% of a consumer's cost for fresh potatoes is expended for energy inputs. The data in Table 2 indicate that most of this energy is used in the home for cooking the potatoes. In general, foods requiring large energy inputs for processing, storage, or cooking will be more vulnerable to changing energy costs than those foods than can avoid such activities. It will be noted that frozen or dehydrated potatoes have a lower percentage of total cost contributed by energy inputs. However, each of these foods will contain about 50% more energy per pound of potatoes consumed than if the potatoes are not processed prior to reaching the consumer. The higher market value of these foods reduces the percentage of total cost contributed by energy, however.

Figure 1 is included to show the current energy cost for each commodity, including household uses, relative to other (non-energy) allocable costs and the current market value. The difference between total estimated costs and retail market value for each commodity is the cumulative profits and returns to unmeasured costs of all activities from production through retail marketing. This margin is much larger for some commodities than for others. Some dairy products actually show costs exceeding market price. Selecting another month or year to determine market food costs, however, could change the relative margins on these commodities. This figure also gives a better picture of the relative role of energy in determining the consumer's food costs.

Figure 1. Relative proportions of total energy costs, other accountable costs and gross marketing margins.



The total energy costs shown so far include the energy used in home storage and preparation of food. Though the cost of this household energy is a real part of the consumer's food costs, its value is not reflected in the market prices of food. Thus, if home energy uses are excluded from the energy costs, per unit costs and percentage of the consumer's food cost currently contributed by energy inputs could be substantially reduced. The fifth and sixth columns in Table 3 are for that purpose. For example, the ratio of energy cost to the market price goes down to 2.86% from more than 10% by excluding home-used energy for fresh potatoes.

Changing Energy Costs

To assess the food costs impacts, four alternative energy pricing schemes were selected. These pricing schemes, labeled Policies A-D, are described below.

Policy A - Petroleum prices are doubled while holding other energy prices constant.

Policy B - Electricity prices are doubled while holding other energy prices constant.

Policy C - Natural gas prices are doubled while holding other energy prices constant.

Policy D - All energy prices are increased 100%.

The last four columns of Table 3 show the cost of energy per food item under the alternative energy pricing policies. The current cost of energy in a can of peas is $.0148. To double the price of all petroleum products used throughout the food chain would increase this cost to $.0200 (Policy A). Doubling electricity and natural gas prices would raise the energy cost per can of peas to $.0221 and $.0172, respectively (Policy B & C). Of course, doubling all energy prices would raise the cost of energy per can to $ .0296.

The effect of changing the cost of a particular form of energy will not be the same for all commodities. Those foods dependent upon large inputs of electricity for storage or cooking will be more vulnerable to changing electricity prices. Foods such as fresh potatoes or wheat requiring relatively larger amounts of petroleum products for production or transportation to market will be affected most by changing petroleum prices. Finally, highly processed foods are likely to be affected most by changing natural gas prices. The data in Table 4 will sharpen the focus on these factors. This table shows the percentage change in consumer food costs that would be imposed by each of the energy pricing policies.

Policy A

Policy A, which doubles petroleum prices, increases consumer food costs about 1 to 3%, Table 4. However, exported wheat stands out as an exception for two reasons. The first is because the price base is the domestic export price rather than the foreign import price and the second is the fact that petroleum products account for most of the energy used for this food item activity. Doubling petroleum prices would increase the consumer's cost of both frozen and canned peas by slightly more than 1%. Potato food costs would increase from 1.2% if dehydrated, to 2.4% if consumed as nonprocessed potatoes. The consumer cost of sugar would increase only 1%. Dairy product costs would increase from 1% to 1.4%. Petroleum costs changes will most seriously affect the transportation and production sectors.

Policy B

Policy B considers a 100% rise in electricity prices while holding other energy prices constant. Table 4 shows the effects of this policy on consumer food costs, though varied, to be slightly greater than when petroleum prices were doubled. Those commodities requiring refrigeration in processing, trade, or the home and/or

Table 4. Percentage change in consumer costs under each energy pricing policy.

Item	Policy A	B	C	D
Canned peas	1.13	2.21	.52	3.22
Frozen peas	1.21	3.97	.30	5.39
Fresh potatoes	2.44	7.70	.49	10.66
Frozen fries	1.53	3.12	1.29	5.92
Dehydrated potatoes	1.20	2.21	2.66	6.20
Sugar	1.00	.31	2.43	3.74
Wheat (export)[a/]	9.79		1.04	10.83
Wheat flour	1.40	6.02	1.20	8.62
Fresh apples	2.27	1.28	.07	3.61
Apple juice	2.92	1.89	.22	5.00
Applesauce	2.46	.54	.95	3.81
Dried apples	1.67	.30	.12	2.08
Fluid milk	1.08	2.42	.23	3.74
Cheese	.82	.85	.02	1.69
Cottage cheese	1.24	1.51	.19	2.92
Butter	1.43	1.77	.43	3.65
Ice cream	1.18	3.28	.33	4.80
Dehydrated milk	1.19	.46	.95	2.59

[a/] Wheat price changes are calculated on the basis of domestic export prices, and not foreign consumer prices.

substantial cooking had the largest cost increases. Frozen peas, frozen fries, and ice cream all require refrigeration and the first two need to be cooked. Fresh potatoes and flour requiring large amounts of cooking energy, had even larger percentage cost increases. A large share of the electricity used for commodities requiring refrigeration and cooking is consumed in the home. We estimated the share of electricity costs expended for food in the household to be 84% of the total electricity costs in the food system.

Policy C

Under Policy C natural gas prices would be increased 100%. Such a policy has effectively been implemented in Washington over the past 18 months. Table 4 shows this policy will increase food costs by less than 1% for most commodities. Dehydrated potatoes and sugar using natural gas in processing show final cost increases of about 2.5%.

Nitrogen fertilizer is largely produced using natural gas. However, even at a price of $1.00 per thousand cubic feet, several times the price of natural gas used for fertilizer production prior to the fall of 1973, natural gas contributes only about $40 to the cost per ton of anhydrous ammonia. Thus, the 100% plus increase in fertilizer prices since 1973 cannot be blamed entirely on the increase in energy prices. A 100% increase in natural gas prices from today's level could add about 15% to the farm cost of nitrogen fertilier which in turn could add about 3% to the farmer's cost of producing wheat. The percentage effect would be even less for other crops.

Policy D

Policy D merely increases the cost of all energy by 100%. Such action could effect a 10% increase in the consumers cost of fresh potatoes. Other commodities would be affected to a lesser degree. Wheat flour could increase by 8.6% by the time it is used for baking bread. Dairy product costs would generally increase by less than 4%.

CONCLUSIONS

It is apparent from these data that modest increases in energy costs should not result in significant food cost increases. However, the impacts of an energy cost increase will not fall equally on all sectors or commodities.

The resulting change in food costs from a 100% change in petroleum prices averaged 2%; a 100% change in electricity prices caused food costs to rise about 2.3%; a 100% increase in natural gas prices caused food costs to increase about .7%; and a 100% increase in all energy prices would cause about a 5% increase in food costs.

Thus, governmental action causing, say, 25% - 50% increases in petroleum prices is not likely to result in substantial food cost increases, even though it will significantly affect the transportation and production sectors. That is not to say that food prices would not rise by more than 1% if petroleum prices were increased by 50%. But, such energy price increases should not be directly blamed for larger food cost increases.

The household or consumer currently pays the highest price per unit of electricity and also uses the largest share of electricity for refrigeration and cooking. Thus, the consumer will be affected most by increases in the price of electricity. Because electricity use is also concentrated in those commodities requiring refrigeration and/or cooking, products such as frozen peas, frozen fries, and

ice-cream would be expected to receive the largest impacts of rising electricity prices.

Natural gas price changes fall most heavily on the food processing sector and those commodities requiring large amounts of heating during the processing. Sugar and dehydrated potatoes are examples of such commodities.