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Audit, Evaluation and Control Branch

A Report on the Evaluation of the Energuide Program Part II (Technical)

Consommation et Corporations Canada

Consumer and Corporate Affairs Canada

Bureau de la coordination des politiques

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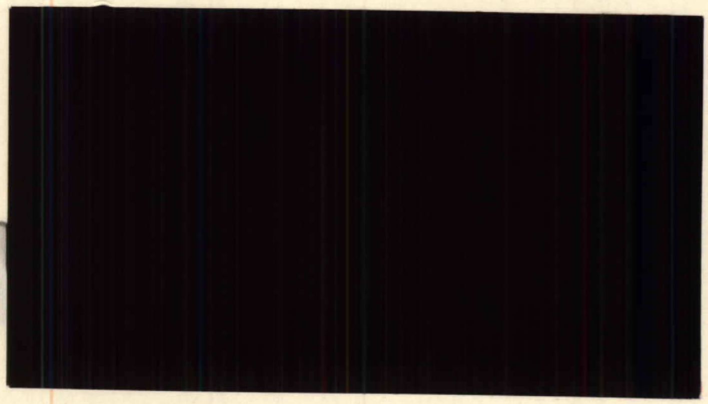

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A Report

on the

Evaluation

of the Energuide Program

Part II (Technical)

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This report is one of several prepared by independent consultants as input for the evaluation of the Energuide Program. All evidence, advice and recommendations represent the independent views of the consultant rather than the views of the Government of Canada or any of its departments or agencies.

A Report
on an
Evaluation of the Energuide Program
Part II (Technical)

Executive summary

A review of the technical aspects of the Energuide program utilizing a series of interviews with appliance manufacturers and others with specialized knowledge of the field was conducted as a part of an evaluation of the program.

The Canadian appliance market is dominated by three major companies which are subsidiaries of, or are affiliated with, American firms. These three manufacture products carrying brand names once associated with separate companies.

Expect for freezers, which are exported, and dishwashers where over twenty per cent were imported in 1983, neither imports nor exports are particularly significant in the Canadian appliance market.

The design of refrigerators has changed in the life of the program in two important ways. Manual defrost units with a single door have declined in popularity relative to the two door frost free model despite the higher energy consumption of the latter. At the same time, the energy efficiency of both has increased. There is a prospect of further substantial reduction in the use of energy to levels about half those presently required. This will not require any major technical advances, but merely the

application of well known practices. The cost of making the necessary changes would be fairly low except for the amortization of tooling costs which would be significant.

Freezers designed and built in Canada are as efficient as any made anywhere. Further improvements, as in the case of refrigerators are possible, but are not considered economically justified at present.

Front load washers would be more energy efficient than the commonly sold centre-post-agitator type, but are not popular in the North American market. The design changes made to date to clothes washers have been mainly concerned with the conservation of water, particularly hot water and are thought to have reached the practical limit. No major additional saving appears to be in prospect.

Clothes dryers have not been changed significantly in terms of their use of energy. Little change is considered to be technically feasible.

Dishwashers now made, use less energy than those produced pre-Energuide. As in the case of clothes washers, the gains have been largely through conservation of hot water. Some models have had insulation added and/or are using more efficient motors. No other improvements with a significant effect on energy use are likely to come about.

Ranges have changed very little. Most manufacturers consider that there is very limited scope for improvement.

The changes in appliance design effected to date have resulted in a substantial reduction in the cost of electrical energy to the consumer. This is estimated to have been of the order of $140 million, to the end of 1983. The value of the future cash flow is estimated at $125 million. There were no significant costs in terms of reduced appliance performance nor was there any large benefits except the saving in cost of energy.

The Canadian appliance industry is linked closely with that of the United States, and technical information arising there flows freely into Canada. The Canadian affiliates or subsidiaries spend less on research and development than do their American parents, but the industry as a whole is not a highly technical one.

Test procedures worked out by committees for each appliance are performed by each manufacturer and results are confirmed by CSA. In general, the program is well supported by industry.

Electric hot water heaters are not covered by Energuide. The sizes used domestically may be sold under the Cascade label promoted by the major utilities, provided they meet a minimum performance standard administered by CSA. Ontario Hydro requires that all electric hot water heaters sold in Ontario meet its own standard (closely similar to that of CSA). Because of the size of the Ontario market, this in effect applies all across Canada, because manufacturers do not find it economical to produce to more than one level of efficiency.

Gas fired hot water heaters, and gas furnaces both warm air and hydronic, must conform to standards laid down by CGA. Early in 1985, a program very similar to Energuide will be in place with respect to warm air furnaces. The other products will likely follow a similar pattern.

Standards if set so as to permit the continued sale of appliances currently manufactured, should not meet strong opposition. These would provide some protection against the import or local production of very low efficiency appliances in the event that the Energuide program were to be terminated.

The technological change most likely to come about in appliances in general is the application of micro-processors in control circuits. These may reduce manufacturing costs and imporve serviceability, but are unlikely to have much effect on the use of energy.

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1.0 INTRODUCTION

With the abrupt increase in the price of oil brought about by OPEC in 1973, the world's attention was focussed on the cost of energy, and on ways of reducing it. The Organization for Economic Co-operation and Development (OECD) prepared a report in 1974, "Energy Prospects to 1985" which gave attention to the potential for energy conservation in the residential sector, among others. This report was followed in 1976 by a report of the OECD Committee on Consumer Policy on the labelling of domestic appliances as a means of realizing at least a part of this potential saving. It drew attention to projects then underway in several countries in the world including Canada. The committee noted that:

> Consumer information by means of labelling is an important element of consumer policy . . . . in most member countries.

Voluntary labelling schemes were, as of mid 1976, in operation in France, Switzerland and the United States. Corresponding programs were at the planning stage in Canada, Germany, Japan and the Netherlands. The report concludes with the suggestion that authorities which have not yet undertaken any action, should do so, and depending upon the results of these, some common guidelines might be developed.

Whether or not a program common to several countries would be valuable or not, there seems to be little doubt that Canada's activity in the field has been effective.

The Energuide program announced in May 1978 by the federal Government was to cover major household electrical appliances. It was applied in turn to refrigerators, freezers, clothes washers, dishwashers, electric ranges and finally electric clothes dryers. As each appliance was brought under the program, all units sold in Canada were required to bear a label indicating the results of a test of energy consumption.

This report covers the work carried out to identify the impact of the technical aspects of the program on appliance manufacturers and on the public which they serve.

It considers the various design changes which have been proposed to each of the six Energuide appliances. The results actually obtained by making these are contrasted with the those predicted from theoretical considerations.

2.0 BACKGROUND

2.1 Energy conservation and the appliance industry

With the sudden escalation of energy costs in the early 1970s, it was not surprising that the residential demand for electrical energy came under close scrutiny. The use of more energy efficient appliances was one of the ways in which it was felt that this could be reduced. In the United States, the Energy Policy and Conservation Act was passed in 1975. It required, among other things, an improvement in energy efficiency for 13 different types of appliances by 1980.

The target figure, 20 per cent improvement compared to 1972, was to be met as an aggregate figure. The act also provided that a mimimum performance standard could be applied in the case of any appliance, which in the opinion of the administration, was not likely to reach the target.

In part due to vigorous objections by industry and in part due to the technical difficulties in establishing the details of the program, the original plan was not followed. At present, several states have enacted minimum efficiency standards for some appliances. Of these, those in force, or proposed by 1985 in California are the most demanding. The prospect of federal legislation with any major impact is considered to be remote.

In Canada, the program has had, in general, much better support from industry. There may be several reasons for this. In the first place, the Energuide program was promoted to industry as a joint effort between the manufacturers, the utilities and the government with goals and objectives arrived at jointly. It also came at a time when the industry was in a state of disarray following a series of take-overs and mergers. There was a need to rationalize product design and in at least some cases, this could be met with manufacturing methods which led to more energy-efficient products. The use of foam insulation in refrigerators and freezers is an example of this. Foamed-in-place insulation provides better thermal performance, but also reduces labour costs. When major re-alignment of manufacturing facilities was necessary to rationalize production, the capital cost to utilize the new material was easier to justify economically.

Despite this more favourable situation in Canada, there was not universal agreement about the savings to be made. A 1981 analysis of major household appliances by an economist of the Ontario Hydro was responded to later that year by the Canadian Appliance Manufacturers's Association. While this response indicates that

> . . . there is a wide measure of agreement relating to the overall objectives in the field of energy conservation,

it goes on to claim that:

> the energy consumption of some appliances is already equal to or below levels considered [in the CEA report] to be technically possible

and product by product concludes as follows:

> Refrigerators - Industry action already in effect, has significantly reduced energy consumption levels. Current indications are that these levels will be reduced to CAMA's identified technically possible levels within a five year period,

Chest freezers - Products already made and sold in Canada, representing more than 50% of all chest freezers sold, exceed the "technically possible" levels proposed in the CEA report by a wide margin. Within the forseeable future, competitive activity will bring the energy consumption of all freezers manufactured and sold in Canada to these levels,

Dishwashers - The majority of dishwashers sold in Canada already exceed CEA's identified "technically possible" levels. While some further energy reduction may be possible, they can not yet be quantified. The inevitable further progress should be left to the effect of competitive market forces,

Automatic clothes washers - Energy consumption levels of automatic clothes washers have already been considerably reduced by reducing the consumption of hot water. Further reduction can not yet be quantified, but it is possible that further reductions may be achieved as a result of extensive design changes. The effect of competitive market forces will exert an appropriate influence on this activity,

Electric ranges - The CEA report indicated that identified potential energy reductions resulted in only a marginal overall benefit. CAMA does not agree with the method used by CEA to calculate available energy reductions; this particular item requires to be resolved,

Clothes dryers - CAMA agrees with CEA that insufficient potential appears to exist in this product for substantial energy reductions to be made. It is anticipated, however, that as a result of the Energuide labelling programme for these products, some significant reductions in energy consumption will occur.

2.2 Appliance market in Canada

The demand for domestic electrical appliances in Canada is met largely by Canadian production. With the exception of freezers and dishwashers, almost all the manufacture of the six Energuide appliances is in the hands of three companies. The import of appliances is for the most part limited to units of a type or size not manufactured here.

The buying public is probably unaware of the very limited number of companies which actually manufacture the products whose names have been household words for decades. In addition to such familiar ones as Frigidaire, McClary, Kelvinator and Whirlpool, there are the names applied to products sold by the major retailing chains. This latter group are referred to in the trade as 'stencil lines' and are made under contract for the retailer by any one of the three major companies. Some products bearing the same generic brand name may also be imported. Table 1 below, lists the major manufacturers and familiar brand names which each applies to at least some of their output. Because the contractor responsible for production of any given stencil line may change from year to year, these are not included.

Also, due to close corporate ties, a Canadian company may market a product of an American parent or affiliate under the same name as units of a size or style different to those manufactured locally.

Table 1

Major Canadian Manufacturers, Brand Names and Products

Manufacturer	Brand Names
Camco (all appliances except freezers)	General Electric Hot Point Moffat McClary
Inglis (all appliances except freezers)	Admiral Inglis Whirlpool
WCI (all appliances)	Frigidaire Gibson Kelvinator Leonard Roy White Westinghouse Arctic Star
Woods	Woods
General Freezer (freezers only)	Atlas General Freezer Gensave Zero Freeze
Hobart (dishwashers only)	Kitchenaid

2.3 Relationship to foreign markets

There are very close corporate ties between the three major Canadian appliance manufacturers and American companies. Some are wholly owned subsidiaries, others have licensing agreements. In every case, they have full and easy access to the technology of their parent or affiliate.

The freezer industry is in a somewhat different position. Here there are wholly owned Canadian companies. Two of these have substantial sales in the United States and derive a considerable fraction of their corporate income from these and other export sales.

Aside from freezers, exports are not a major factor in the appliance manufacturing industry. On the other hand, with the exception of dishwashers, imports are not particularly significant either.

The Canadian Appliance Manufacturer's Association compiles and publishes annually, data on the appliance market. These include the approximate percentage of the market supplied by imports. Table 2 shows estimates of these for 1983, based on January to October data. Because some imported units, such as coin-operated laundry appliances are not covered by the program, the table does not accurately reflect the percentage of Energuide labelled appliances supplied from outside Canada.

Table 2

Estimated percentage of Canadian market for appliances taken by imports in 1983

Appliance	Percentage of total market
Refrigerators	10.3
Freezers	*
Clothes washers (automatic)	12.6
Clothes dryers	9.0
Dishwashers	22.8
Electric ranges	5

* Imports of freezers are neglible

The imported appliances may have specialized features not available in Canadian made equipment, but except for refrigerators, there does not appear to be any consistent pattern.

In the case of refrigerators, both very small units having volumes of the order of 1 m^3 and absorption types, comprise the bulk of the imports, which also includes a few top-of-the-line models.

3.0 THE EFFECTS OF CHANGE IN THE MARKETING AND MANUFACTURE OF APPLIANCES, 1977 - 1984.

In order to study at first hand how the various market and economic forces have influenced the appliance industry, a series of meetings with appliance manufacturers was held. Personnel interviewed generally included the chief executive officer, and the senior executives in marketing and in engineering.

The interview schedule used is reproduced as Appendix C to this report. The questions ranged from those intended to elicit the general impression which the chief executive had of the Energuide program, to detailed questions, change by suggested change, asked of the engineering respondent. The questions were answered fully and freely despite the fact that the full set of interviews required several hours in the case of a manufacturer of more than one product.

The results of these interviews, together with data from the literature and other sources is arranged below by appliance.

3.1 Refrigerators

3.1.1 The market pre-Energuide

In 1977, at the beginning of the Energuide program about one quarter of all refrigerators manufactured were one door manual defrost types. It was expected that these would encounter a decreasing share of the market demand, falling to about half their 1977 level by 1988. In general, these units were small by present standards, most being in the range 10-12 ft.^{3}.

Energy demands of the order of 60-90 kW.h/month were typical.

Even in 1977 the two door frost-free design was more popular. The output of this model constituted 65 per cent of total production. The refrigerator section of these appliances were about the same size as the manual defrost single door units, but the added freezer compartment brought the total volume to about 15 or 16 $ft.^3$. The energy consumption of these models was proportionally higher, figures in the range of 150 to 170 were typical. However, even then, some were available with monthly energy demands below 120 kWh.

The marketing managers of the manufacturers interviewed were asked to list the three factors which they considered to be the most important in influencing buying decisions in the period before Energuide. The responses obtained are tabulated below.

Table 3

Refrigerator design features, rank ordered by estimated sales appeal, 1960-1970

Attribute	No. placing attribute in position shown		
	1	2	3
User Convenience	1	-	-
Special Features	1	-	2
Appearance	-	2	-
Efficiency	-	-	-
Reliability	-	-	1
Cost	1	2	-
Performance	-	-	-
Other	-	-	-

3.1.2 The impact of change to date

The effect of a combination of factors on product design in the appliance manufacturing industry was nowhere more pronounced than in the manufacture of refrigerators. The traditional refrigerator design consisted of a sheet-metal shell, and a layer of glass fibre insulation into which the inner shell was fitted. Plastic parts were used around the door or doors and the compressor was located at the base of the unit.

These units performed quite satisfactorily, particularly when energy costs were low, but involved a considerable amount of hand labour in their construction.

Analysis of the manufacturing processes showed that re-designing the enclosure to utilize foamed-in-place insulation would be cost-effective. This was true because it permitted a higher degree of automation in production. While the capital costs were high, the pay-back period was low enough to make the conversion economic.

The resulting re-design could have concentrated on the cost-saving features to the exclusion of concern for the use of energy. Urethane foam being a superior insulation to conventional glass fibre, a 22 per cent thinner section would have had the same thermal characteristics. However, in the re-design, the wall thickness was not changed substantially. About 22 per cent of the cost of the foam insulation is, therefore, properly attributable to energy saving.

3.1.3 Current market conditions

Although some marketing executives reported that energy ratings influenced sales where prices had to be quoted in terms of life cycle costs, they were generally unimpressed with the sales appeal of energy efficiency in the market place in 1984.

Answers with regard to the recovery of cost increases associated with energy saving design changes were inconclusive. The period during which these changes took place was one of rising costs. Identifying a specific market response to one of the factors causing these cost increases was predictably difficult. Generally speaking, most respondents were of the opinion that the relatively small cost increases which were properly traceable to energy conservation per se, did not affect sales volume.

The overall market for refrigerators has moved more or less as was expected five years ago. Manual defrost units now take 10.5 per cent of the market, rather less than was anticipated even by 1988, while the frost free units are selling slightly better than the earlier forecast. Energy demands of these models differ rather little from those of the same type and size made earlier. This probably results from a low priority assigned to the re-design of a unit having decreasing sales.

The popular two compartment frost-free model has however, clearly been improved. Several suppliers now offer 15 cubic foot or larger refrigerator-freezers using less than 120 kWh per month, while one lists an 18 cubic foot unit rated at 79 kW.h per month.

3.1.4 Analysis of engineering review - refrigerators

The results of the interviews with engineering executives of companies manufacturing refrigerators are tabulated below.

The first group of changes tabulated are those which a 1981 Ontario Hydro report considered as being technically feasible at that time. The next group are those for which further R&D was thought (as of 1981) to be necessary before they could be implemented. Changes shown under the sub-head 'Others', are those made by one or more companies and which did not fall into either of the categories above.

The energy savings shown as being actually realized were those claimed by the engineer interviewed. In most cases, their claims were checked by him using records of in-plant tests, in others, data were cited from memory. Estimates of the costs, applicable to energy conservation as such, were usually made without reference to any records and should be regarded as indicating the order of magnitude only.

Table 4

Analysis of design changes in the manufacture of refrigerators

Proposed change	Made by N mfrs	Antic svng kWh/m	Actl saving kW.h/m Min	Max	Avg	Cost $
Changes possible as of 1981						
Add insulation	3	27	2	35	21	3
More efficient motor	-	13	-	-	-	-
Anti-sweat heater redesign	1	13	10		10	2
Improve door seals	-	8	-	-	-	-
Changes requiring R&D as of 1981						
More efficient compressor	3	8	12	27	20	1.5
Optimize refrig. cycle	-	5	-	-	-	-
Redesign evaporator	-	5	-	-	-	-
Redesign condenser	-	4	-	-	-	-
Relocate evaporator fan	-	3	-	-	-	-
Improve refrigerant	-	1	-	-	-	-
Others						
System redesign and heaters	1		5		5	Nil
Energy switch	1		10		10	1.5
Fan motor - low wattge	1		6		6	1
Optimize defrost	1		6		6	Nil
Mullion heater	1		4		4	Nil
Improved gaskets	1		1		1	Nil

Notes: The savings shown in the column headed 'Antic. svng' are those shown in a CEA report of 1981.

'Actl. saving' are those estimated by the engineering executive interviewed as having been achieved by the design changes concerned.

3.1.5 Prospect for future design improvements

The improvements made in the energy efficiency of refrigerators to date are technically capable of being surpassed. The review of manufacturers and of the literature showed that for this appliance at least, more could be done to conserve energy than was predicted on the basis of the 1981 report referred to earlier.

As of early 1983, an 18.0 cubic foot refrigerator freezer was offered on the American market which was rated to use 72.5 kW.h per month. A second unit of the ssme size made by another company was undergoing field tests. It's energy consumption was estimated to be 65 kW.h/m.

If the design features of these two appliaces were combined, it has been estimated that a refrigerator using only 48 KW.h/m would be possible.

3.2 Freezers

3.2.1 The market pre-Energuide

The domestic freezer is a somewhat simpler appliance than its relative the regrigerator. It is available in two configurations, the upright and the chest types.

In 1977, chest freezers dominated the Canadian market 92 to 8 per cent. Of these, slightly more than half (51 per cent) were 14 cubic feet and under in capacity. It was then expected that these smaller sizes would continue to grow in popularity.

The three design features considered to have been the most important in the market before energy costs became an important factor are tabulated below.

Table 5

Design of freezers rank ordered by estimated sales appeal 1960 - 1970

Attribute	No. placing attribute in position shown		
	1	2	3
User convenience	-	-	-
Special features	1	-	1
Appearance	-	-	-
Efficiency	1	-	-
Reliability	1	1	1
Cost	-	2	-
Performance	-	-	-
Other	-	-	-

3.2.2. The impact of change to date

Chest freezers are invariably manufactured for manual defrosting. This is found to be satisfactory for two reasons. First, the design with a top opening reduces the air circulation and consequently the introduction of moisture associated with each opening as compared to upright types. Secondly because the principal function of a freezer is relatively long term storage, door operings are less frequent than in the case of the freezer compartment of a combination refrigerator-freezer. Thus, the design complications, costs and energy demands associated with automatic defrosting are avoided and a relatively simple appliance results.

Some freezers manufactured prior to the beginning of the Energuide program already used foam insulation. This is now standard, in thicknesses up to three inches, although most use two or two and one half inches. Further increases are not thought to be cost effective, as heat gains other than those through the walls become the controlling factors.

Not all units now manufactured use foam insulation in the lids, nor are lid gaskets considered to be as satisfactory as they could be.

Compressors are gradually being improved, principally by off-shore manufacturers. As these become available, they will be introduced.

The chief executive officer of one manufacturer expressed some disinterest in further design changes to reduce energy consumption on the grounds that his company could not recover additional costs. The rate of payback was, in the opinion of some of his customers even in sub-tropical areas, too low to warrant the necessary increase in first cost.

3.2.3 Current market conditions

The market for freezers appears to be highly competitive. This is due in part to a decline in total sales in 1981-82 and only a modest increase of 2.6 per cent in 1983. As a result, this is a price conscious market, where even modest price increases to cover design improvements are hard to come by.

Somewhat surprisingly, a company not now active in the field is considering entering it.

Contrary to the position of sales executives in the appliance industry generally, one respondent for a freezer manufacturer placed energy efficiency at the top of his list of important sales features in today's market. This may relate as much to the ability of a highly efficient freezer to maintain good storage conditions throughout as it does to energy conservation.

The percentage of the market captured by freezers of 14 cubic feet capacity and less continues to climb, albeit not as quickly as was forecast in 1977.

3.2.4 Analysis of engineering review - freezer

Designers of freezers appeared to be very conscious of energy efficiency and feel that theirs is a competitive market in this respect.

The energy savings shown as being actually realized were those claimed by the engineer interviewed. In most cases, their claims were checked by him using records of in-plant tests, in others, data were cited from memory. Estimates of the costs, applicable to energy conservation as such, were usually made without reference to any records and should be regarded as indicating the order of magnitude only.

Table 6

Analysis of design changes in the manufacture of freezers

Proposed change	Made by N mfrs	Antic svng kWh/m	Actl saving kW.h/m			Cost $
			Min	Max	Avg	
Changes possible as of 1981						
Add thermal insulation	3	27	10	46	28	5
Changes requiring R&d as of 1981						
More efficient compressor	3	7	5	10	8	1.6
Others						
Door gaskets	1	-	5	-	-	1
Thermal contact of tubing	1	-	3	-	-	-

Notes: The savings shown in the column headed 'Antic. svng' are those shown in a CEA report of 1981.

'Actl. saving' are those estimated by the engineering executive interviewed as having been achieved by the design changes concerned.

3.2.5 Prospect for future design improvements

The probability of design improvements to enhance the energy efficiency of domestic freezers is a purely economic matter. The manufactuers are well aware of how the postulated energy savings would be achieved.

In addition to improved and/or increased insulation and more efficient compressors better bonding between evaporator tubing and chest liners would be effective. This change is largely one of improved manufacturing techniques and is not likely to be costly.

3.3 Clothes Washer

3.3.1 The market pre-Energuide

The automatic clothes washer had almost replaced the wringer or the twin tub design by 1977. Sales in that year were 469 thousand automatic units compared to only 90 thousand of the simpler design.

Design features considered to be important were reported by marketing executives as shown in the table below.

Table 7

Design of clothes washers rank ordered by estimated sales appeal 1960 - 1970

Attribute	No. placing attribute in position shown		
	1	2	3
User Convenience	1	-	-
Special Features	1	-	1
Appearance	-	-	-
Efficiency	-	-	-
Reliability	-	-	1
Cost	-	2	-
Performance	-	-	-
Other	-	-	-

3.3.2 The impact of change to date

None of the manufacturers of washing machines interviewed had made significant changes to their designs with a view to improving energy performance.

A reduced setting of the normal water level was introduced in all models manufactured by one company which also changed the wash cycles on part of their production. It was the opinion of the engineer reporting these changes that they probably reduced performance of the equipment.

3.3.3 Current market conditions

Sales of clothes washers to the replacement market continue to exceed those to equip newly completed dwelling units. These sales are not made on the basis of any significant change in energy efficiency, but rather because of the increasing age of the stock of this appliance. Over the past five years, it is estimated that the number of automatic washers over 10 years of age has increased by almost thirty per cent.

3.3.4 Analysis of engineering review - clothes washers

The consensus among the engineers interviewed was that most of the design changes made to date, consisted of modifications to the wash cycle. While they felt that these were justified, the lack of any performance criteria was somewhat disturbing.

The energy savings shown as being actually realized were those claimed by the engineer interviewed. In most cases, their claims were checked by him using records of in-plant tests, in others, data were cited from memory. Estimates of the costs, applicable to energy conservation as such, were usually made without reference to any records and should be regarded as indicating the order of magnitude only.

Table 8

<u>Analysis of design changes in the manufacture of clothes washers</u>

Proposed change	Made by N mfrs	Antic svng kWh/m	Actl saving kW.h/m			Cost $
			Min	Max	Avg	
Changes possible as of 1981						
Eliminate hot rinse	1	44	10	30	20	1
Front load washer	-	44	-	-	-	-
Solid tub	-	19	-	-	-	-
Suds saver	-	13	-	-	-	-
More efficient motar	-	1	-	-	-	-
Changes requiring R&d as of 1981						
Water temperature mixing valves	-	2	-	-	-	-
Higher spin dry speed	-	2	-	-	-	-
Others						
Optimize water use	3	-	5	29	18	-

Notes: The savings shown in the column headed 'Antic. svng' are those shown in a CEA report of 1981.

'Actl. saving' are those estimated by the engineering executive interviewed as having been achieved by the design changes concerned.

3.3.5 Prospect for future design improvements

The design changes to clothes washers which are more than adjustment of operating conditions are few in number.

It is well known in the industry that a front load machine is more efficient, but it is costly to manufacture. This necessitates a substantially higher selling price and the demand for it is being met by those now making it. Tooling and design costs to produce it are estimated to be as high as ten million dollars. Unit costs would increase, perhaps as much as one hundred dollars to amortize the tooling expense and to meet other cost increases.

A solid tub, also suggested as a possible design change would again be expensive to tool. One estimate placed this at three to four million dollars.

The suds saver feature has been available for years and is not popular.

Two changes were considered, each was expected to save about two kW.h/m. Automatic temperature mixing valves were guessed to cost about thirty-five to fifty dollars and a high speed spin dry cycle, from five to ten. Even if these estimates are on the high side, the investment which a customer would make in first cost to save 2 kW.h/m would be unlikely to cover the actual cost plus the usual mark-up.

3.4 Clothes Dryers

3.4.1 The market pre-Energuide

In 1977, sales of electric dryers in which the drying cycle was terminated by a timer constituted 28 per cent of the total. Although the alternative designs in which drying is ended by a temperature or a humidity sensor are more energy efficient, it is not likely that their share of the market was due to this factor. These units are more convenient for the user who does not have to estimate the probable drying time in advance.

As in the case of most other appliances, user convenience is a more important factor in selecting a clothes dryer than any concern for energy conservation.

In the market of this period, the three most important product attributes were identified by the marketing executive interviewed as tabulated below.

Table 9

Clothes dryers design features, rank ordered by estimated sales appeal, 1960-1970

Attribute	No. placing attribute in position shown		
	1	2	3
User Convenience	-	1	-
Special Features	1	1	-
Appearance	-	-	-
Efficiency	-	-	-
Reliability	-	-	-
Cost	1	1	-
Performance	-	-	-
Other	-	-	-

3.4.2 The impact of change to date

Aside from the introduction of sensors to terminate the drying cycle, this appliance has changed very little since it was first introduced.

3.4.3 Current market conditions

The sale of automatic dryers continued its climb over the timed models. In 1983, these represented 70 and 30 per cent of the market respectively. Because of a significant price differential, the market shares are expected to change only slightly over the next few years.

3.4.4 Analysis of engineering review - clothes dryers

No possible changes were felt to be economically attractive in this product. Several of the engineers interviewed had considered recapturing the exhaust heat, but could not see an economic solution.

Reduction in dryer temperature might result in the need for hand ironing to remove wrinkles from some fabrics and so is not desirable.

The energy savings shown as being actually realized were those claimed by the engineer interviewed. In most cases, their claims were checked by him using records of in-plant tests, in others, data were cited from memory. Estimates of the costs, applicable to energy conservation as such, were usually made without reference to any records and should be regarded as indicating the order of magnitude only.

Table 10

Analysis of design changes in the manufacture of clothes dryers

Proposed change	Made by N mfrs	Antic svng kWh/m	Actl saving kW.h/m Min	Max	Avg	Cost $
Changes possible as of 1981						
Add thermal insulation	-	2	-	-	-	-
Heater redesign	1	2	8	-	8	Nil
Changes requiring R&d as of 1981						
Redesign of dryer chamber	-	2	-	-	-	-

Notes: The savings shown in the column headed 'Antic. svng' are those shown in a CEA report of 1981.

'Actl. saving' are those estimated by the engineering executive interviewed as having been achieved by the design changes concerned.

3.4.5 Prospect for future design improvements

Minor improvements in energy efficiency were suggested as being possible by the addition of thermal insulation and re-design of the heater. One manufacturer had achieved a greater saving than that estimated by reducing the heater element from 5000 to 4500 watts, without apparently any significant effect on drying time. The addition of insulation was thought to be as effective as claimed, but prohibitive tooling costs would be involved. There is also concern that glass fibre particles could get into the exhaust air.

More sophisticated controls capable of measuring the rate of change of moisture in the exhaust air were thought to be possible but the costs were unknown. A guess of $35 was made for a possible saving of 5 KW.h/m.

The only way a major saving in energy use could be achieved would be through recovery of the latent heat of vapourization of the water removed from the clothes and re-cycling the dried heated air. While theoretically possible, the only design which ever accomplished it was not a market success. It is considered to be impracticable by most authorities.

3.5 Dishwashers

3.5.1 The market pre-Energuide

Over 62 per cent of the market for dishwashers in 1977 was supplied by imported units. Of these, nearly half (47.5 per cent) were convertible as compared with built-in types.

Dishwasher performance was significant to most users from the first introduction of these appliances and most design efforts were directed toward this end. By the late 1970s, most of the design problems had been solved so that first cost was the predominant factor in sales.

Table 11

Dishwasher design features, rank ordered by estimated sales appeal, 1960-1970

Attribute	No. placing attribute in position shown		
	1	2	3
User Convenience	2	-	-
Special Features	-	-	2
Appearance	-	1	-
Efficiency	-	-	-
Reliability	-	1	-
Cost	1	1	-
Performance	-	-	1
Other	-	-	-

3.5.2 The impact of change to date

One manufacturer, considered the industry leader, began to incorporate design changes as early as 1978, well before Energuide was applied to dishwashers. The chief engineer of this company commented that:

> Engineers are always making changes and even before Energuide, energy usage was a factor.

This was a clear statement of an attitude observed throughout the review. While marketing managers disavowed any concern for energy efficiency most engineers displayed a keen interest in improving their products in this respect.

3.5.3 Current market conditions

After a slump in sales in 1982, sales of dishwashers rose last year, but were still far below the 1979 peak and only marginally ahead of the 1977 volume. However, the share of the market obtained by domestic suppliers rose to 77 per cent of the total. Built-in units continued to outsell portable and by an increasing margin. They now account for 69 per cent of the total. This is attributed in large measure to their inclusion in many, if not most of the newly constructed houses. This market is not ordinarily sensitive to energy-efficiency in its purchase of appliances.

3.5.4 Analysis of engineering review - dishwashers

Design changes intended to save energy in the appliance were inconsistently applied from company to company. Of the five listed:

1. Optional hot dry
2. More efficient motor
3. Reduce number of rinse cycles
4. Modify wash chamber
5. More accurate fill control

all claimed to have incorporated the first, one was using a more efficient motor, two said they had reduced the number of rinse cycles, the third said this was impracticable. One had modified the wash chamber, another said they didn't know how, while the third felt that the tooling costs would be prohibitive. The fifth suggested change had been incorporated by one, at least partially, the other two estimated the probable material cost at five dollars and one hundred dollars respectively.

As well as their different views on the practicability of the proposed design changes, all manufacturers had made others which had some beneficial effects on energy use. None were very significant nor had any two made exactly the same modifications.

The energy savings shown as being actually realized were those claimed by the engineer interviewed. In most cases, their claims were checked by him using records of in-plant tests, in others, data were cited from memory. Estimates of the costs, applicable to energy conservation as such, were usually made without reference to any records and should be regarded as indicating the order of magnitude only.

Table 12

Analysis of design changes in the manufacture of dishwashers

Proposed change	Made by N mfrs	Antic svng kWh/m	Actl saving kW.h/m			Cost $
			Min	Max	Avg	
Changes possible as of 1981						
Optional hot dry	2	4	2	6	4	1.5
More efficient motor	-	2	-	-	-	-
Reduce number of rinses	3	15	5	37	21	4
Modify wash chamber	-	15	-	-	-	-
More accurate fill control	-	6	-	-	-	-
Changes requiring R&d as of 1981						
Cold water rinse	-	30	-	-	-	-
Others						
Filter models	1	-	20	-	20	15
Add insulation	1	-	12	-	12	1
Improve timing cycles	1	-	8	-	8	5
Independent water heating saves water heating in main tank	1	-	-	-	-	-

Notes: The savings shown in the column headed 'Antic. svng' are those shown in a CEA report of 1981.

'Actl.saving' are those estimated by the engineering executive interviewed as having been achieved by the design changes concerned.

3.5.5 Prospect for future design improvements

There was among dishwasher engineering personnel, concensus in one respect. Further changes are not in immediate prospect. One felt that a recent re-design had exhausted the practical possibilities, another that changes would involve uneconomic costs, while the third was concerned that performance might be deteriorated.

3.6 Ranges

3.6.1 The market pre-Energuide

The market for electric cooking ranges may be classified in terms of the mode of oven cleaning or as large (28 inches and over), small (up to 27 inches) and built in oven. In 1977, the market was distributed as shown below.

Self-clean	19.8 per cent
Continuous self-clean	14.3 per cent
non self-clean	65.9 per cent

and by size and type

Free standing	
up to 27 inches	21.6
28 inches and over	74.8
built-in ovens	3.6

Thus, at this time, the larger free standing range without self cleaning features was the market leader. This may be because roughly 25 per cent of sales of this appliance are made to home builders. These large impressive looking appliances would probably have maximum appeal to new home buyers.

Table 13

Electric range design features, rank ordered by estimated sales appeal, 1960-1970

Attribute	No. placing attribute in position shown		
	1	2	3
User Convenience	1	-	-
Special Features	-	-	2
Appearance	-	1	-
Efficiency	-	-	-
Reliability	-	-	-
Cost	1	1	-
Performance	-	-	-
Other	-	-	-

3.6.2 The impact of change to date

None of the manufacturers of ranges reported having made any design changes which were intended to the affect the use of energy.

The Energuide ratings for this appliance are more uniform than for any other which reflects a very limited scope for design change.

3.6.3 Current market conditions

After a steady decline since 1978, reaching a 1982, sales of electric ranges rose in 1983. Despite this, they were still only 80 per cent of the earlier level.

Continuous self-clean ovens no longer appear in the sales distribution figures published by CAMA but the self-clean oven now accounts for about a quarter of the market, down somewhat from the 1977 level. It is forecast to recover to about 31 per cent by 1989.

The distribution by size and type has changed slightly. Small (up to 27 inch) ranges now account for only 13.5 per cent, down from 21.6 in 1977. Those with built-in ovens have almost doubled their market share at 7.0 per cent, up from 3.6 per cent.

These changes tend to have a very modest effect on energy demand. The reason for this is that although the self-cleaning feature uses energy not otherwise required, the Energuide rating of many self-cleaning ranges is as good as, or even slightly better than apparently equivalent models without it. The explanation lies in the increased insulation used in self cleaning ovens.

3.6.4 Analysis of engineering review - electric ranges

The engineers interviewed were aware that ranges are not covered in the U.S. equivalent program and felt this was correct. Those who had been in the field for some time, felt that most of the proposed changes had been tried and discarded for one or another reason.

Table 14

Analysis of design changes in the manufacture of electric ranges

Proposed change	Made by N mfrs	Antic svng kWh/m	Actl saving kW.h/m			Cost $
			Min	Max	Avg	
Changes possible as of 1981						
Forced oven air circulation	-	28	-	-	-	-
Improved oven door seals	-	8	-	-	-	-
More efficient insulation	-	5	-	-	-	-
Greater surface element area	-	2	-	-	-	-
Reduce oven vent area	-	2	-	-	-	-
Reflective element pans	-	1	-	-	-	-
Changes requiring R&d as of 1981						
Reflective oven interior	-	12	-	-	-	-
Reduce oven thermal mass	-	2	-	-	-	-
Anti-convection element	-	1	-	-	-	-
Flatter elements	-	5	-	-	-	-

Notes: The savings shown in the column headed 'Antic. svng' are those shown in a CEA report of 1981.

3.6.5 Prospect for future design improvements

Most companies appear to have concluded that the cost-benefit ratio of design changes to electric ranges is unattractive. Of those suggested, forced air oven circulation offers the greatest prospect for improvement. However, it would appear to be overstated at 28 kW.h/m.

The Energuide rating for electric ranges lies between 60 and 70 kW.h/m. The U.S. survey on which the CSA standard for ranges is based, ascribes 47.09 kW.h per year to conventional ovens out of a total for a range of 324.8 kW.h per year.

Applying this ratio to some 65 kW.h/m would suggest that the use of the oven accounts for only about 9 kW.h of this.

In addition to this, the oven performance would be changed substantially if forced convection was used. If there were adequate benefits to be derived, consumers could no doubt be trained to change their cooking practices, but with the possible saving rather problematic, this does not appear to be likely.

Each manufacturer reviewed all of the other proposed changes, but only one felt that any were very likely to be adopted by his company. This firm felt that a saving of about five kW.h/m might be achievable at a cost of the order of $2.00.

4.0 COSTS AND BENEFITS TO CONSUMERS

4.1 Direct Price Effects

The effects of design changes on the prices paid by consumers are difficult to trace. In a period of inflating prices, neither the manufacturer nor the consumer can readily separate out increases due to changes in product design from those attributable to generally rising material and labour costs. In addition, it is not clear why an increase of cost at the manufacturing level should carry the same mark-up as that which applies to the original. Neither the wholesaler nor the retailer incurs any additional expense by reason of a change in material or labour cost at the manufacturing level, except insofar as any cost increase legitimately passed to them increases their financing costs.

Despite this, the effect on retail prices of changes in manufacturing costs is frequently estimated by multiplying the latter by a constant factor, usually about 2.5. If we adopt the same method and also take the manufacturing cost changes estimated as being accurate, Table 15 results. The value of this table is limited by the inaccuracies in the input data, but does suggest that the effect on reatil prices has been small. This was the general opnion of marketing personnel consulted.

The cost change tabulated was arrived at by summing all of the estimates made by each manufacturer and applying the result to his claimed market share. Needless to say, this increases still further the inaccuracy of the data.

Table 15

Estimated Effect on Retail Prices of Design Changes Reported for Each Appliance

Appliance	Weighted Manufacturing Cost Change * $	Estimated Retail Price Increase * $
Refrigerator	18	45
Freezer	4.8	17
Clothes washer	nil	nil
Clothes dryer	nil	nil
Dishwasher	5.5	14
Electric range	nil	nil

* See caveat in text re. probable accuracy

4.2 Performance degradation costs

Concern has been expressed that the performance of some appliances have been or could be degraded in order to conserve energy. These concerns focus on three issues.

4.2.1 Draw-down capability of freezers

Because a domestic freezer must be capable of cooling material placed in it at room temperature, its compressor must have capacity over and above that required to hold the contents at a safe storage temperature. In general, mechanical devices function most efficiently when operated continuously at their design load. Intermittent operation may be substantially less efficient. Thus a freezer with a relatively large compressor operated infrequently, could have a higher energy consumption than one with a smaller unit operating on a more favourable duty cycle.

Interviews with consumer representatives did not support this cause for concern, although one manufacturer reported offering some models with smaller compressors to get a better Energuide rating.

4.2.2 Cold rinse in clothes washers

When a load of clothes is spun dry in an automatic washer which has just completed a hot rinse cycle, the load retains a good deal of heat. Some users find handling these warm items more pleasant than dealing with the same things at the temperature of the cold water supply. This is a real if minor disadvantage and so constitutes a definable 'cost'.

4.2.3 Degradation of dishwasher performance

The Energuide rating of a dishwasher is based upon what its designer designates as its normal cycle. Most washers have optional cycles, some of which use less hot water than others. When dishwashers were first introduced, the maximum emphasis was placed on performance and there was little concern for energy consumption. Thus, a washer could have been designed so that its normal cycle used more hot water than would be necessary to do an adequate job on lightly used dishes. If it was designed with another cycle, sometimes referred to as econo-wash, using less hot water, this could have been later re-named normal and the unit re-submitted for test with a different model number. This actually happened in the case of an imported unit, but has never been a common practice. Consumers who purchased one of these washers undoubtedly incurred a cost in degraded performance. Whether or not this was adequately compensated by an off-setting benefit in price is not known.

4.3 Opportunity costs due to convenience features not offered or promoted

One manufacturer of clothes washers reported postponing a design change which would have used more hot water and improved performance at the expense of a somewhat poorer Energuide rating.

No consumer group appeared to be aware of any features which they were denied due to energy conservation. In fact, all the evidence shows the opposite. Frost-free refrigerators out-sell those requiring manual defrosting despite higher energy demands; there is no concern for the use of self-cleaning ovens; and at least some users object to cold rinsing their clothes and automatic clothes dryers outsell timed units because of convenience, not efficiency.

4.4 Savings in energy consumption

Engineering executives interviewed were asked to list the design changes made to each product. The date when the change was made was noted, together with the estimated saving in energy use each month. Assuming that the modified appliances went into service during the next model year, it is possible to make a crude estimate of the energy saving which should have resulted to date. The actual totals arrived at by summing the product of the estimated monthly energy saving for each change and known appliance production were rounded and expressed in gigawatt hours. The agreement with figures derived in an earlier study is only fair. With the exception of clothes washers, the 1984 savings based on our interviews with manufacturers exceed the earlier estimates. Our estimates are shown in column 3 of Table 16 below.

Using the Canadian Appliance Manufacturer's Association (CAMA) forecast of 1984 sales, the saving for 1984 were estimated and are shown in column 4 of the table. Neglecting changes in production or design, these savings should be realized in each of the future years.

The weighted Canadian average cost of electrical energy can be taken as 4.77¢ per kW.h. This means that the value of the energy saved (excluding the offsetting demand for increased home heating) was approximately $140 million.

Assuming constant production of appliances at the rate forecast for 1984, a 15 per cent discount factor and a useful life of current designs of ten years, the cash flow from future energy savings has a present value of another $125 million.

Table 16

Estimated total energy saved to end of 1983 from design changes made 1977 - 1982 and saving in 1984 and future years from these and others to date*

Appliance	Component changed	Cumulative saving to 1983 GW.h	Saving in 1984 and beyond GW.h
Refrigerator	Insulation	600	125
	Compressor	100	60
	Misc.	300	90
	Totals	1,000	275
Freezers	Insulation	400	100
	Compressor	100	25
	Misc.	--	-
	Totals	500	125
Clothes washers	Water control	500	100
	Totals	500	100
Dishwasher	Water control	400	50
	Heated dry	50	-
	Inulation	100	-
	Misc.	200	25
	Totals	750	75
All Energuide appliances	GRAND TOTAL	2750	300

* Assumes constant production at 1984 levels with no further design changes.

4.5 Improved appliance performance

There were some benefits to consumers arising directly from the Energuide program, in addition to those from reduced costs of energy. These were limited to refrigerators and freezers. Better insulated cabinets and improved door gaskets produce more uniform storage conditions, although these effects are probably rather small.

5.0 TECHNOLOGICAL AND MARKETING FACTORS IN THE APPLIANCE MANUFACTURING INDUSTRY AS A WHOLE

5.1 Research and development in Canada

The nature of the domestic appliances covered by the Energuide program has not up to now, demanded a high level of sophisticated research. Improvements in design were relatively simple, although they required a good deal of detailed manufacturing engineering effort. With the exception of household freezers, Canadian appliance manufacturers were able to call upon design assistance from their American parent or affiliate and most did so extensively.

There does not appear to be any reason to suppose that the flow of technical information across the Canadian-U.S. border is influenced by the existence of the Energuide program, except insofar as it has influenced Canadian demand for energy efficient appliances. Thus, if the program were to be cancelled, the American parent companies would be no less ready to supply design information to their Canadian subsidiaries or licensees than they would be if it were continued. Companies continue to manufacture to existing designs and to avoid the costs of re-design and re-tooling as long as possible. Competition is the most effective prod to action and a Canadian company which feels its competitive position would be improved by utilizing designs owned by its parent will take prompt action to acquire these.

In the study it was not possible to separate out a true research element as distinct from product development, nor could this be distinguished from the work associated with minor design changes to utilize Canadian components, or to meet peculiarly Canadian standards or conditions. As well as the engineering effort associated with bringing new products into being, further technical effort is devoted to testing. Part of this is in support of new or modified designs, part is quality assurance testing. This work too,is lumped together with other technical contributions.

Given the foregoing as a description of what is covered by it, each chief executive officer was asked to make some estimate of his company's expenditure in this area, either as a percentage of total sales or in terms of the number of employees. Not all were willng or able to provide any figures.

For those who contributed an estimate, most fell at about two per cent of total sales. Considering the broad interpretation given to the term, this is a very low percentage, particularly when contrasted with that in other parts of the world.

5.2 Research and development in the U.S.

As in the case of Canadian companies, the only American company with which we made contact was reluctant to provide very precise figures on research and development. The vice president for corporate engineering felt that this was sensitive information, but admitted that when all engineering and testing effort was taken together, the total would be in the range of "five to ten per cent of sales".

More precise estimates based upon a recently completed review of the U.S. appliance industry are shown in Table 17 below.

Data of the sort shown in the table are typically supplied by the company concerned on the basis of their own definition of what constitutes R&D. Thus, it may not be true that General Electric devotes twice as much of its sales dollar to these activities as the Whirlpool corporation. It is however, very likely that any of these companies is spending a much larger fraction of gross income on developing new products than their Canadian affiliates. At least a part of this discrepancy will be made up by inter-company transfers of funds over and above the amounts spent on engineering and other technical work by the Canadian company.

Much of the focus of current product development is on the application of electronics to appliance design. The cost of micro-processors has come down fast enough in the past few years to make some in the past few years tomake some quite sophisticated control systems practicable. It is probable that the use of electronic controls will make more sophisticated performance possible. It is also expected that manufacturing costs will be reduced but there is no reason to expect any major change in energy use in the U.S. There is concern in the industry that its domestic market will be eroded both by imports and by products manufactured there by foreign owned companies. As of 1984, there were eleven such organizations producing at least some domestic appliances in the U.S. Of these four were from Japan, two from Korea, three from Italy and one each from Taiwan and the Netherlands.

Table 17

Measures of Research and Development Expenditures of Major White Goods Manufacturers in the United States, 1983

Firm	Research & Development Sales		
	Total R&D Expenditures	Percent of Sales	Dollars per Employee
General Electric	$814.0	3.0	$2,015
Whirlpool	41.0	1.5	1,812
White Consolidated	20.2	1.0	885
Maytag	NA	1.5 1/	NA
Norge	NA	1.5 1/	NA
Kitchen Aid	NA	2.0 1/	NA
Magic Chef	8.2	1.1	1,102
Tappan	NA	1.0 1/	NA
Caloric	NA	1.5 1/	NA
Roper	NA	1.0 1/	NA

1/ Estimates

from "Comparative Analysis of U.S. and Selected Foreign Household Appliance Industries"

prepared for U.S. Department of Energy by Sterling Hobe Corporation, Washington D.C.

5.3 Research and development elsewhere

The country from which most innovative ideas are likely to come in the immediate future is Japan. Although some of their products in the appliance field are advanced, particularly with repsect to the application of micro computers to control functions, many are not directly competitive in North America. They are however, an immediate threat in Europe and products of the size and style demanded in U.S. and Canadian markets are beginning to be test marketed.

A major reason for the sophisticated design of some Japanese appliances is the fact that they are manufactured by companies with extensive experience in solid state electronics. Unlike the American companies, these firms can and do, design their own micro-processors. This almost certainly reduces the lead time in new product design and probably has a beneficial effect on costs.

Japanese companies are believed to be spending three to four per cent of gross sales on R&D, considerably above the corresponding effort in North America.

Information on R&D by firms in Korea and Taiwan is even less well known, but is thought to be about two and a half per cent, well above the level in Canada.

Appliance manufacture in Europe varies from country to country, the OECD countries as a group meet most domestic needs with a significant surplus for export sales. European made appliances are thought well of by Canadians in the industry, but have little to offer technically. They are undoubtedly supported by an R&D program which is better funded than that in Canda. Japan is making inroads both into the domestic and export markets of OECD companies.

The active participation of Eastern and European countries, world wide, in appliance sales, virtually eliminates any prospect of off-shore American and still further Canadian sales, except to the Caribbean and South Amerian markets.

5.4 The prospect for technological change

While not all products manufactured in the world wide appliance industry have universal appeal, they or at least the technology embodied in them, are available everywhere. For example, Singapore is an important supplier of the compressors used in refrigerators and freezers wherever in the world the final products are assembled. Consequently, any technically feasible modification will be introduced somewhere and will, sooner rather than later, appear in the Canadian market. Despite this, it does not appear that any very major reduction in energy use for appliances other than refrigerators and freezers is to be expected. In the following section, each of the Energuide appliances is considered separately.

5.4.1 Refrigerators

There is some considerable potential for improvement in the energy consumption of refrigerators. The means by which this will be achieved are well known. These are improved insulation in the cabinet proper, the use of plastic liners, foam insulation in the door, improved gaskets, dual evaporators, continuation of the steady improvement in the efficiency of compressors and moving the motor for the circulating fan outside the box. Some or all of the above features have been adopted by manufacturers in North America or elsewhere, no major surprises are to be expected.

A recent Swedish paper discussing refrigerator efficiency covered these points, adding the well known fact that frost-free designs are inherently less efficient than those requiring manual defrosting.

Using a reversal of the refrigeration cycle to defrost so that the evaporator becomes the condenser and vice versa has been tried. The energy saving is not large but the principal disadvantage is the extreme unreliability of the solenoid operated valves which are required to effect the change-over. This is a point at which some new device, if one ever became available might have some beneficial effect on energy use.

The rate at which improvements known to be possible will actually be adopted will depend on market conditions. Whirlpool in the United States has tested a Japanese made refrigerator of about 16 cubic feet capacity with an annual energy consumption of about 600 kWh. The marriage of an Amana box to Kelvinator compressors expected to perform at least as well was disappointing, but further trials will probably be made. There is little doubt that this level of efficiency is within the competence of Canadian manufacturers aided by their American affiliates. However, unless they are forced to take earlier action by off-shore competition, domestic producers will probably prefer to recover costs incurred in the recent round of re-design.

5.4.2 Freezers

Canada produces the most energy-efficient freezers made anywhere. We could make even better units if the market were prepared to pay a somewhat higher price for them.

These appliances are not widely used outside North America, so that the prospect for foreign made units setting the pace at which changes come about is not great.

Improvements in efficiency will come from universal adoption of 3 inches of foam insulation, foam insulation in the lid with plastic liners, better thermal contact between evaporator tubing and box liner and more efficient compressors.

There would be an advantage in using an evaporator of the type used in some refrigerators in which the refrigerant circulates in channels formed between two copper or aluminum plates. These are considered to be too expensive for this application.

The market for chest freezers is quite price sensitive. One manufacturer felt that they had had to absorb some of the higher costs of design changes made already. The same firm mentioned a price premium of $50.00 for a fourteen cubic foot freezer with substantially better performance as being unacceptable even in off-shore sales to sub-tropical countries.

5.3.3 Clothes washers

The front load clothes washer is widely used in Europe and is known to be more efficient both for washing and in terms of its energy requirements. It is not a popular design in North America.

The European models mainly use an internal heater to provide hot water. This coupled with the fact that they use as many as seven fillings during the rinse phase makes the whole wash cycle very long.

This long wash cycle coupled to the unpopular front load feature means that European washers are unlikely to make major inroads on the North American market.

Aside from this, there do not appear to be any candidates for energy saving in clothes washers.

5.4.4 Clothes dryers

Clothes dryers are one appliance in which a micro-processor might produce some saving in energy. At the present time, the drying cycle is ended when the humidity of the exhaust air falls below a set point. A more sophisticated control circuit capable of sensing the rate of change of humidity might be able to begin to reduce the heat input earlier so that residual heat might take care of the final drying. Although this might be a theoretical possibility, it is not likely to be applied. Clothes dryers of the size and capacity required by our market are not widely used elsewhere, so that design changes affecting these units will likely arise in North American. The appliance industry here concluded some time ago, that clothes dryers offered little scope for innovative design intended to save energy.

5.4.5 Dishwashers

We have a verbal report from a research worker in the U.S. (Geller) that an unknown Asian company plans to manufacture and sell in the U.S. market a newly designed dishwasher. This is said to use very high pressure jets of water, thus reducing the quantiy required. If production is achieved, it will likely take place in China.

European dishwashers generally depend on heating the water internally. As in the case of clothes washers, this necessitates a very long cycle. Energy savings are thought to be very small.

Unless the Asian company competes effectively in the North American market, this appliance is unlikely to change its use of energy significantly.

5.4.6 Ranges

It is known that more insulation in ovens would save some energy, but there is little market incentive to do this. Forced convection in the oven will save energy, but is not useable for all baking. Top elements are already at about 90 per cent efficiency and further improvements are not considered likely. As in the case of the other appliances there do not seem to be any products made elsewhere which offer any novel features which would be of interest in the Canadian market.

6.0 INCLUSION OF HOT WATER HEATERS AND FURNACES UNTER THE ENERGUIDE PROGRAM

Analysis of the use of energy shows that space heating and the provision of domestic hot water are the largest factors in the residential sector. Despite this, these two appliances were initially excluded from the Energuide program. All of the reasons for this are unknown, but the fact that neither is exclusively an electrical appliance sets them somewhat apart from those which were covered. In addition to the distinction by type of energy used, furnaces and hot water heaters are purchased by home builders to a greater extent than the six Energuide appliances and this market is less concerned with operating costs than with first cost.

It is now being asked if furnaces and hot water heaters should be included, if the Energuide program is to continue. The rationale for this should be looked for in the objectives of the program. One objective was to increase consumer awareness of the differences in the energy efficiency of otherwise similar appliances. It was expected that this would influence purchasing decisions in favour of energy conserving models, even if necessary at the penalty of somewhat higher first cost. A second objective was to motivate manufacturers to produce and promote more efficient appliances, so as to increase their market share.

While probably the Energuide program cannot claim all of the credit, certainly the energy efficiency of appliances covered by it has increased considerably since its inception. If the market for and the manufacture of, furnaces and hot water heaters shows characteristics similar to those of the pre-Energuide appliance market, there would be a sound arguement for adopting a similar approach to correcting its deficiencies. This however does not appear to be the case.

6.1 Hot water heaters

There are practically speaking, only two types of hot water heaters sold in Canada. Oil fired units, solar heaters, heat pumps and coils in space heating furnaces together account for about five percent of the total market. For reasons peculiar to the various designs, their total market share is unlikely to increase significantly.

Electric hot water heaters are inherently very efficient. The conversion of electrical to thermal energy is essentially without loss, as is the transfer from the heated element to the water which surrounds it. The only inefficiency is associated with standby loss. This occurs because electric heaters are invariably designed to heat water at a rate commensurate with average use, relying upon the storage of hot water to meet peak demands. Heat is lost from the storage tank by radiation and conduction to the surrounding air and by conduction through the plumbing connections. These losses are well understood and are the subject of one of the tests under the governing CSA standard, series C 191. This standard covers the 175 and 270 l (40 and 60 gallon) sizes which are those most used for domestic service.

The Canadian electrical utilities have promoted the sale of efficient electric hot water heaters under the name Cascade and allow any manufacturer meeting C 191 to use the name and logo on its products.

An Ontario Hydro standard C 357 covers all hot water heaters of the sizes covered by the CSA standard sold in Ontario. It is essentially the same as C 191 except with respect to the heating elements. Because of the size of the Ontario market and the relatively small number of companies manufacturing these appliances, the Ontario standard sets the mimimum level for all of Canada. Two of the three manufacturers produce units which have lower standby losses than required by the standard and promote their sales on this basis. Thus, it would seem to be unnecessary to consider applying Energuide to this product.

Gas water heaters are also sold subject to standards. At the present time, all gas fired heaters must meet one of two standards. CAN 1-41-77 applies to gas fired automatic storage type water heaters with inputs less than 75,000 BTUh. CANI-4.3-77 covers circulating tank, instantanious and large automatic storage type gas water heaters. The committee of the Canadian Gas Association having jurisdiction plans a review of these standards early in 1985.

Both of the present standards require a minimum efficiency in terms of the energy input required to heat water and also with respect to standby losses. It is considered likely that the hot water heater committee will follow the lead of the warm air furnace committee described below. If so, a revised standard will cover condensing type burners and will require all heaters to be labelled in accordance with their energy use on an as installed basis.

Although hot water heaters employing condensing type burners are at present undergoing tests at CGA laboratories, these units are not yet commercially available. Manufacturers considered that a burner of this type would increase costs considerably. Estimates ranged from two to four hundred dollars. One manufacturer who has plans to market such a unit, felt that an Energuide type program would be an asset in the sales campaign which the company would have to mount to promote it. Other companies, perhaps because they have no corresponding plans were less supportive. All who make electrical units, manufacture to Cascade standards and with one exception seemed content with them.

6.2 Domestic heating equipment

By far the largest part of the market for home heating equipment in Canada is divided between electric heating and gas fired furnaces, principally forced warm air.

Electric heaters are not of concern with respect to Energuide because the conversion of electrical to thermal energy is, practically speaking, one hundred per cent efficient.

Forced warm air furnaces however, differ quite widely in their energy efficiency. The Canadian Gas Associaton requires that all gas fired types must have a steady state efficiency not less than 75 per cent. Since this is a laboratory maesurement a furnace meeting this criterion may show 60 per cent efficiency or less when tested on an annual fuel utilization basis. On the other hand, the most efficient units may operate on a seasonal basis at 90 per cent or better.

This range in efficiency might suggest the merit of applying the Energuide program to the distribution of furnaces of this type. It does not appear to be necessary to do this. The Canadian Gas Association (CGA) has the authority under various provincial statutes to require that all furnaces carry a label showing their seasonal gas utilization efficiency. The committee of CGA having authority, has decided to make this effective as of January 1985. Judging from the intense competition observable in this industry, there is little prospect that this will not occur.

Hydronic heating systems using gas fired boilers are the responsibility of another committee of CGA. This committee has not yet adopted the central furnace standard which is the controlling document in the case of the forced warm air units, but it is considering doing so. It appears probable that this segment of the market may later also be covered by a mandatory labelling procedure.

Gas furnaces as at present applied to forced worm air heating systems fall into three broad classifications by their efficiency in the use of energy. The conventional furnace with convection draft can show a 75 per cent rating on a steady state test, but this falls to 60 per cent or less on an annual fuel consumption basis.

By introducing a blower to assist in exhausting combustion products, lower flue temperatures and reduced off-cycle losses can bring seasonal efficiency to the 80 per cent range.

When a condensing type burner is used, efficiency rises still further, to 90 per cent or better. While the first cost of such a unit is considerably higher than a conventional furnace, manufacturers claim simple payback periods of three to five years. When income tax considerations are introduced, the investment increases in attractiveness.

There are at present, seven manufacturers offering condensing type furnaces to the Canadian market. It would thus appear that no program is necessary to encourage manufacturers to produce highly efficient furnaces.

The companies consulted are marketing these units aggressively. No customer who indicates an interest in an replacement furnace is likely to escape the attention of the distributers of these products.

For reasons of openly stated self-interest, the company acknowledged by its competitors as the best at marketing, was in favour of Energuide. They feel that their furnace would have the highest rating and there little doubt that they would exploit it to the full.

There is a close parallel between the case for gas hot water heaters and gas furnaces. In both caes, the industry leaders would welcome comparison with their competitors. It is however less clear that the public would be better served because in the case of the gas furnaces at least, there are some offsetting disadvantages to the furnace which claims the highest combustion efficiency.

A present barrier to the adoption of a testing and labelling program for gas appliances closely paralleling that of Energuide is the capital cost of establishing the necessary test facilities. Assistance with this would be an effective way of achieving the Energuide objectives with respect to gas fired furnaces and hot water heaters.

7.0 TESTING AND ENERGUIDE RATINGS

The tests for the various appliances covered by the Energuide program are intended to reflect typical domestic use. There are insufficient data to determine how closely ratings correspond to actual household experienc. Load tests recently completed and now being analyzed by Ontario Hydro may clarify this relationship somwehat, but will still not provide a precise correlation.

That the use of appliances differs very widely amongst households is a matter of common experience. The size and age distribution of the family are major factors, but there are others in addition. In a test in 1979, 58 different homemakers each prepared the same 21 meals on identical ragnes. The results showed differences as great as fifty per cent.

Field tests of the annual energy use of sixteen samples of the same model of refrigerator in Orlando Florida gave results ranging from 1460 to 2701 kWh. It is probable that these would not represent the extremes of energy requirements even for this one model. A household consisting of a single person who is at work during most of the day and in the habit of eating many meals in restaurants will make very modest use of a refrigerator compared to a family with several children where most meals are home cooked. There will be similar and perhaps even greater diversity in the use of laundry equipment and dishwashers.

As well as great variability in the results of field teste, some have yielded data consistently above and others below those predicted by laboratory measurements. With respect to refrigerators particularly, there is some reason to expect an increasing gap between field and laboratory measurements as energy efficiency increases. The standard assumes that testing at a temperature about 11°C above normal room ambient, is thermally equivalent to use at the lower temperature with typical door operings. Since the heat gain per opening is essentially constant, these must become an increasingly important factor as other heat gains reduced.

An alternative labelling requirement used for appliances in the United States has been suggested for adoption in Canada. In place of labelling the appliance to show its estimated energy consumption, the American system labels it with the estimated cost of electricity. It also shows the range for appliances of the same type. The potential buyer is then able to make an approximate estimate of life cycle cost and also to see where the particular unit fits with its competitors.

While superficially attractive, this has led to some difficulties. The cost of energy varies so widely acoss the country, that a dollar value which is meaningful in one location is misleading in another. There is also the matter of temporal change to be considered.

While dollars may be easily understood as a unit of measure, even if a consumer is unaware of what a kilowatt-hour actually is, he or she can readily appreciate that a low number is better than a higher one.

In general, it appears that the testing and rating methods of the Energuide program meet the objectives quite satisfactorily.

7.1 Test procedures

Test procedures and standards for the Energuide appliances were developed by a committee of the Canadian Standards Association. The Technical Committee on Performance of Major Electrical Appliances included representatives from the appliance manufacturing and service industries, the Canadian Electrical Association, consumers, the Federal Government and an associate member from the United States Department of Commerce. A separate sub-committee with a similarly broad make-up dealt individually with each of the six appliances covered by the program.

The committee and the associated sub-committees have continued to meet to review the operation of the procedures established and to revise the standards from time to time as required.

Full details of the test methods will be found in the CSA Standards listed in the Appendix. Some of the more significant features are described briefly below.

7.1.1 Refrigerators and combination refrigerator freezers

A major factor in the selection of a refrigerator by a consumer is its capacity expressed as a volume. Because energy consumption is closely related to the physical size of the unit, the standard begins by describing in some detail the way this is to be measured.

The conditions under which the refrigerators and refrigerator-freezers are to be tested is specified with care. These include:

- test room temperature, air circulation and radiation
- instrumentation
- preparation of the sample
- temperature measurements in fresh food and freezer compartments
- procedures for determining energy consumption
- test measurements

The test is designed to simulate the heat gains which would be experienced under reasonably severe domestic conditions. Experiments have shown that the heat gains associated with door openings at normal room ambient temperatures can be approximated closely by testing at a higher ambient temperature without door openings. Reproducible results are obtained more easily under these conditions so that all tests are conducted at a uniform temperature of 32 +/- 0.6°C.

7.1.2 Household freezers

A household freezer is required to perform two separate but closely related functions. It must be capable of removing enough heat from a load of food to bring it to the desired storage temperature and it must hold the contents of the unit at this temperature under normal household condition.

In the test procedures specified for freezers, the factors listed above for refrigerators and refrigerator-freezers are set out and values assigned where applicable.

During the test, the compressor is required to hold the cabinet at -18°C at an ambient temperature of 32°C.

The fraction of time during which it is not required to run to maintain the storage temperature is a measure of its availability for cooling product. This is expressed as the same fraction of the compressor's ability to freeze water, in kilograms per 24 hours.

7.1.3 Clothes washers

Unlike refrigerators and freezers, clothes washers require two separate sources of energy. In addition these units are required to do mechanical work in the form of the agitation of clothes and the water in which they are washed. As a result of these two factors, the required test procedure is somewhat more involved than for the food storage appliances. There is a further complication introduced by the availability in most models of a choice of washing program.

The test standard specifies the type and size of the test clothes, the temperature of the wash water, the pressure of the supply and the characteristics of the electrical service. It also requires that the test be conducted at maximum and minimum settings of water level and where the feature is provided, at a partial fill as well. The hot water energy input is determined by the sum of the energy at the maximum and minimum levels each multiplied by an appropriate usage factor.

The use of electrical energy is measured for a normal and for a suds-return cycle. These are combined by adding, after each is multiplied by a factor less than unity which is intended to represent the frequency with which each cycle would be used. The coefficients also relfect a temperature use factor, the value of which is dependent upon various possible wash/rinse temperature selections.

An important consideration in the operation of the washer is its efficacy in removing water from the clothes during the spin cycle. The significance of this is that water remaining in the clothes will in general be removed in a clothes dryer which has to introduce enough energy to vapourize any which remains. Thus, a final step in the test procedure is to measure the water retained at the end of the spin cycle. The standard dampness allowed is an amount of water equal in weight to 1.735 times the weight of the test cloths. If more water than this is retained, the energy required for its removal is estimated at 0.94 kW.h/kg.

The total use of energy per normal wash cycle is then determined as the sum of the electrical energy required to operate the appliance, the energy content of the hot water used, and the energy required to remove water above the allowed maximum.

The estimated monthly use of energy is arrived at by multiplying the energy determined as above, by 34, an empirically determined number of usages per month.

A deficiency in the test procedure which is acknowledged by all, is that no evidence is required that the wash cycle would be effective in making a load of clothes acceptably clean. As one engineer expressed it:

> How dirty is dirty, and how clean is clean?

7.1.4 Clothes dryers

The test standard for a clothes dryer specifies the nature and size of the test cloths to be used as in the case of the clothes washer. The cloths are first dried and weighed. They are then dampened and spun to a prescribed moisture content. With this moisture content, they are then placed in the dryer and the appliance is then operated until the moisture content of the test load is below two per cent. The monthly use is estimated as 34 times the energy used per operation.

The procedures differ slightly for dryers with and without automatic termination controls.

7.1.5 Dishwashers

The standard requires that dishwashers be tested at the control setting recommended by the manufacturer for completely washing a full load of normally soiled dishes. This is to include the heated-dry feature if this is provided.

Dishwashers are tested without a load on the normal cycle setting as defined above, and also on a truncated cycle, (heated dry feature eliminated).

Energy consumption is determined based upon the sum of the energy required for heating water plus the electrical energy used in each cycle. A simple average of the two levels of energy is multiplied by 34 to estimate monthly usage.

The problem of measuring or even estimating efficacy in washing dishes is, as in the case of the washing of clothes not addressed by the test procedure.

7.1.6 Ranges

Because the principal factor in determining the amount of energy used by an electric range is the extent of its use, the basis of the energy standard is the annual useful cooking energy, empirically determined from field tests conducted in the United States.

This energy is thus arbitrarily set as:

324.8 kWh per year for conventional ranges.
277.7 kWh per year for conventional cooking tops.
47.09 KWh per year for conventional ovens.

To estimate the annual energy consumption for cooking, these aribitrary figures are divided by the measured efficiency of the oven and the surface elements of the range under test. These efficiencies in turn are arrived at by the following test procedures.

To measure the efficiency of an oven, the energy required to raise the temperature of an oven and a test block by 130°C is first determined. In this test, the oven thermostat is set at the point which a prior test showed would result in a quasi steady-state temperature of 180°C. From the weight, specific heat of the test block and its temperature rise, the energy actually absorbed by it is determined. The efficiency is this energy divided by the oven input during the test.

The efficiency of each surface elements is arrived at in a similar manner. The efficiency of the cooking top is taken as the arithmetic mean of the efficiencies of the separate elements.

For ranges with self cleaning ovens, the energy per cleaning cycle is measured. Based on field survey data, the amount of energy used annually is taken as eleven times the energy per cycle.

The energy use of the clock per hour is measured directly and multiplied by 8760 to obtain the annual use.

In combination, these data then provide the estimate of annual energy consumption as the sum of cooking, self cleaning and clock energy consumption.

7.2 Administration of tests

When an appliance covered by the Energuide program is to be offered on the market, the manufacturer or importer conducts tests to determine its use of energy in accordance with the appropriate standard.

Samples of the unit, not fewer than three nor more than seven are tested and the results submitted to CSA. This organization reviews the results and requires that one of the units be delivered for verification tests. On confirmation, the manufacturer is entitled to sell the appliance bearing an Energuide label disclosing the test results. In the event of non-confirmation, the manufacturer can elect to withdraw the sample for re-design or can accept the CSA rating.

Subsequent to the initial tests, CSA has the authority to enter the company's premises at any time during normal working hours and to take samples for confirmation testing. In the event that the mean energy usage of such a sample is not within 10 per cent of the nominal value, the company is notified. It is required to make any necessary changes to its production to bring the output back to the nominal value within the accepted tolerance limits.

7.3 Experience with tests

The energy use of an appliance is subject to a very large number of variables. If several of these happen to be off in the same direction, the test results may lie well outside the acceptable limits. A simple frequency count shows that during the period August 20 to September 14, in the current year, 22 samples out of 100 appliances were in the out-of-limit category.

Some appliance manufacturers contend that the limits are unrealistic and do not allow for normal manufacturing tolerances. Contrary opinions expressed suggest that the problem lies in the lack of proper quality controls in the manufacturing process.

8.0 Standards Pro and Con

An alternative to a continuation of the Energuide program would be the adoption of minimum performance standards.

With only a single exception, nobody was in favour of standards in the companies manufacturing appliances covered by the program. This was not true for all of the hot water heater manufacturers. Most of these professed satisfaction with the Cascade standard which was virtually imposed on them by the utilities. The one individual who was most hostile to standards, blamed the Cascade program for the demise of many of the small manufacturers in this field. His argument was that a free industry would try to compete on the basis of product quality as well as on price. When all have the same apparent quality because all meet some standard, price becomes the only factor and sooner or later a company cuts it too close and goes under.

The adoption of standards was seriously investigated in the United States but was later abandonned, largely because of intensive lobbying by the appliance manufacturing industry.Some of the arguments for and against are summarized briefly below.

"It would be impossible to get agreement on a performance standard"

This was a major stumbling block in the United States. There were so many different designs of each appliance on the market that a very large number of categories had to be created. Decisions had to be made as to the utility of features which caused an appliance to use more energy than an otherwise similar one without it. If a particular feature was felt to offer significant benefit to the consumer, appliances having it were considered essentially different from those without. If the benefit was not thought worthwhile the designer would have been forced to remove it or be in violation of the standard.

While the arguments were impressive enough to delay the plan during the Carter administraion and to kill it under Reagan, several states have enacted legislation which appears to be working fairly well.

If we were to move to standards in Canada a replay of the industry's objections would be certain. However since the Energuide program has already established categories,these would offer a starting point.

"Standards would drive some companies out of business"

If the least efficient unit of a particular type were used to set the minimum acceptable level of efficiency there is no reason why any company should be hurt by standards as such.

"There would be high administrative and enforcement costs"

Unless all manufacturers changed their designs so as to barely meet the standard, many would find it easier to stay above some minimum than to hold a previously established level, as they must do under Energuide.

"Standards would kill any desire to improve designs"

This has not turned out to be the case with respect to the standards for hot water heaters. At least two companies offer units which exceed the standard for standby loss.

"Standards are necessary to ensure that product quality does not deteriorate"

If standards were set at the level of the least efficient designs now offered they would provide some measure of protection to buyers of new homes in which the appliances were a part of the package without injury to any company now operating.

"The buyer of an appliance meeting a standard has the assurance that a competent person or agency has checked its value"

As a rule standards are a more comprehensive indicator of overall quality than is offered by the measure of a single variable.

"If all appliances meet a common standard it is safe to choose by lowest cost"

The assumption that equality in one attribute implies equality in all is unlikely to be valid.

9.0 CONCLUSIONS

There is a dichotomy in the views expressed by many of the persons interviewed in other than engineering positions. On the one hand, there was a consensus that Energuide was no longer necessary in part because energy was no longer an "in" topic. On the other, the expectation that the market forces would continue to bring about product improvement would suggest not only that there is a demand for more efficient appliances, but logically any form of publicity should assist in this regard.

Among the engineering personnel, the pursuit of more efficient products seems to be regarded as worthwhile, almost regardless of the question of increased saleability. Thus, it would seem that if some of the negative attitude or the part of management could be overcome, there would be the prospect of continued improvement.

One universal source of annoyance is with the Energuide label itself. Almost without exception, chief executive officers and/or marketing executives complained about it. They consider it ugly, a nuisance to put on, and hard to remove. The more tolerant ones, suggested that using dollar amounts, rather than kilowatt-hours would make the label more understandable to the public.

Overall, the conclusions may be summarized as follows:

1. Since the inception of the program there has been a marked improvement in the energy efficiency of appliances manufactured and sold in Canada.

2. Among the people concerned with the design of appliances, there has been keen interest in seeing that the Energuide rating applied to their product was as low as possible.

3. Concern for energy efficiency continues to be the case in the engineering departments of most companies.

4. After what appears to have been a fairly general acceptance of the value of the program amongst chief executive officers and marketing executives, there now appears to be some cooling of interest toward it.

5. Improvements in energy consumption have been most marked in refrigerators and household freezers. There have been some benefits in dishwashers as well. Laundry appliances have been affected to a lesser extent. No manufacturer consulted, felt that any changes improving the energy efficiency of ranges had been made.

6. At least in the opinion of Canadian manufacturers, there is a prospect for substantial further improvement in only two products; refrigerators and household freezers.

7. Design changes made to Energuide appliances have produced a worthwhile saving in costs of energy to consumers.

8. Appliance performance in terms of consumer convenience has been substantially unaffected.

9. With the exception of those manufacturing household freezers, Canadian manufacturers of appliances, do relatively little research and development compared to their American parents or affiliates. American companies do less R&D than do those in Japan.

10. A good deal of the R & D effort devoted by the world wide appliance industry, is directed to applying micro-processors to these equipments.

11. The primary objective of the application of electronic controls, is to reduce manufacturing costs.

12. Manufacturing cost reduction will probably be most marked in Japan where the appliance manufacturers have the in-house capability of dealing with the electronic aspects.

13. Micro-processors will likely increase sophistication with only minor, if any effects on energy use.

14. The testing procedures worked out for each appliance, have produced results in the manufacturers' plants which are consistent with those obtained in the CSA laboratories.

15. The correlation between the test ratings and actual energy use of appliances in the field, is not well established.

16. There have been significant improvements in the energy consumption of domestic forced warm air furnaces.

17. The Canadian Gas Association will adopt early in 1985, a program of mandatory labelling of these forced warm air funaces, not unlike that of Energuide.

18. There is a prospect that this labelling program will be extended in the near future to boilers and gas fired hot water heaters.

19. Because of these developments there does appear to be any necessity of applying Energuide to this product sector.

20. The appliance industry professes continuing interest in energy conservation. As long as this remains a factor in making purchasing decisions by the consumer, this will remain true.

21. If the Energuide program were merely cancelled, without anything to take its place, it is probable that there would be some degradation in the energy efficiency of appliances, merely because the testing program now required, would be reduced if not stopped.

22. Major redesign to affect cost saving at the expense of energy consumption, while possible, is unlikely, because it would be uneconomic.

23. In the absence of any regulation, the import of appliances having low efficiency would be possible, but there does not appear to be any immediate source of these from any of our trading partners.

24. Standards are universally disliked by the industry.

25. Despite the hostility displayed toward the imposition of federal standards in the United States, they appear to be working satisfactorily in several individual states.

26. Lacking any other regulation minimum performance standards would offer protection against appliances with very low efficiency.

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Appendices

Appendix A

Study Methods

In collecting the data on which this report is based, meetings were held with representatives of the Canadian appliance manufacturing industry with respect to Energuide appliances; with a senior executive of an American company in the same field; with manufacturers of hot water heaters and of domestic furnaces; with officials and engineers of Ontario Hydro, the Canadian Standards Association, the Canadian Gas Association and of the Standards Council of Canada. There were also discussions in person or by telephone with officials of the federal Government departments of Consumer and Corporate Affairs, Energy, Mines and Resources, the National Research Council, and with the U.S. Energy Conservation Coalition and the Ontario Research Foundation.

The literature was studied intensively, publications consulted are listed in the bibliography.

Some indication of the specific topics discussed and the data obtained is given in the brief notes which follow. Because this sector was being covered in detail by others (Marbek), no direct contact was made with consumer groups or associations.

All of the major and most of the smaller Canadian companies which manufacture Energuide appliances, hot water heaters and domestic furnaces were asked to meet with either or both of the engineers who conducted this study on behalf of A.D. Revill Associates. For the names of the persons interviewed and the positions held in each company, see Appendix B.

In the case of those companies making appliances covered by Energuide and also those manufacturing hot water heaters a structured interview was used. A copy of the interview schedule for each group will be found in Appendix C.

Domestic furnace manufacturers were interviewed at length, but somewhat less formally. The objective for these interviews was to determine the level of technical sophistication in this market, the concern for energy efficiency and the prospects for continued development of energy efficienct products. In attaining this objective, it was expected that some indication of the advantage of extending the Energuide program to these appliances would be gained.

Other meetings and discussions

The objective of the meetings with engineers from Ontario Hydro was to confirm the data in estimates of potential improvements in appliances covered under the program and to obtain any further information relevant to the study.

During the meeting at the Canadian Standards Association laboratories, the testing areas were toured and copies of all standards obtained. There was a frank discussion of certain problems which have been encountered in the operation of the testing program. One specific objective was to clarify the discrepancy between test results on a Japanese refrigerator as tested in Japan, and at the CAS Laboratories. (This seems to have been due to a misinterpretation of procedures or a failure of communication).

Most of the other meetings referred to were aimed at increasing our understanding of the appliance manufacturing industry elsewhere in the world. The information obtained will be found in the main body of this report.

Appendix B
Persons contacted during the study

Canadian Energuide Appliance Manufacturers

Company	Personnel	Position	Topic
Camco (Toronto)	R. Lane	for CEO	Overall effect of Energuide on company.
Camco (Hamilton)	Bob Harwood	Manager Marketing	Market factors
	Dave McCullough	Manager Engineering	Design changes
	Stan Slynka	Engineer	Design changes
	Les Flett		
Camco (Montreal)	Steve Milz	Manager Engineering	Design changes
	Bob St. Louis	Production Engineer	Design changes
Hobart (Toronto)	E.T. Jackson	CEO	Overall effect of Energuide on company
	Don Graham	V.P. Marketing	Market factors

Company	Personnel	Position	Topic
Hobart (Owen Sound)	R. Pridham	Plant Manager	Design changes
	J. Gray	Chief engineer	
Hupp	Y. L'Heureux	CEO	Overall effect of Energuide on company
	M.E. Blanchette	V.P. Marketing	Market factors
	J.M. Leger	V.P. Engineering	Design changes
Hoover	J.L. Wabschall	CEO	Overall effect of Energuide on company and Market factors
	B. Arnett	Manager Engineering	Design changes

Company	Personnel	Position	Topic
Franklin	E.G. Buckthorp	CEO	Overall effect of Energuide on company
	Bob Crocker	V.P. Marketing	Market factors
	Les Smart	V.P. Engineering	Design changes
Wood	J. Wood	CEO	Overall effect of Energuide on company, and market factors, design changes.
General Freezer	J. Bull	CEO	Overall effect of Energuide on company.
	K. Kumra	V.P Engineering	Market factors and design changes
Hitachi	M. Hayashi	Prod. Manager for CEO	Japanese market and design
	K.B. Takabe	Field engineer	Japanese market and design

Company	Personnel	Position	Topic
Inglis	L.G. Patterson	V.P. Manu-facturing	Overall effect of Energuide on company, market factors, and design changes

Canadian Hot Water Heater Manufacturers

Company	Personnel	Position	Topic
Giant	J.L. Lesage	CEO	Overall effect of Energuide on company, market factors, design changes.
A.O. Smith	G. Peck	CEO	Overall effect of Energuide on company, market factors, design changes.
Wood (div. of GSW)	J. Wood	CEO	Overall effect of Energuide on company, market factors
	E. Edwinka	Manager Engineering	Design changes

Company	Personnel	Position	Topic
Rheem	M. Jensen	Chief Engineer	Overall effect of Energuide on company, market factors, design changes

Canadian Furnace Manufacturers

Company	Personnel	Position	Topic
Clare Bros.	E. Clare	CEO	Market for domestic furnaces, applicability of Energuide
Duomatic Olsen	A. Steinfield	Manager Admin.	Market for domestic furnaces, applicability of Energuide
Lennox	A.L. Jannetta	Marketing Manager	Market for domestic furnaces, applicability of Energuide
	C.L. Webster	Sales Promotion Manager	Marketing strategy

Others

Company	Personnel	Position	Topic
Ontario Hydro	G.K.F. Pepper	Co-ordinator Product performance	General considerations re. Energuide
	W. Jones	Research engineer	Potential for for design changes
Canadian Combustion Laboratory EMR	A.C. Hayden	Research	Domestic furnaces
National Reserach of Canada	G. Mager	Energy technologist	Level of Canadian vs. foreign technology
Standards Council of Canada	G. Zaleski	Standards officer	Canadian vs. foreign technology
International Standards	R. Lane	Canadian Represent-ative	Canadian vs. foreign technology

Company	Personnel	Position	Topic
Canadian Gas Association	K.G. Bales	Manager Standards	Gas appliances
Canadian Standards Association	R. Patterson	Energuide coordinator	Testing procedures
American Council for an Energy Efficient Economy	H. Geller	Associate Director	International level of technology
W.C.I.	R. Potterbough	V.P. Mfr.	Level of technology in U.S.A.

Appendix C

INTERVIEW SCHEDULES

Date: ....

Company Name: ....

Interview Schedule - Chief Executive Officers

We would like to gain some understanding of the overall impression which you have of the Energuide program. In particular, can you tell us:

1. Would you consider that the program was good for the industry as a whole?

2. Do you think that the improvement in energy would have come about without the program?

3. What impact did it have on your company?

4. Was it a significant factor in market penetration?
   For the industry as a whole?
   For this company?

5. Did the Energuide program act in any way as a non-tariff barrier against imports?

6. If your company makes export sales, were these helped by the program?

7. Can you give us some measure of your company's expenditure on R&D? (ask for one or the other of the following).
   As a total figure?
   As a percentage of sales?
   Number of employees in R&D?

8. Do you have a licensing agreement with any foreign company?

9. Should the Energuide program be continued?

   (If no) Why is that?

   Should something else be substituted?

   (If yes) Do you think any changes would improve it?

   What would you suggest?

Interview Schedule - Marketing Manager

We are interested in comparing the impact of the Energuide program with that of other market factors.

1. For electrical appliances in general as to the late 60s early 70s, what were the three design features most important to sales? Assign rank to three only.

User convenience	Reliability.....
Special features	Cost ....
Appearance	Performance ....
Efficiency	Other ....

2. Would energy efficiency be in the first three today? Where would you place it?

3. When did energy use become a significant market factor?

4. Suppose we consider the appliance market as having four segments:

   1 End users through a distribution network
   2 Builders and developers of new homes
   3 Institutions and government
   4 The stencil lines of the major retail firms.

For which of these would energy efficiency be an important consideration?

<u>Circle the number of any mentioned or if none, write none</u>.

5. We would like to find out if any additional costs for energy conservation were covered by equivalent increases in setting prices, what effect these had on sales and if there was no increase in price, how the extra cost was absorbed. First let's talk about (refrigerators, washers etc.)

Were there manufacturing cost increases because of energy conservation programs?
Did prices increase to cover these cost increases?
Were they fully covered? Partially?

<u>If price increase</u>
How did this affect sales?

<u>If no, or inadequate price increase</u>
Did this affect gross returns?

Refrigerators	Freezers	Washers
Cost increase Yes ___ No ___	Cost increase Yes ___ No ___	Cost increase Yes ___ No ___
Price increase to cover Yes ___ No ___ Part. ___	Price increase to cover Yes ___ No ___ Part. ___	Price increase to cover Yes ___ No ___ Part. ___
Dollar value of sales Unaffected ___ Reduced ___ Increased ___	Dollar value of sales Unaffected ___ Reduced ___ Increased ___	Dollar value of sales Unaffected ___ Reduced ___ Increased ___
Reduced mark up covered by Company's loss ___ Increased market share ___ Overall market increase ___	Reduced mark up covered by Company's loss ___ Increased market share ___ Overall market increase ___	Reduced mark up covered by Company's loss ___ Increased market share ___ Overall market increase ___
Market Share $..... or ......%	Market Share $..... or ......%	Market Share $..... or ......%

Dryers	Dishwashers	Ranges
Cost increase Yes ___ No ___	Cost increase Yes ___ No ___	Cost increase Yes ___ No ___
Price increase to cover Yes ___ No ___ Part. ___	Price increase to cover Yes ___ No ___ Part. ___	Price increase to cover Yes ___ No ___ Part. ___
Dollar value of sales Unaffected ___ Reduced ___ Increased ___	Dollar value of sales Unaffected ___ Reduced ___ Increased ___	Dollar value of sales Unaffected ___ Reduced ___ Increased ___
Reduced mark up covered by Company's loss ___ Increased market share ___ Overall market increase ___	Reduced mark up covered by Company's loss ___ Increased market share ___ Overall market increase ___	Reduced mark up covered by Company's loss ___ Increased market share ___ Overall market increase ___
Market Share $..... or ......%	Market Share $..... or ......%	Market Share $..... or ......%

Interview Schedule - Chief Engineers

1. What were the factors which influenced appliance design in the 60s and early 70s?

1	Convenience of use	5	Size for capacity
2	Price	6	Special features
3	Appearance	7	Use of energy
4	Quiet operation	8	Other............

2. When did energy efficiency become an important consideration? 19..

3. Interest in energy efficiency could have come about for a number of reasons.
   Which do you think was most important, to this company in 1975-78? What came second? Third? Would it be the same now?

	Ranking 1975-8	Ranking 1984
A parent company made the change, and it was easier to go along than to source components separately.		
The competition was doing it.		
Then there was Energuide.		

<u>Continue interview with some remark like:</u>

Let's talk about specific design details and then I would like to end with some general questions.

<u>After completing the appropriate section for each appliance manufactured, return to this sheet and ask the following:</u>

4. We have discussed some of the design changes to your product line. How was the total R&D effort distributed?

   1 All working drawings furnished under lisence
   2 Design adapted here for Canadian market
   3 Design was predominantly Canadian
   4 Full design responsiblilty here
   5 Design supplied to export market

5. Are you satisfied with the testing procedures used in deriving the estimates of monthly energy use?

<u>If no</u>

   What changes are needed?

6. Some people seem to feel that standards for minimum acceptable efficiency would be preferable to a continuation of the labelling program.
   How do you feel about it? Would there be any cost savings? Higher costs?
   Would it suit some products but not others? If so, which?

6. Do you think the public is prepared to pay a premuim first cost for energy-efficiency if life cost is lower?

Yes ☐ No ☐

7. Several American states have introduced minimum standards for the efficiency of appliances. Some people argue that we should adopt this practice in Canada. It is in our overall interest to conserve energy, but they feel that the average consumer either doesn't care, doesn't feel a single purchase is important, or is unaware of the differences in appliances with respect to the use of energy. On the other hand, if standards are adopted, these become not only a floor, but a ceiling, and the incentive for further improvement to increase market share is reduced if not eliminated.
How do you feel about it?

Refigerators

1. Just as they occur to you, tell me what changes you have made to any of the refigerators in your product line.

2. When was the change made?

<u>Ask about each change in turn</u>

3. Did the (added insulation, more efficient motor etc.) apply to all models? Premium only? Economy only?

4. What effect did this have on energy use?

5. What was the effect on the cost of material? On labour costs/unit?

6. Did this change have any effect on the sourcing of components?

<u>If yes</u>

By about what dollar amount would the Cdn. material content have changed?

A given change order may have affected several components with differing effects on energy use. Divide into two or more separate changes as required. For each component affecting energy use, estimate effect on monthly energy demand as shown in box.

7. Did any of the design changes made to increase efficiency reduce performance? (e.g. poorer defrosting in refrigerators, lower water temperature in dishwashers, etc.)

   Yes ☐ No ☐

8. Were any possible design changes dropped or postponed because of energy considerations.

   Yes ☐ No ☐

Ask same questions for the remaining changes as follows:

Optimize the refrigeration cycle. Potential saving 5 kWh/m.

Reasonable? ☐ Should be .... kWh/m.

Cost Est. $.....or $1-5 ☐ 5-10 ☐ about $10 ☐ over $10 ☐

Redesign the evaporator. Potential saving 5 kWh/m.

Reasonable? ☐ Should be .... kWh/m.

Cost Est. $.....or $1-5 ☐ 5-10 ☐ about $10 ☐ over $10 ☐

Redesign the condenser. Potential savinge 4 kWh/m.

Reasonable? ☐ Should be .... kWh/m.

Cost Est. $.....or $1-5 ☐ 5-10 ☐ about $10 ☐ over $10 ☐

Relocate the evaporator fan. This was expected to save 3 kWh/m.

Reasonable? ☐ Should be .... kWh/m.

Cost Est. $.....or $1-5 ☐ 5-10 ☐ about $10 ☐ over $10 ☐

Improve the refrigerant. This was expected to save 1 kWh/m.

Reasonable? ☐ Should be .... kWh/m.

Cost Est. $.....or $1-5 ☐ 5-10 ☐ about $10 ☐ over $10 ☐

Do you have any plans for reducing the power consumption of your refrigerators?

Yes ☐ No ☐

If yes

Have you a target, or if not, what do you think is practicable? .... kWh/m.

Have you any estimate of cost? $..........

If no plans for further reduction

Why is that?

Impracticable ☐ Plans in abeyance ☐

Uneconomic ☐ Parent company uninterested ☐

Other ☐

Chest Freezers

1. Just as they occur to you, tell me what changes you have made to any of the chest freezers in your product line.

2. When was the change made?

Ask about each change in turn

3. Did the (added insulation, more efficient motor etc.) apply to all models? Premium only? Economy only?

4. What effect did this have on energy use?

5. What was the effect on the cost of material? On labour costs/unit?

6. Did this change have any effect on the sourcing of components?

If yes
By about what dollar amount would the Cdn. material content have changed?

A given change order may have affected several components with differing effects on energy use. Divide into two or more separate changes as required. For each component affecting energy use, estimate effect on monthly energy demand as shown in box.

7. Did any of the design changes made to increase efficiency reduce performance? (e.g. poorer defrosting in refrigerators, lower water temperature in dishwashers, etc.)

   Yes ☐ No ☐

8. Were any possible design changes dropped or postponed because of energy considerations.

   Yes ☐ No ☐

Do you have any plans for reducing the power consumption of your chest freezers?

Yes ☐ No ☐

<u>If yes</u>

Have you a target, or if not, what do you think is practicable? .... kWh/m.

Have you any estimate of cost? $..........

<u>If no plans for further reduction</u>

Why is that?

Impracticable ☐ Plans in abeyance ☐

Uneconomic ☐ Parent company uninterested ☐

Other ☐

Clothes Washers

1. Just as they occur to you, tell me what changes you have made to any of the clothes washers in your product line.

2. When was the change made?

<u>Ask about each change in turn</u>

3. Did the (added insulation, more efficient motor etc.) apply to all models? Premium only? Economy only?

4. What effect did this have on energy use?

5. What was the effect on the cost of material? On labour costs/unit?

6. Did this change have any effect on the sourcing of components?

<u>If yes</u>
By about what dollar amount would the Cdn. material content have changed?

A given change order may have affected several components with differing effects on energy use. Divide into two or more separate changes as required. For each component affecting energy use, estimate effect on monthly energy demand as shown in box.

7. Did any of the design changes made to increase efficiency reduce performance? (e.g. poorer defrosting in refrigerators, lower water temperature in dishwashers, etc.)

   Yes ☐ No ☐

8. Were any possible design changes dropped or postponed because of energy considerations.

   Yes ☐ No ☐

The second change was higher spin dry speed. This was expected to save about 2 kWh/m. in the dryer.

Does this sound reasonable?

Yes ☐ No, should be about .... kWh/m.

Can you make an estimate of the probable additional cost of this in 1984 dollars?

If no

Can you provide a ball park guess?

Est. $ .... $1-5 ☐ 5-10 ☐ about $10 ☐ over $10 ☐

Do you have any plans for reducing the power consumption of your clothes washers?

Yes ☐ No ☐

If yes

Have you a target, or if not, what do you think is practicable? .... kWh/m.

Have you any estimate of cost? $..........

If no plans for further reduction

Why is that?

Impracticable ☐ Plans in abeyance ☐

Uneconomic ☐ Parent company uninterested ☐

Other ☐

Clothes Dryers

1. Just as they occur to you, tell me what changes you have made to any of the clothes dryers in your product line.

2. When was the change made?

<u>Ask about each change in turn</u>

3. Did the (added insulation, more efficient motor etc.) apply to all models? Premium only? Economy only?

4. What effect did this have on energy use?

5. What was the effect on the cost of material? On labour costs/unit?

6. Did this change have any effect on the sourcing of components?

<u>If yes</u>

By about what dollar amount would the Cdn. material content have changed?

A given change order may have affected several components with differing effects on energy use. Divide into two or more separate changes as required. For each component affecting energy use, estimate effect on monthly energy demand as shown in box.

7. Did any of the design changes made to increase efficiency reduce performance? (e.g. poorer defrosting in refrigerators, lower water temperature in dishwashers, etc.)

   Yes ☐ No ☐

8. Were any possible design changes dropped or postponed because of energy considerations.

   Yes ☐ No ☐

Do you have any plans for reducing the power consumption of your clothes dryers?

Yes ☐ No ☐

If yes

Have you a target, or if not, what do you think is practicable? .... kWh/m.

Have you any estimate of cost? $..........

If no plans for further reduction

Why is that?

Impracticable ☐ Plans in abeyance ☐

Uneconomic ☐ Parent company uninterested ☐

Other ☐

Dishwashers

1. Just as they occur to you, tell me what changes you have made to any of the dishwashers in your product line.

2. When was the change made?

Ask about each change in turn

3. Did the (added insulation, more efficient motor etc.) apply to all models? Premium only? Economy only?

4. What effect did this have on energy use?

5. What was the effect on the cost of material? On labour costs/unit?

6. Did this change have any effect on the sourcing of components?

If yes
By about what dollar amount would the Cdn. material content have changed?

A given change order may have affected several components with differing effects on energy use. Divide into two or more separate changes as required. For each component affecting energy use, estimate effect on monthly energy demand as shown in box.

7. Did any of the design changes made to increase efficiency reduce performance? (e.g. poorer defrosting in refrigerators, lower water temperature in dishwashers, etc.)

   Yes ☐ No ☐

8. Were any possible design changes dropped or postponed because of energy considerations.

   Yes ☐ No ☐

Do you have any plans for reducing the power consumption of your dishwashers?

Yes ☐ No ☐

<u>If yes</u>
Have you a target, or if not, what do you think is practicable? .... kWh/m.

Have you any estimate of cost? $..........

<u>If no plans for further reduction</u>

Why is that?

Impracticable ☐ Plans in abeyance ☐

Uneconomic ☐ Parent company uninterested ☐

Other ☐

Electric Ranges

1. Just as they occur to you, tell me what changes you have made to any of the electric ranges in your product line.

2. When was the change made?

Ask about each change in turn

3. Did the (added insulation, more efficient motor etc.) apply to all models? Premium only? Economy only?

4. What effect did this have on energy use?

5. What was the effect on the cost of material? On labour costs/unit?

6. Did this change have any effect on the sourcing of components?

If yes

By about what dollar amount would the Cdn. material content have changed?

A given change order may have affected several components with differing effects on energy use. Divide into two or more separate changes as required. For each component affecting energy use, estimate effect on monthly energy demand as shown in box.

7. Did any of the design changes made to increase efficiency reduce performance? (e.g. poorer defrosting in refrigerators, lower water temperature in dishwashers, etc.)

   Yes ☐ No ☐

8. Were any possible design changes dropped or postponed because of energy considerations.

   Yes ☐ No ☐

Ask same questions for the remaining changes as follows:

Reduce oven thermal mass. Potential saving 2 kWh/m.

Reasonable? ☐ Should be .... kWh/m.

Cost Est. $.....or $1-5 ☐ 5-10 ☐ about $10 ☐ over $10 ☐

Anti-convection element. Potential saving 1 kWh/m.

Reasonable? ☐ Should be .... kWh/m.

Cost Est. $.....or $1-5 ☐ 5-10 ☐ about $10 ☐ over $10 ☐

Flatter elements. Potential savinge 5 kWh/m.

Reasonable? ☐ Should be .... kWh/m.

Cost Est. $.....or $1-5 ☐ 5-10 ☐ about $10 ☐ over $10 ☐

Do you have any plans for reducing the power consumption of your electric ranges?

Yes ☐ No ☐

If yes

Have you a target, or if not, what do you think is practicable? .... kWh/m.

Have you any estimate of cost? $..........

If no plans for further reduction

Why is that?

Impracticable ☐ Plans in abeyance ☐

Uneconomic ☐ Parent company uninterested ☐

Other ☐

Interview Schedule with Chief Engineer and/or Chief Executive Officer

of Hot Water Heater Manufacturers

Company Name ....

Date ....

Interview Schedule with Chief Engineer and/or Chief Executive Officer of Hot Water Heater Manufacturers

Ask question only if range of products not known

1. What type of types of hot water heater do you manufacture?

   Electric resistance heater ☐ Electric heat pump ☐

   Gas ☐ Oil ☐ Other ☐

2. Are types other than the ones you manufacture, made in Canada?

   Elec. res. heater ☐ Gas ☐ Furnace coil ☐

   HP (heat pump) ☐ Oil ☐ Other ☐

3. Are any types manufactured elsewhere imported into Canada?

Type of Heater	Yes	No	Don't think so
Electric resistance heater			
Gas			
Furnace coil			
HP (heat pump)			
Oil			
Other			

If any types manufactured in Canada are also imported, ask:

4. Why would .... heaters be imported?

   Price ☐ Special design features ☐ Other ....

If any special design features, note information volunteered or ask:

What advantages do these (imported units) offer?

5. Do you know at least roughly, the market share of all types of hot water heaters?
Electric resistance heaters .....%   Oil .....%

HP hot water heater ....%   Furnace .....%

Gas ....%   Other ....%

6. Has this distribution of the market changed since the cost of energy has increased so sharply?
About what would have been the market share back in the mid 70s?

Electric resistance heaters .....%   Oil .....%

HP hot water heater ....%   Furnace .....%

Gas ....%   Other ....%

7. Considering only your own products, have you made any design changes which would affect the heat losses from the tank and associated plumbing?

Yes ☐ No ☐

<u>If yes</u>
What were they (was it)?

More insulation on tank ☐   Thermal isolation of plumbing ☐

Lower water temperature set at factory ☐ Other ....

Why was this done?

As industry leader, wanted to retain lead ☐ Other ☐

Competitive pressure ☐

So we can have a basis for comparing the efficiency of the various types of hot water heaters, let me display my very limited knowledge of the subject in order to arrive at a definition.

In a hot water heater, electrical or chemical energy is converted into heat and this heat is transferred by conduction and convection to the water in the tank. The tank loses heat by conduction to the surrounding air and by radiation. The plumbing connections conduct heat away as well.

I assume that we can regard heat losses from the tank and plumbing as being independent of the source of heat. If so, can thermal efficiency be defined as the ratio of the heat energy delivered to the water to the electrical or chemical energy supplied?

8. Has the thermal efficiency of the units you make changed over the past six or seven years?

Yes ☐ No ☐

<u>If yes</u>

To what extent? (as a percentage)

9. What change(s) did you make?

Why did you make this (these) change(s)?

Change			
Want to retain leadership	☐	☐	☐
Competitive pressure	☐	☐	☐
Other	☐	☐	☐

10. Is any (further) improvement technically possible in the thermal efficiency of the units you manufacture?

Yes ☐ No ☐

<u>If yes</u>

What would be changed?

11. How much would this change (these changes) affect thermal efficiency? Effect on manufacturing cost?

Design Change	Change in Efficiency	Cost

12. Do you plan to make these changes? Yes ☐ No ☐ Some ☐

If yes or some

Why do you intend to (make this change)?

Change			
Want to retain leadership	☐	☐	☐
Competitive pressure	☐	☐	☐
Other	☐	☐	☐

If no

Why is that?

Cost/benefit unattractive	☐	☐	☐
Technical problems	☐	☐	☐
Other	☐	☐	☐

Don't ask Q. 12 if respondent has said no changes are technically possible.

13. If the Energuide program were to be extended to cover hot water heaters, would this influence the rate at which any possible changes would be made?

Yes ☐ No ☐

14. What would the effect of the Energuide program be on this company?

15. If instead of Energuide requiring testing and labelling, it was decided to establish minimum standards of thermal efficiency, would this be better or worse than Energuide?

Better ☐ Worse ☐

Why is that?