International Update on the Status of Energy Labelling and MEPS

Part 1 - Energy Labelling of Household Appliances

A REVIEW OF INTERNATIONAL DATA SOURCES TO PROVIDE INFORMATION FOR THE CURRENT AUSTRALIAN APPLIANCE ENERGY LABELLING REVIEW

DRAFT REPORT

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Executive Summary

The overall purpose of this study is to collect key information on energy labelling programs in other countries and present it in a way that will assist in the current review of labelling in Australia.

It is generally recognised that the efficiency of the market for household energy services could be greatly enhanced if buyers were able to take into account not just the cost of the appliance but otherwise invisible factors such as energy consumption. Therefore energy labelling of household appliances now operates in most OECD countries, and has been implemented in several developing countries as well.

The most commonly labelled household appliances are refrigerators, freezers and air conditioners. Most OECD countries also label clothes washers, clothes dryers and dishwashers. A few label water heaters and other products such as lighting.

There are two main types of labels: *endorsement* and *comparison*. Endorsement labels indicate that the product meets a certain standard (eg for energy consumption in standby mode) or belongs to the "most energy efficient" class of products. While this label type allows consumers to segregate products into those which have and those which lack the endorsement, they cannot otherwise compare products within those two groups.

Comparative labels allow consumers to form a judgement about the energy efficiency (or energy consumption) and relative ranking of all products which carry a label. Endorsement and comparative labels can coexist, and do so in the USA.

The comparative labelling programs in OECD countries are all mandatory. Some developing countries with labelling programs also make it mandatory, while some do not. All endorsement labelling programs are voluntary.

A review of appliance energy labels from around the world shows that most countries have decided to adopt a comparison label using a scale with absolutely defined categories. This type of label allows consumers to easily assess the efficiency of a product in relation to an absolute scale, by means of a numerical or other categorical rating or ranking system. Examples are the European Union's appliance labels, which have a rating scale from A (best) to G (worst); the Korean and Thai appliance energy labels, which have a rating scale from 1 to 5 and 5 to 1 respectively; and the Australian appliance label, which has a rating scale from 6 to 1 stars.

Canada and the US have adopted labels with a common basic design with national variations. They use a comparison label with a continuous scale representing the actual range on the market, with extremes of annual kWh used and an arrow indicating where the particular model falls within the range in its category of the market.

The Philippines label for air conditioners provide some product information and the energy-efficiency ratio (EER) of the model in large bold font. There is no information on the label itself which allows comparison either with an absolute rating

scale or with what is on the market, so the user needs to compare labels or refer to a separate guide to make a judgement.

Table ES1: Overview of Energy Label Types

Country	Type of label	Comments
Canada	comparison: actual market range	scale shows range of models in size class
United States	comparison: actual market range	scale shows range of models in size class
Australia	comparison: absolute categories	categories from 1 to 6 stars (best)
South Korea	comparison: absolute categories	categories from 5 to 1 (best)
Hong Kong	comparison: absolute categories	categories from 5 to 1 (best)
European Union	comparison: absolute categories	categories from G to A (best)
Thailand	comparison: absolute categories	categories from 1 to 5 (best)
Philippines	energy performance data (no comparison)	shows EER of air conditioner only

Analysis of comparison labels shows that the visual designs in use around the world. can be grouped into three basic types as follows:

Australian Style Label: This type of label tends to have a square/rectangular base with a semi-circle or "dial" across the top. The "dial" resembles a speedo or gauge, with the concept that the further advanced the gauge in the clockwise direction, the better the product. This type of label is used in Australia, Thailand, and South Korea. The number of stars or the "grading" numeral on the scale depends on the highest preset threshold for energy performance which the model is able to meet.

European Style Label: This type of label is a vertical rectangle with letters ranging from A (best) near the top of the label to G (worst) at the bottom. There is a bar next to each letter: eg short and green for A and long and red for G. All 7 grade bars are visible on every label. The grade of the model which is labelled is indicated by a black arrow marker located next to the appropriate bar (eg for a C grade product the marker carries the letter C and is positioned against the C bar). Iran has a variant of the European Style label which is a mirror image, because of the direction of Persian script, and uses numerals rather than Roman script letter for the gradings: ie 1 (best) to 7 (worst).

US Style Label: This rectangular label shows energy operating cost (based on a stated notional energy tariff). It also has a linear scale indicating the highest and lowest energy use of models on the market, and locates the specific model on that scale. This design is now used in USA and Canada: Canada had its own label design before (and the USA had a different design from the present version), but the programs have become technically (if not visually) harmonised.

While there is only limited information on the effectiveness of energy labelling programs overseas, labelling appears to have had some impact on the operation of the appliance market in every country in which it has been introduced.

The following types of impact have been observed in one or more countries:

- the priority which appliance buyers give to energy efficiency among their purchase criteria increased

- the average efficiency of the range of products on the market increased (in Thailand, where labelling is voluntary, the average efficiency of labelled products increased, but this could have been because suppliers only volunteered their more efficient models for labelling)

- appliance buyers showed greater preference for the more efficient products.

The best documented programs (apart from the Australian program, for which the documentation has not been reviewed in this paper) are the Europe Commission program, the US and Canadian programs and Thailand.

The European program is relatively recent, but has been well researched and monitored. Although evidence is still inconclusive, both suppliers and consumers appear to have responded (to different degrees in different countries). There is a wide range of anecdotal evidence that energy impacts are significant and that savings appear to be ongoing. However, some of the implementation aspects of the program (such as compliance levels, accuracy of the labels etc.) appear to be lacking, at least in the short term.

Although they are the oldest programs, the energy impact of the US *EnergyGuide* and Canadian *EnerGuide* does not appear to have been satisfactorily evaluated. They are the only programs so far where the original labels have been substantially redesigned to improve consumer comprehension, but assessments still show comprehension is relatively poor. The effectiveness of the programs is uncertain, and is complicated by the fact that the US also has a very active MEPS program and the *Energy Star* endorsement label is now used for many of the same products as the *EnergyGuide* label.

The Thai label, and the extensive publicity campaign with which it was launched, appears to have greatly increased the level of consumer interest in energy efficiency. However, the impacts on actual sales-weighted efficiency trends have not yet been established. The label only appears on a limited proportion of showroom stock and due to the limited range of ratings available (most models are now "5"), it is probably functioning more as an endorsement label than a comparison label.

It is difficult to assess to what extent the format and design of the label itself contributes to the effectiveness of a labelling program. The original US EnergyGuide design, locating the models' running cost (in $) on a comparative scale with the most and least efficient in its class, was found to be confusing to many consumers. However, it is not clear which element caused the difficulty: the scale or the "$

running cost" (said to be misunderstood as "$ saved"). There is evidence that consumers find the details of comparison scales difficult to remember when comparing products in different locations. It is also unclear whether the US label would have been better understood if it had received more publicity support.

The Thai experience suggests that with adequate publicity, the actual design of the label may well be less important. People will become familiar with it and learn how to use it if they see it on TV often enough. But the Thai publicity message (buy an appliance with the rating "5") is simple and powerful and provides strong support for the argument of a simple absolute categorical rating system.

There is evidence that program support measures such as guides (at the point of sale or distributed prior to retail visits), Internet access and databases of products, will assist informed consumers (those seeking third party independent data sources) to select a more energy efficient appliances. While these consumers are likely to be a minority, even in OECD countries, they will create market pull for higher efficiency products and entice manufacturers to respond with product improvements. Marketing of the program is important as well, but to be most cost effective, the target audience needs to be narrowed to those consumers who are considering the imminent purchase of an appliance. Program support measures such as guides, marketing and consumer advisory services and all enhance the effectiveness of an energy label and it is important to consider these aspects when reviewing the operation of a scheme.

However, if the label has to do its own communication work without external assistance, then the following conclusions may be drawn:

- most consumers would prefer $ running costs somewhere on the label, but no labelling program appears to have satisfactorily resolved how to do this, given that energy prices vary regionally and over time and that there is potential confusion between operating costs and savings (and in some cases purchase costs);

- comparative labels using an absolute reference scale (eg "A to G" or "1 to 5", or in Australia's case 1 to 6 stars) appear to be more effective than the US label, which uses a continuous scale where the extremes represent the actual market spread;

- there is a strong case for separating the label elements to minimise confusion for the consumer. The most important elements (such as the rating category) need to be clearly delineated, with the most important aspects (3 maximum) highlighted.

- While being generally complementary in nature, endorsement labels appeal to a distinct market segment that want to know which products are "the best" without having to wade through detailed analysis.

It is impossible to form a judgement whether endorsement labels would be more effective than comparative labels: in the US they have recently started to be used together, and this may turn out to be the most effective approach.

A review of past evaluations of energy labelling programs indicates the need to redirect research efforts in three areas:

- field studies that assess consumer preferences and understanding of labels directly in the store environment;

- in-depth interviews and participant observation to assess consumer decision-making, both in the retail environment and elsewhere; and

- a need to link the label to actual behaviour and to quantify the extent to which the label influences consumers to purchase more energy-efficient models.

It is also important to monitor all of the operational aspects of an energy labelling program to ensure that the infrastructure which delivers the information is functioning smoothly and that labels are displayed and that they are accurate.

Finally, it must be said that there is nothing in other countries' labelling programs which has not been encountered or anticipated (and in some cases, consciously avoided) in the design of the Australian program. All programs and label designs are local variations on a narrow range of themes, and all grapple with similar issues: eg how to address the latent demand for running cost data, how to convey a notional efficiency range and locate each model on it, and how to address bunching at the top of the grading scale.

There is no single answer to addressing these issues. Each country appears to have adopted the approach which best suits the needs of its consumers, its appliance suppliers and its trade blocs. Once an approach has been adopted, changes have been infrequent and evolutionary in nature rather than revolutionary.

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1. Introduction

This report contains a review of international appliance energy labelling programs and examines their broad aims and objectives in the context of energy policy. It also looks at the need for an energy label to take into account local cultural and socio-economic considerations if its implementation is to be successful. It reviews the label types, information content and communication strategies of the major energy labelling programs currently in operation around the world. Examples of the labels are included.

Some proposed labelling schemes are also noted. This report does not discuss the principles of minimum efficiency performance standards (MEPS) for appliances, even though these are often closely related to energy labelling programs in terms of technical standards, administration and implementation, except to the extent that there are direct links with labelling. MEPS as such are covered in a separate volume.

1.1 Background

1.1.1 Energy labelling in Australia and Relationship with Other Programs

The energy labelling of refrigerators and freezers first became mandatory in NSW in 1986, and in Victoria in 1987. Since then the labelling program has been extended to dishwashers, air conditioners, clothes dryers and clothes washers. It is now effectively a national program, even though not all of the States and Territories have mandatory labelling requirements for all of the product types. Relatively few products of the types covered by the program are now displayed for sale without an energy label, anywhere in Australia.

Australian energy labels are also seen on many electrical appliances displayed for sale in New Zealand and in Pacific Island nations, and more formal and complete extension of the program to those markets has been considered from time to time.

There is a separate energy labelling program covering gas water heaters, room heaters and central heaters. While not mandatory in the legal sense, gas appliance labelling is now required in the product approval codes enforced by the Australian Gas Association (AGA), which makes it mandatory in effect.

Energy labelling is now an integral element of the appliance market in Australia. The design of the Australian energy label, with its semicircular arrangement of up to 6 stars, has very high recognition among appliance buyers. This has been reinforced by:

- the stability of the design (unchanged for electrical appliances since its introduction);
- the use of the same design (in different colours) for gas as well as electrical appliances. The first energy labels used in Australia were in fact the "E" labels introduced by the Gas and Fuel Corporation of Victoria in the early 1980s. The AGA took over the program and changed the gas label design to resemble the electrical appliance label in the late 1980s;
- the extension of the labelling concept, using a variant of the same design, to the Home Energy Rating Scheme.

Energy labelling in Australia has an extensive history. There is considerable investment in the program in terms of administrative structure, support and coordination by government, the appliance industry and consumer groups, and label recognition. In this respect the situation is different from countries which have implemented labelling only recently or are still considering its adoption.

For countries still considering labelling, many possibilities are open, and a review of energy labelling programs and label designs around the world (as indeed was done in Australia before electrical appliance labelling was first introduced) can lead to the adoption of the best elements of each. Of course, these elements still need to be adapted for local needs.

For countries like Australia however, the benefits of changing crucial aspects of the program, and possibly including elements that have proved successful elsewhere, needs to be weighed against the costs of abandoning parts of the investment already made. Furthermore, elements which work in other countries may do so because they have evolved out of *their* situation, and build on the social investment in *their* labelling program.

At the same time, there is a considerable experience in other countries with developing and implementing labelling, and some experience with evaluating, revising and improving existing programs.

1.1.2 Purpose of the study

The overall purpose of this study is to collect key information on energy labelling programs in other countries and present it in a way that will assist in the current review of labelling in Australia.

The project brief developed by DPIE was as follows:

> "The appliance energy labelling scheme is currently being reviewed. The scope of the review includes potential changes to the technical basis for the measurement of energy and performance of the various appliances, the method of determining a comparative energy rating, as well as possible changes to the label design and the range of information included on the label. Some of these options have been investigated in two recently completed consultant studies.

Any changes to the scheme will need to take into account improvements in the level of energy efficiency of appliances since the introduction of the scheme and the impact of the introduction of MEPS for refrigerators and freezers in 1999. [The consultant will:]

1. Collect information on household appliance energy labelling schemes currently in use in different parts of the world, including copies of the labels, the type (eg comparative or endorsement), appliances covered, rating system, date of implementation, implementing agency, and whether major elements of the scheme have changed since inception.

2. Analyse and review the information contained on the above energy labels with a view to identifying the purpose of the information and the communication strategy with the consumer (where this is documented) and to identify the most common information types found on labels

3. Review any available international research and reports which document the development of the above energy labels and their communications strategy and provide a summary of the processes used to optimise the content of the energy label, including the main conclusions of this research.

4. Review any available international research and reports which have evaluated existing energy labelling programs in terms of consumer awareness, consumer understanding and estimated impact evaluation, and which have resulted in changes in the major elements of the schemes.

5. Review any available international research and reports relating to changes in the major elements of existing energy labelling schemes.

6. Collect information on household appliance MEPS schemes currently in use in different parts of the world, including appliances covered, MEPS levels, date of implementation, implementing agency, and whether major elements of the scheme have changed since inception.

   The scope of this work is to cover (for labelling) refrigerators, freezers, clothes washers, dishwashers, clothes dryers and household size air conditioners."

It was not within the brief to directly compare overseas programs and indicators of effectiveness (eg levels of consumer recognition) with Australia. Therefore it is not possible to use this report to draw conclusions whether other countries' approaches are more effective than Australia's, or how different programs rate on common performance indicators.

1.1.3 Preparation of this Report

This report was prepared primarily by Lloyd Harrington of Energy Efficient Strategies, with editorial and technical assistance from George Wilkenfeld of George Wilkenfeld and Associates. Specific input on Europe was provided by Paul Waide of PW Consulting, currently based in the UK, while information on the USA, Canada

and Thailand was provided by Peter du Pont who, is completing his PhD thesis on evaluation of energy labels at the University of Delaware, USA.

Lloyd Harrington, as part of his work on energy labelling in Australia, has been collecting information on energy labelling programs from around the world for the past 4 years. This report is the manifestation of much of this work. The author would like to thank the many individuals that have contributed labels and data on their energy labelling programs for this report. In particular many thanks are extended to:

- Anne Lorraine who scanned and edited the energy labels
- Gunther Ennen - Miele (Germany)
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- Matthew Kestner, European Commission (Belgium)
- Rolf Schmitz, Swiss Federal Office of Energy
- Ali Heydari - Sharif University of Technology (Iran).
- Juan Quintanilla Martinez, Universidad Nacional Autonoma de Mexico.

Notwithstanding the many individuals and organisations that have assisted during this project, the content and form of this report, and all of the views, conclusions and recommendations expressed in it, are those of Energy Efficient Strategies.

1.2 Intervention in appliance markets

1.2.1 Reasons for Intervention

Markets for household energy services do not operate efficiently, for a number of reasons. Consumers are not generally aware that they are purchasing not just an appliance but an energy service, the cost of which includes the value of utilities (electricity, gas, water), consumables (eg detergents) and maintenance over the operating lifetime of the appliance. In most cases the net present value of these costs will exceed the purchase price of the appliance.

Even if consumers are aware that these costs exist, it may not be possible to get reliable information about them in a way which allows informed decisions to be made at the time of appliance purchase. Inspection of an appliance such as a refrigerator does not reveal its energy consumption, energy efficiency or standard of performance.

In fact, the determination of these performance attributes requires careful testing and sophisticated equipment, which is not readily accessible to the consumer.

Even if information about these hidden attributes and costs is made available, consumers may not act on it because they attach a high discount rate to future savings, or because they cannot raise the additional capital required for the purchase of the product that they know to be most cost-effective when all costs are taken into account.

Finally, even the best-informed consumer will in most cases react to prices rather than to underlying costs.[1] Since household electricity prices have historically been cross-subsidised, investments in household energy-efficiency have appeared less cost - effective to consumers, and consequently the take-up of efficiency has been less than the economic optimum from a societal perspective. This is even more so when it is considered that most costs of environmental damage from energy production are externalised from the price.

Energy labelling and MEPS are interventions designed to compensate for market imperfections and failures, and to increase the efficiency of the market for household energy services.

An organised labelling program enables appliance buyers to get consistent and reliable information about the energy consumption of specific models. Without such a program, suppliers who perceive a commercial advantage from claiming their products are "energy efficient" could do so in any way they wish. Without standard definitions of "energy efficiency" or standard ways to measure energy consumption, each supplier can present information in the way which best suits its own products. Other suppliers can adopt different definitions of "energy efficiency" which suit them, and criticise their competitors' products and definitions accordingly. The end result is that the consumer is no better informed than before.

Consistent rules for testing and labelling energy performance are almost always developed by agents outside the appliance industry, although the industry is usually involved in the development of the technical details. The first energy labelling scheme in Australia, for gas appliances, was developed mainly by a gas utility. The development of electric appliance labelling was driven by the NSW and Victorian state government energy agencies.

1.2.2 How Labelling and MEPS Transform the Market

In nearly all appliance and equipment markets (whether for refrigerators, air conditioners or motors) the energy efficiency of the best products on the market tends to improve over time, even without labelling. Suppliers of high quality products are competing to improve their models in every respect, including energy. At the other

[1] An exception is the purchase of solar water heaters. If buyers carried out a discounted cash-flow analysis using actual capital costs and energy prices, they would find in nearly all cases that the solar unit has a higher life cycle cost than the conventional alternative. However, buyers tend to value the energy saving more highly than their monetary value - in effect they voluntarily internalise the cost of the environmental damage into the energy price.

end of the market, the suppliers of poor quality products build for price-driven customers, and rarely bother to improve energy efficiency.

If customers have no specific information on product energy efficiency, the average purchase will lie somewhere between the between best and worst. With the introduction of "comparative" energy labelling, which allows buyers to compare the energy efficiency of different models, two things tend to happen:

- suppliers of higher quality products respond to the introduction of labelling by improving their most efficient products, to take advantage of the higher part of the label scale;

- an increasing number of buyers take the label into account, and so buy a more efficient model than they would have if there had been no labelling.

The trend in average efficiency follows a different path. The total energy saved is the area between the "new average" and "old average" trend lines. Even buyers who do not use the label get some benefit from its existence, since the average efficiency of all products on the market improves. The more effective the labelling program, the greater the divergence of the "new" from the "old" average.

The effectiveness of the label is influenced by factors such as how well the label is promoted, whether it is possible for buyers to avoid less efficient models as well as to seek out more efficient models (ie *all* models are labelled) and the range between best and worst (ie if all models carry a 5 star label then there is little effect).

Experience has shown that even where labelling is mandatory, it does not remove the least efficient products from the market. This is because some buyers will always be driven by purchase price, even if they know that they would save more in energy costs than the extra they would need to spend to buy a more efficient model. Also, some buyers will not bother to buy more efficient products because someone else will pay the running costs (split incentives). This is typically the case with appliances bought for rented housing or offices.

For this reason, some countries have supplemented energy labelling with low-level MEPS. "Low-level" MEPS typically set to eliminate the least efficient 15 to 20% of models on the market, and to guard against the future introduction of low-efficiency products. This is a growing issue as more countries adopt MEPS and poor quality imports are diverted to neighbouring countries.

It is usual to give suppliers a lead time of 2 to 3 years to meet a foreshadowed MEPS level, and the least efficient products must be removed, or improved, within the lead time. (It is assumed, of course, that suppliers comply - the probability that they will is higher if they are well informed about what is happening and if they know their products will be subject to random verification tests). The effect is to drive the average efficiency level even higher than it was with labelling alone. It is still important to continue labelling, since there is still a wide range of efficiencies from best to worst, and buyers will still benefit from seeking out the most efficient.

Instead of "low-level" MEPS it is possible to set so-called "high level" MEPS above the market average efficiency, or even above the current best on the market. When the 1993 MEPS levels were first announced in the USA, in 1989, there were only 2 out of a total of 2,000+ models on the US market at the time which would have met them. The regulators were able to confidently set high MEPS levels because of extensive cost-benefit analyses which showed that it was technically possible to meet the levels while maintaining a positive benefit-cost ratio.

Sometimes it is also necessary to set MEPS at a high level otherwise there is no impact at all on the market. For example, fluorescent lamp ballasts tend to be made in a number of distinct efficiency types: standard, low loss, super low loss and electronic. Unless the MEPS level is set above one of these types (say just higher than the standard level) it will have no effect.

High level MEPS will have a dramatic effect on the average efficiency of products, and will lead to greater reduction in energy use than other approaches. However, high level MEPS narrows the range between the best and worst on the market to such an extent that comparative energy labelling is much less effective. The buyer will not take much notice of labelling if MEPS has eliminated all but the 5 star models.

Different countries have used different combinations of labelling and MEPS in their strategies to increase appliance and equipment energy efficiency. For example, Australia has used comparative labelling (mandatory since 1986) followed by low-level MEPS for refrigerators, which are labelled, and high-level MEPS for water heaters, which are not labelled.

The USA has taken the path of high level MEPS for most product groups. This has meant that comparative energy labelling has been less effective, since most of the potential cost-effective energy savings were already realised through MEPS. Consequently, the USA is now widening the use of the "Energy Star" endorsement label.

2. Energy Labelling Principles

2.1 Threshold Decisions

A recent meeting of the Energy Labelling task force of NAEEEC concluded that:

"The purpose of energy labelling is to influence consumers to buy the appliance which will result in the lowest energy consumption and which meets their (energy service) needs."

If labelling is successful in this aim, then it follow that energy efficiency will affect commercial success, and appliance manufacturers, importers and retailers will have a greater incentive to introduce and market more energy efficient products.

However, not every energy-using product is suitable for labelling, and many issues need to be considered in the design of a labelling program.

2.1.1 Deciding What to Label

The appliances and equipment types which are most suitable for energy labelling are those that:

- use a significant amount of energy
- have a reasonably high level of penetration and ownership (or where ownership is increasing rapidly)
- where the purchaser also pays the energy bills
- where the purchaser has some involvement in the purchasing process
- where there is (or could be) a significant variation in the energy efficiency of the product

These pre-requisites need to be considered when developing an energy labelling program.

There are some appliances in the residential sector which have a high level of energy consumption but which are not suitable for energy labelling. Electric space heaters is a good example. The efficiency of resistive space heaters is close to 100% and there is little that can be done to vary the efficiency. So although the end use may be a significant share of total energy, there is little point in labelling as there is no possibility for differentiation in the efficiency of the energy service. Of course, space heating can also be provided by other fuels or through the use of heat pumps, so in this case labelling could be used to compare fuels or technologies.

2.1.2 Designing the Labelling Program

Key program design issues to consider when designing a new energy labelling programs are (after Harris et al, 1996):

- should a comparison or endorsement label be used, or both?
- format of label - accuracy versus complexity
- emphasis of either energy consumption or cost indicators?
- how is appliance performance handled?
- what is the most trusted source of labels - labels need to be authoritative
- need for verification of label claims
- updating of efficiency criteria to account for market changes - review cycles
- energy only versus eco-labels (multi-criteria, cradle to grave analyses)
- marketing the label to consumers - buyer awareness & response
- retailer participation - sales training
- manufacturer acceptance of energy labelling.

Whether labelling is to be mandatory or voluntary is a threshold decision, which will affect almost every aspect of the program design. Comparison labels operate best when they are mandatory. Experience has shown that where labelling is not mandatory or where mandatory provisions are not enforced, energy labels on appliances with lower ratings are actively removed by retailers to improve their chances of selling the product. Alternatively, where labelling is mandatory, more resources need to be allocated to monitoring and verification, since the commercial incentive to falsify information is greater.

The above issues also need to be taken into account when reviewing an existing labelling program, but from a somewhat different perspective:

- how is the program performing in relation to each factor?
- what can be done to improve performance in relation to each factor?

2.2 Types of Energy Labels

This section begins with a typology of energy labels, in order to compare the different ways of communicating energy information to the consumer. Casey-McCabe and Harris surveyed a range of energy and environmental product labels and make the following typology distinctions (Casey-McCabe 1995, Harris 1996):

- endorsement versus comparison labels;
- by sponsor (government, manufacturing association, or third party);
- energy-only vs. environmental criteria.

2.2.1 Endorsement labels

These labels are essentially a “seal of approval” that a product meets certain specified criteria. Endorsement labels help consumers distinguish between a range of similar products by providing a “seal of approval” for products which meet or exceed some established criteria. Supplier participation in these programs tends to be voluntary and endorsement labels tend not to disclose much information on energy or performance (although this is sometimes available through lists of endorsed products).

It is a system which operates on the principle - "we know what is good, trust us" and works best if only a limited proportion of the market carries an endorsement.

Primary examples of endorsement labels are the US EPA Energy Star program, Swiss Energy 2000 (E2000) program (office equipment) (now also used in several European countries), Power Smart in Canada (primarily energy), Green Seal in the US (primarily environmental), Blue Angel in Germany (primarily environmental).

Since its introduction for office equipment, the Energy Star label has been applied in the USA to heating, ventilation, and air-conditioning equipment. It has recently been extended to TVs and VCRs , and is being tested for refrigerators in the USA as part of a national pilot project (the Energy Star Retailer Initiative). The Power Smart label has been developed for a range of electrical products by a Canadian utility.[2]

Endorsement labelling schemes may be based on a range of criteria which may include energy consumption (either when operating or in the standby mode, as is the case with Energy Star) and/or energy efficiency. They tend to be structured such that only the top 10% to 40% of performers can achieve endorsement - this is intended to produce maximum market impact. An exception here is the Energy Star program, which because of US government IT purchasing requirements, has now become a defacto industry standard. Endorsement labels can be sponsored by governments, but sponsorship by utilities, industry and environmental groups is also common.

2.2.2 Comparison Labels

Comparison labels show key information on energy consumption and/or performance data in a way which allows different products to be compared, either with each other or in relation to some absolute scale.

In the simplest label cases the label gives energy consumption data only, and it is up to users to find similar data for other products and to draw their own conclusions. The label may also have some indication of energy efficiency (eg a star or efficiency rating) which combines the raw energy consumption value with information about the product's size or performance, in a way that may not be readily apparent to the user. Sometimes the energy consumption (or efficiency) relative to other models on the market is also indicated.

Comparison labelling works best when it is mandatory for all products to carry a label (so that poor performers can be identified and readily avoided by consumers). Examples of this type of label can be found on appliances in Australia, Europe, USA and Canada, as well as a number of Asian countries (eg Philippines, Hong Kong, Thailand and Korea). As they tend to be mandatory in nature, comparison labels are generally sponsored by governments, although there are exceptions.

The two main types of comparison labels are described below.

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[2] Power Smart was initially developed by British Columbia Hydro as an endorsement label for its DSM programs. It has now been spun off as an international membership organisation with more than 30 utility members around the world.

2.2.2.1 Comparison using Absolute Scale

This type of label allows consumers to easily assess the efficiency of a product in relation to an absolute scale, by means of a numerical or other categorical rating or ranking system. Examples are the European Union's appliance labels, which have a rating scheme from A (best) to G (worst); the Korean and Thai appliance energy labels, which have a rating scheme from 1 to 5 and 5 to 1 respectively; and the Australian appliance labels, which have a rating scheme from 6 to 1 stars.

For the label to have a comparison effect, the user needs to be aware through observation (or be made aware through advertising, guides etc) that there is range of efficiency levels on the market. The scale itself can suggest this: for example "if this model is rated D there must be some around rated A", or "if this is A it must be the best on the market", but neither inference may in fact be true.

However, once they become familiar with what is on the market, users of "absolute scale" labels are quickly able to discern which products are poor, average, above average, or superior. While the labels may also contain detailed information on the operating characteristics, costs, and energy use of the model, the main emphasis is on establishing clear categories, so that the consumer can tell, by looking at a single label, how energy-efficient it is and form a judgement about its relativity to others on the market.

For categorical systems to be effective, consumers need to be familiar with the label and the rating scales. For Europe the rating system is quite obvious without much additional information (ie A is the best and G is the worst - all possible ratings are shown), however, for other schemes like in Korea, consumers need to know that 1 is the best, while in Thailand, they need to know that 5 is the best. "Best" and "worst" ratings are often clearly marked on categorical comparison labels.

Some exceptions include star rating for Australia (maximum number of stars is not widely known - most consumers think that 5 is the maximum rather than 6), the Hong Kong energy label where the worst rating is not declared, and the Philippines rating for air conditioners which only includes the model's EER (no subjective or relative rating system is provided).

2.2.2.2 Comparison with Actual Range on Market

This type of label provides detailed information on the energy consumption of the labelled model and compares it with the actual range on the market, rather than with some theoretical or absolute rating scale. Examples of comparative labels with a continuous scale are the U.S. Energy Guide and Canadian EnerGuide labels.

As continuous scale labels usually compare energy consumption, there needs to be a number of defined product size categories, so that larger appliances are not compared with smaller appliances. Often there are also sub-categories for various features or

product types (eg for refrigerators: frost free versus cyclic defrost, top mounted freezers/bottom mounted freezers/side by side, with or without ice-makers and so on). A critical difference between labels based on absolute comparison and those based on the actual range on the market is that the latter needs to be regularly updated as the market range changes. Historically, both the "best" and "worst" on the market get better as new models are introduced and old models are retired. Therefore: there needs to be a central agency which regularly collects market data and informs manufacturers (or whoever is responsible for printing and affixing labels) about the extremes of the range. In the past the US appliance labelling program has not been able to do this frequently enough.

2.3 Information Contained on Energy Labels

Energy labels can communicate a wide range of data to the consumer. However, as the complexity of the label increases, the level of understanding by the consumer is also likely to be reduced. Label design is a balance of providing enough information to influence the consumer, while avoiding confusion. Therefore the information which is included should be the most influential and salient and the least complicated. This is a difficult issue: there is no universal solution as the optimum label content will vary between cultures and to some degree will depend on literacy levels. Certain colours and shapes can have good or bad connotations in some cultures, so even the overall design and look of a label is not a trivial issue.

Endorsement labels tend not to show actual energy consumption or efficiency data, but contain logos or simple statements to support endorsement. They may also show the year of the endorsement (eg E2000), especially where the eligibility criteria change from year to year.

The following sections provide a brief overview of the types of information that can be found on comparison labels from around the world.

2.3.1 Information Found on Most Comparison Energy Labels

The following types of information are found on the majority of comparison labels around the world: this could form an initial list for consideration for inclusion on a comparison energy label:

- Appliance type (eg refrigerator, freezer, dishwasher etc)
- Brand and Model
- Energy consumption (usually per month or year, sometimes per cycle or power during use eg kW for air conditioners)
- Assumed frequency of use if annual or monthly energy is shown (not necessary for refrigerators, which operate continuously)
- Efficiency rating (either category (absolute scale) OR relative on a continuous scale)
- Appliance capacity or size (eg litres for refrigerators & freezers, kg for clothes washers and clothes dryers, place settings for dishwashers, kW for cooling/heating)

- Program used for the test (mainly for clothes washers and dryers and dishwashers)
- Test standard used to measure energy consumption (and performance)

For comparison labels with rating on a continuous scale, there is usually information on the category within which the model lies. For refrigerators in the USA, the comparison categories are tightly defined: eg "automatic defrost (frost free) with side mounted freezer with through the door ice service between 20.5 and 22.4 cubic feet" is one rating category description. In the USA at the moment there are about 33 such type/size categories for refrigerators and refrigerator/freezers and about 26 size/type categories for separate freezers (AHAM 1997). For other products (eg dishwashers) the product size/type categories are much simpler: eg "standard" or "benchtop".

2.3.2 Information Found on Some Comparison Energy Labels

The following types of information are found on some comparison labels around the world in addition to those outlined above:

- Performance data (eg washing, spin performance or spin speed for clothes washers, washing and drying performance for dishwashers, freezing capacity for freezers)
- Noise emissions
- Category or type or class of the appliance
- Data for alternative connection options (eg energy for hot water connect versus cold water connect, energy cost for gas vs electric hot water systems)
- Energy cost for the model (at an assumed energy price or range of prices)
- Energy cost calculation tables (for a range of assumed usage levels and energy prices)
- Water consumption (where applicable)
- Minimum efficiency requirements for the model
- Date of label rating system or energy prices
- Registration number or regulatory reference or approval number
- Contact details for advice

2.4 Relationship Between Appliance Performance and Energy Consumption

The declaration of energy consumption values without reference to other performance attributes has the potential to seriously mislead consumers. Some performance attributes are clear cut and easy to specify in conjunction with energy consumption information. For example with clothes dryers, standard test procedures specify an initial and final moisture content for a clothes load and this constitutes a definition of "wet and dry clothes" for the purposes of comparative energy consumption and efficiency. In the case of refrigerators, the definition of suitably cooled space for the storage of food is a complex one and is defined through a series of tests in the ISO refrigerator standards (operation temperature performance tests). However, for clothes washers and dishwashers, the issue of what constitutes clean clothes and dishes is a vexed one and to some extent subjective. What is acceptable in one country may not be acceptable in another.

There are two fundamental approaches to the issue of the interrelationship between performance and energy consumption. The approach adopted in Australia for the energy labelling program is that the standard test procedure specifies a minimum acceptable performance level for each of the key performance attributes. Thus for clothes washers and dishwashers, the standard specifies a minimum soil removal and washing index as a mandatory performance requirement. This minimum acceptable level has been developed on the basis of reasonable consumer expectations. Thus manufacturers are able to modify the performance of their appliances to meet the required minimum performance requirements while achieving the minimum energy consumption possible. This creates a so called "level playing field" for performance when comparing energy consumption values on the energy label. Naturally, the relevant performance tests need to be highly reproducible and repeatable for this approach to be successful.

An alternative approach has been adopted in Europe as the basis for their energy labelling program. No minimum performance levels are prescribed in either the European standards or the European Commission Directives, but both the performance and the energy consumption are declared on the energy label and on the information fiche that accompanies the appliance. While this has the advantage of being less prescriptive (in terms of mandating a minimum performance levels), it has the disadvantage of possibly providing too much information for the consumer to compare (eg is a clothes washer with a D energy rating and an A wash score better or worse than a model with an B energy rating and a C wash score?). Although on a particular clothes washer there will be a trade off of wash performance versus energy (to some degree), analysis of the European database of clothes washer models and ratings has shown that it is most common for the wash performance and the energy performance to be the same rating (ie clothes washers with B rated energy most commonly have a B rating for wash performance as well). Those models that achieve higher washing and energy ratings are technically more advanced and are therefore likely to have a higher cost.

The USA has a slightly different approach again in that there are no minimum performance levels prescribed and no performance declarations necessary (in fact performance measurements are not required at all for most products that carry an energy label). However, the US test procedures are very prescriptive in terms of defining capacity and energy consumption and many argue that this effectively stifles much potential manufacturer innovation in terms of product design. The US test procedures also have problems with some of the more advanced products. For example, some dishwashers on the market now have fuzzy logic soil load sensors in the recirculating water systems to help determine when to stop the washing operation. As the US test procedures specify washing with an unsoiled load during the measurement of energy consumption, these machines only operate with very short cycles and achieve unrealistically high energy ratings. Another example of the US energy labelling requirements being unable to cope with product innovation occurred when an off-shore manufacturer sought approval in the USA for a clothes washer energy label. Under the current requirements, the model would have to have been tested over 1,000 times to include all consumer programmable options!

3. Energy Labelling Programs

3.1 Label Styles in Common Use

A review of appliance energy labels from around the world shows that most countries have decided to adopt a comparison label using a scale with absolutely defined categories (see Section 2.2.2.1). The European Union, Australia, South Korea, Hong Kong and Thailand all have this kind of label.

Canada and the US have adopted labels with a common basic design with national variations. They use a comparison label with a continuous scale representing the actual range on the market (see Section 2.2.2.2), with an arrow indicating where the particular model falls within the range in its category of the market.

The Philippines label for air conditioners provide some product information and the energy-efficiency ratio (EER) of the model in large bold font. There is no information which allows comparison either with an absolute rating scale or with what is on the market.

Table 1: Overview of Energy Label Types

Country	Type of label	Comments
Canada	comparison: actual market range	scale shows range of models in size class
United States	comparison: actual market range	scale shows range of models in size class
Australia	comparison: absolute categories	categories from 1 to 6 stars (best)
South Korea	comparison: absolute categories	categories from 5 to 1 (best)
Hong Kong	comparison: absolute categories	categories from 5 to 1 (best)
European Union	comparison: absolute categories	categories from G to A (best)
Thailand	comparison: absolute categories	categories from 1 to 5 (best)
Philippines	energy performance data (no comparison)	shows EER of air conditioner only

Analysis of comparison labels shows that there are just a few basic designs in use around the world. These can be grouped into three basic types as follows:

Australian Style Label: This type of label tends to have a square/rectangular base with a semi-circle or "dial" across the top. The "dial" resembles a speedo or gauge, with the concept that the further advanced the gauge in the clockwise direction, the better the product. This type of label is used in Australia, Thailand, and South Korea. The number of stars or the "grading" numeral on the scale depends on the highest preset threshold for energy performance which the model is able to meet.

European Style Label: This type of label is a vertical rectangle with letters ranging from A (best) near the top of the label to G (worst) at the bottom. There is a bar next to each letter: eg short and green for A and long and red for G. All 7 grade bars are visible on every label. The grade of the model which is labelled is indicated by a black arrow marker located next to the appropriate bar (eg for a C grade product the marker carries the letter C and is positioned against the C bar). Because of EU language requirements the label is in two parts. The right hand part carrying the data is non-language-specific and tends to be affixed or supplied with the appliance at the point of manufacture, while the left hand part carrying the explanatory text is language-specific, and tends to be supplied and affixed in the country of sale. This label is used throughout Western Europe and parts of Eastern Europe (there are some local variants here). Iran has a variant of the European Style label which is a mirror image, because of the direction of script, and uses numerals rather than Roman script letters for the gradings: ie 1 (best) to 7 (worst).

US Style Label: This rectangular label shows energy operating cost (based on a stated notional energy tariff). It also has a linear scale indicating the highest and lowest energy use of models on the market, and locates the specific model on that scale according to its energy use. This type of label is used in USA and Canada. These labels are now technically (if not visually) harmonised.

Variants: There are a number of variants or hybrids of the above three types:

- Hong Kong uses a label which is a similar shape to the European label, but there are five efficiency grades (1 to 5) and only the grade achieved is shown.
- Mexican and South American labels are similar in concept to the European labels, but the details are quite different.
- The proposed Indonesian label shows stars for efficiency (5 = best, 1 = worst - these are in a straight line - there is no dial) and relative energy consumption on a continuous scale - this is a hybrid of US and Australian style labels.
- Philippines is not like any other label as there is no comparison data.

3.2 Energy Labelling Programs Around the World

This section provides some limited information on energy labelling programs in operation in different parts of the world. It is not an exhaustive list, but provides examples from some of the larger and better known programs. A sample label is shown for each country.

3.2.1 Energy Star

The Energy Star endorsement label was launched in 1992 by the US Environmental Protection Agency (EPA). It originally covered only computers, monitors and printers, but has now expanded to include fax machines and photocopiers, heating, ventilation, and air-conditioning equipment, and more recently, refrigerators and other appliances in the USA. The program is administered by the Global Climate Change Division of the EPA, which now has over 100 staff in the energy area, mainly working on energy efficiency programs.

During the development of the Energy Star program, the EPA quickly found that the market for information technology was global rather than national. This necessitated discussions with major computer and office equipment manufacturers around the world. EPA now has formal government to government arrangements regarding Energy Star in Japan and Europe, and various levels of involvement from other countries. For example, SEDA has an agreement with the EPA to promote Energy Star for office equipment in Australia.

Although the Energy Star logo for office equipment is now effectively global, the use of the logo for other products is still confined to North America. The power management standards which office equipment meet to qualify for the logo are simple, and since they were set in 1992, now fairly lenient. The standards are being reviewed, and the program is concentrating on increasing the probability that products reach the consumer with power management actually enabled and that consumers use the capability to best advantage.

Program Summary:
Implementing Agency: US Environmental Protection Agency with various international partners, including Europe and Japan.
Program Type: endorsement, voluntary.
Appliances Labelled: office equipment, heating, ventilation, and air-conditioning equipment, recently refrigerators and other appliances in the USA.
Date Labelling Commenced: 1992

Primary Colours: blue (ocean) and green (land) part globe, yellow writing
Eligibility: specified energy consumption in standby mode (office equipment) or during use (other equipment).
Approximate Dimensions: size varies, typically 30mm high, 60mm wide

Figure 1: Energy Star label

3.2.2 Swiss E2000 Label

The European E2000 label is an endorsement program set up by the Swiss Federal Office of Energy. It primarily applies to office equipment, televisions and video cassette recorders (VCRs) and complements their Target Value program. Each year, a new energy performance level for endorsement eligibility is declared and manufacturers are invited to nominate eligible equipment for endorsement. Equipment which complies with the current level is entitled to carry the E2000 label once an agreement on the use of the label has been signed. The label carries the year of compliance. The performance level is selected so that about 20% to 30% of products on the market are eligible for a label in that year. SFOE has now licenced the label for use in various European countries. The label is now widely used in Germany for all products (including office equipment) and also in Denmark, Austria,

Finland, Sweden and Netherlands for TVs and VCRs. More information can be found at www.energeavia.org

Program Summary:
Implementing Agency: Swiss Federal Office of Energy.
Program Type: endorsement, voluntary.
Appliances Labelled: office equipment, TVs, VCRs.
Date Labelling Commenced: 1993.
Primary Colours: Red/yellow lighting bolt, blue grid, black writing, yellow background.
Eligibility: specified energy consumption in standby mode to include top 20% to 30% of market in year.
Approximate Dimensions: 60mm high, 30mm wide.

Figure 2: Swiss E2000 label

3.2.3 Australia

Energy labelling for major electric appliances in Australia was first proposed in the late 1970s, by the State governments in New South Wales (NSW) and Victoria (the two largest of Australia's six states and two territories). When the NSW government first raised the matter with the appliance industry in 1982, there was considerable resistance, on the grounds that any program should be uniform nationally rather than risk different State approaches, and that it should be voluntary rather than mandatory.

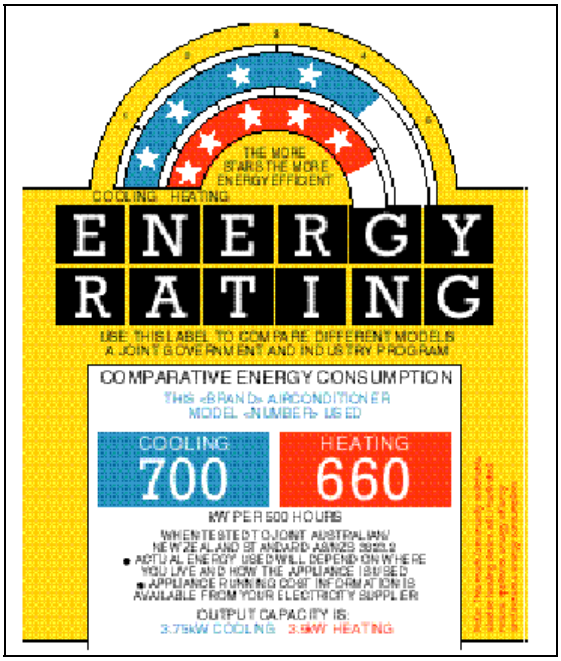
In order the ensure national uniformity, the NSW government referred the matter to the joint Commonwealth-States council of energy ministers. Despite three years of negotiation, government and industry could not agree on a mutually satisfactory voluntary labelling program. Finally, the NSW and Victorian state governments announced in late 1985 they would make energy labelling mandatory in those States. NSW and Victoria account for some 60% of the national appliance market, so the bilateral scheme became a de-facto national program.

Energy labelling for refrigerators and freezers became mandatory in late 1986. In 1987 and 1988, room air conditioners and dishwashers were included in the regulations. After a change of government in NSW in 1988, Victoria pressed on alone with labelling for clothes dryers in 1989 and clothes washers in 1990. In 1991, the State of South Australia introduced labelling regulations for all 5 major appliances.

By 1993 most of the remaining States and Territories had energy labelling regulations in force, finally giving formal nationwide backing for a program which has effectively been in place for 10 years. Major manufacturers and importers now recognise the commercial value of energy labelling, and are generally very supportive of the program. The label is also used by New Zealand, but on a voluntary basis.

The Australian Gas Association (AGA) has members from both the gas utility sector and gas appliance manufacturers. The AGA has promoted various forms of energy efficiency labelling for flued gas space heaters and gas water heaters (both storage

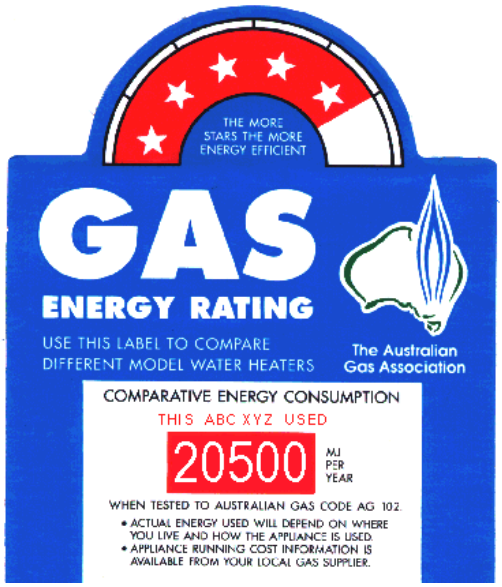
and instantaneous) since the early 1980s (Orlowski 1990). In 1988 the AGA introduced labels similar in format to those for electrical appliances, except blue in colour and with energy shown in MJ. The gas labelling program has been voluntary until recently and the level of compliance has varied considerably from state to state.



Program Summary - Electric:
Implementing Agency: State and Territory Governments.
Program Type: comparative label, mandatory.
Appliances Labelled: refrigerators, freezers, dishwashers, clothes washers, clothes dryers.
Date Labelling Commenced: 1986
Primary Colours: electric: yellow, red (dial), black and white (blue A/C cooling).
Rating System: energy (generally kWh/year), 1 to 6 stars (6 best).
Approximate Dimensions: 110mm high, 90mm wide.

Figure 3: Australian air conditioner energy label

The AGA has now made labelling of all units a requirement for technical approval. This effectively makes the collection of data required to produce a label mandatory, since the AGA is responsible for the entire gas industry including utilities, local appliance manufacturers and importers. However, some labels are either not affixed by manufacturers or appear to be removed at the point of sale (Harrington and Wilkenfeld, 1997).



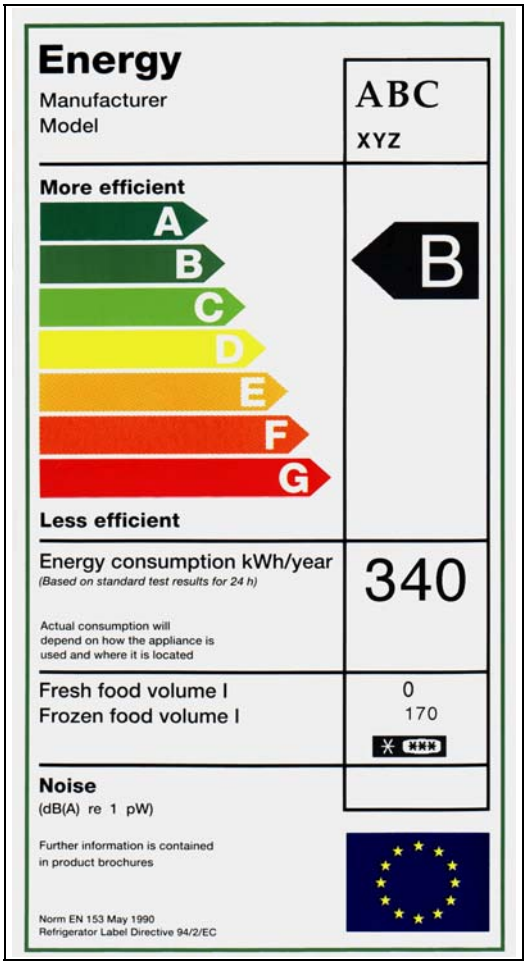
Program Summary - Gas:
Implementing Agency: Australian Gas Association
Program Type: comparative label, voluntary
Appliances Labelled: gas water heaters, gas space heaters, gas central heaters.
Date Labelling Commenced: early 1980's: current label format adopted 1988
Primary Colours: gas: blue, red (dial), white and black
Rating System: energy (MJ/year), 1 to 6 stars (6 best)
Approximate Dimensions: 115mm high, 95mm wide

Figure 4: Australian gas water heater label

3.2.4 Europe

The European Commission issued a generalised energy labelling Directive in 1992 (92/75/EEC, 1992) which granted it authority to issue energy labelling implementation directives for "cold appliances" (refrigerators, freezers and combinations), clothes washers, clothes dryers, dishwashers, ovens, water-heaters, lighting sources, and air conditioning appliances. Other household appliances can be added to this list if significant energy savings can be identified. Details of the current program and status by appliance can be found in Appendix A.

Prior to this directive, there had been a patchwork of programs and directives in various European countries through the 1970s and 1980s, but no European wide system had been implemented. Details of the various early labelling efforts can be found in various reference included in this report.



Program Summary:
Implementing Agency: Central directive through European Commission, Brussels with national legislation for implementation.
Program Type: comparative label, mandatory.
Appliances Labelled: refrigerators, freezers, clothes washers, clothes dryers, combination washer-dryers, dishwashers, lamps.
Date Labelling Commenced: 1994 (progressive).
Primary Colours: white background, black writing, green to red rating scale.
Rating System: energy (kWh/year or per cycle), efficiency rating A to G (A best).
Approximate Dimensions: 250mm high, 110mm wide.

Figure 5: European refrigerator energy label

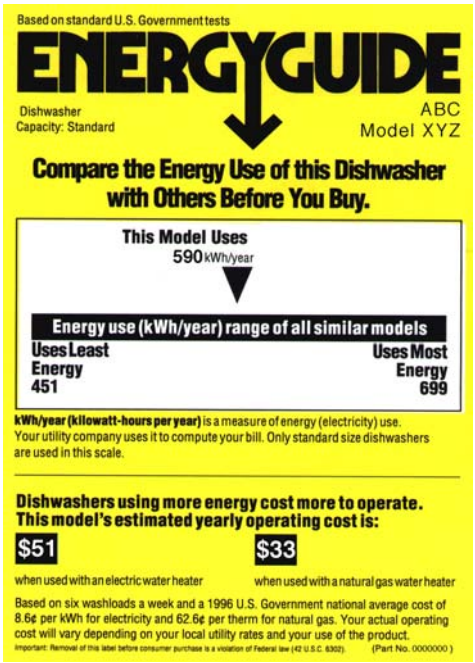
Since 1992 implementation labelling directives have been issued for cold appliances (92/2/EC, passed 21 January 1994, effective 1 January 1995), clothes-washers and clothes dryers (95/12/EC and 95/13/EC, both passed 23 May 1995, both effective from 1 April 1996), combination washer-dryers (96/60/EC, passed 19 September 1996, effective from 31 January 1998) and dishwashers (97/17/EC, passed 16 April

1997). The implementation date for the dishwasher directive has been delayed until the end of 1998. The dishwasher test standard (EN50242) also has to be finalised before then. An energy labelling directive for household lamps was approved on 27 January 1998 and will soon be published in the Official Journal of the European Communities. Studies are under way to assess the technical basis of defining energy labels for electric storage water-heaters and air-conditioners. A study which defines a methodology for the energy labelling of commercial refrigerated- and frozen-foodstuffs storage cabinets has been completed.

3.2.5 USA

The National Energy Policy and Conservation Act of 1978 required the Federal Trade Commission (FTC) to mandate labels for appliances that indicate their energy consumption. The label was developed in 1979 with minimal consumer involvement. The FTC issued guidelines for the label in a rule promulgated in November 1979. This required manufacturers of the seven major home appliance types to place energy labels on their appliances from mid-1980.

The label originally showed only the annual cost of operation with no direct indication of energy consumption. In 1994, the FTC issued a final rule that revised the EnergyGuide labels (FTC 1994). The change was intended to deal with problems that arose when national average electricity price changed from year to year. On the basis of shopping centre interviews with 120 consumers in early 1991, and a Canadian study that recommended using energy consumption rather than dollars, the FTC decided to revise the EnergyGuide label so that annual energy use (in kWh) rather than average



Program Summary
Implementing Agency: Federal Trade Commission (Department of Energy).
Program Type: comparative label, mandatory.
Appliances Labelled: furnaces, refrigerators, refrigerator-freezers, freezers, water heaters (electric, gas, oil), clothes washers, dishwashers, room air conditioners, central air conditioners, heat pumps.
Date Labelling Commenced: 1980.
Primary Colours: yellow background, white insert, black writing.
Rating System: energy (kWh/year), lowest & highest energy for similar products.
Approximate Dimensions: 190mm high, 135mm wide.

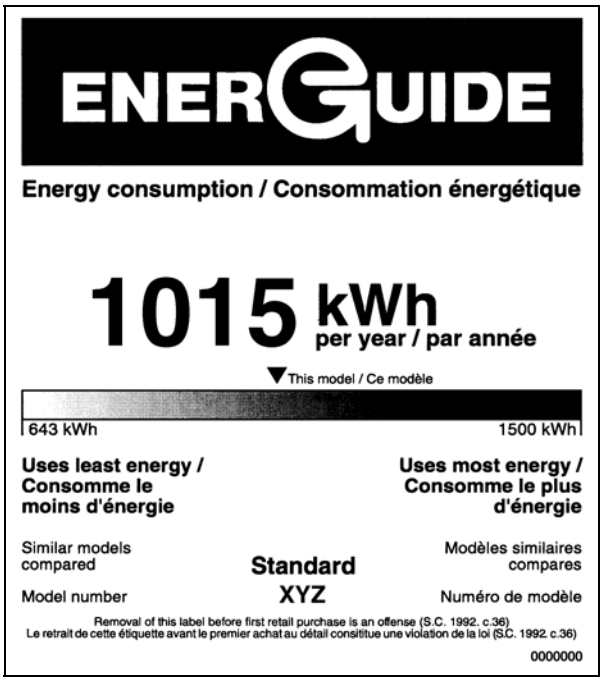
Figure 6: Current US dishwasher label

Annual operating cost is the main comparative indicator.

In summary, the US appliance energy labelling program is the longest running US Federal energy efficiency program and one of the older energy labelling programs in the world. The labelling program is generally seen as having some impact and as being integral to the overall US effort of testing, labelling, and standards. To date, however, there has been no effort to quantify the energy impact of the EnergyGuide labelling program.

3.2.6 Canada

Energy labelling in Canada is a national program administered by Natural Resources Canada and it applies to products shipped between provinces or imported products (NRC 1996). It commenced operation in 1978 and is now administered under the national *Energy Efficiency Act* and the *Energy Efficiency Regulations*. The Canadian system now the oldest appliance energy labelling program in existence. The range of products labelled is similar to but slightly more extensive than that the USA. There are extensive labelling guides for purchasers, listing all available models on the market. Separate guides are available for major appliances, air conditioners and office equipment.



Program Summary
Implementing Agency: Natural Resources Canada.
Program Type: comparative label, mandatory.
Appliances Labelled: clothes dryers, clothes washers, washer-dryers, dishwashers, electric ranges, freezers, refrigerators, room air conditioners.
Date Labelling Commenced: 1978.
Primary Colours: white background, black writing.
Rating System: energy (kWh/year), lowest & highest energy for similar products.
Approximate Dimensions: 150mm high, 130mm wide.

Figure 7: Canadian dishwasher label

3.2.7 Korea

Korea's effort to promote energy efficiency and conservation was triggered by the two oil crises of the 1970s. Korea, which has to import virtually all of its energy, faced the challenge of high energy prices and unstable supply. To overcome this the government developed energy efficiency and conservation policies while endeavouring to secure energy supplies. In Korea, the rapid growth in GNP has resulted in a corresponding increase in energy demand, more or less at the same rate

as GNP growth of about 8% per annum. Imported energy requirements are over 95% in 1995. Major energy sources include fuel oil, coal, nuclear, and LNG.

In 1978 the Ministry of Energy & Resources was established and in 1980 the Korean Energy Management Corporation (KEMCO) was founded to implement energy efficiency and conservation programs. In addition, the government promulgated the "Rationalization of Energy Utilization Act" in 1980 to serve as a basic law for energy efficiency and conservation (MTIE 1997).

In 1992 the Rationalization of Energy Utilization Act was amended to include energy labelling programs for freezers, refrigerators, room air conditioners, fluorescent lamps, fluorescent ballasts, incandescent lamps and passenger vehicles. The following appliances are being considered for labelling in the future ; clothes washers, ovens, rice cookers, compact fluorescent lamps, electric radiant heaters and electric water heaters.

Based on the Rational Energy Utilization Act of 1979, the following products are designated as "Efficiency-indicated Equipment": the law requires that the measured efficiency of certain other equipment types must be declared on those products offered for sale. These products include steel boilers, cast iron boilers, hot water boilers, oil fuelled heaters, LPG instantaneous water heaters, LNG fuelled water heaters and LPG fuelled hot water boilers.

Program Summary
Implementing Agency: Ministry of Trade, Industry & Energy.
Program Type: comparative label, mandatory
Appliances Labelled: freezers, refrigerators, room air conditioners, fluorescent lamps, fluorescent ballasts, incandescent lamps.
Date Labelling Commenced: 1992.
Primary Colours: yellow & white background, red (dial), black writing.
Rating System: energy (kWh/month), efficiency rating 5 to 1 (1 best).
Approximate Dimensions: 85mm high, 60mm wide (AC and RF, lighting labels are smaller).

Figure 8: Korean refrigerator label

3.2.8 Thailand

Appliance energy labelling in Thailand is a little unusual in comparison to most labelling programs in that it is operated by the electricity utility (Electricity Generating Authority of Thailand - EGAT) and it is a voluntary program. The energy labelling project has been approved by the Thai government and is incorporated into the utility's Demand Side Management (DSM) Program. The program is supported by a very high profile publicity campaign to raise public awareness of energy labels and energy efficiency. Refrigerators in the size range 150 to 200 litres are covered:

this constitutes the bulk of sales in Thailand. Air conditioners in the range 2 kW to 7 kW cooling capacity are covered - both split systems and unitary systems (window/wall). EGAT has secured the voluntary participation of the 5 local refrigerator manufacturers and 55 local air conditioner manufacturers (Salisdisouk, 1997).

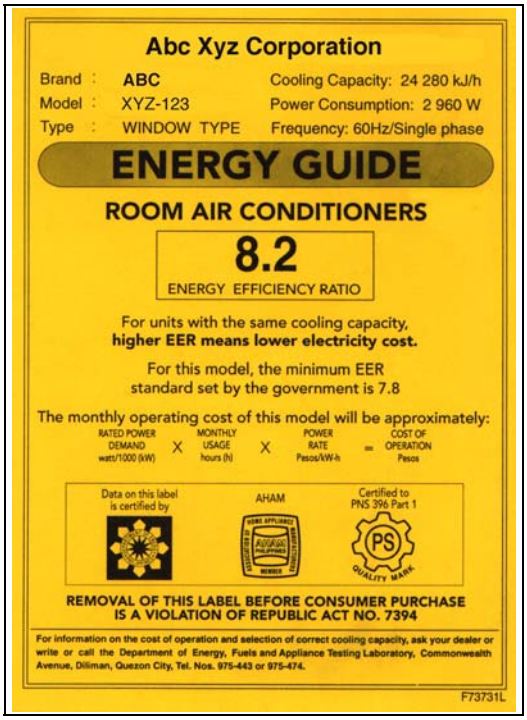
Program Summary
Implementing Agency: Electricity Generating Authority of Thailand (EGAT).
Program Type: comparative label, voluntary.
Appliances Labelled: refrigerators, room air conditioners.
Date Labelling Commenced: 1995
Primary Colours: yellow & green background, red & green dial, black writing.
Rating System: RF kWh/year, AC power, efficiency rating 1 to 5 (5 best).
Approximate Dimensions: 130mm high, 100mm wide.

Figure 9: Thai air conditioner label

3.2.9 Philippines

In July 1992 the Bureau of Product Standards signed an agreement with the Association of Home Appliance Manufacturers (Philippines) for voluntary labelling of household air conditioners. In October 1993, this program became mandatory and by June 1994 had been expanded to cover all sizes of window/wall type air conditioners. From 1994, there has been a national information campaign to increase awareness and understanding of the label (Zabala 1997). Refrigerators, ballasts and clothes washers are also scheduled for energy labelling in the coming years.

The Philippines energy label is one of the few labels in the world that has neither categories of energy efficiency nor comparisons on a continuous scale. However, the label does show that unit's energy efficiency rating (EER: this is calculated from the coefficient of performance, or COP) as measured under the test standard. Consumers can use this information to compare products if they wish. The label also shows the minimum efficiency requirement (MEPS) for that size and type of air conditioner, which may give the consumer an additional clue regarding the efficiency of that model. (Note that the units used for cooling capacity are kJ per hour, for EER kJ per hour per Watt).



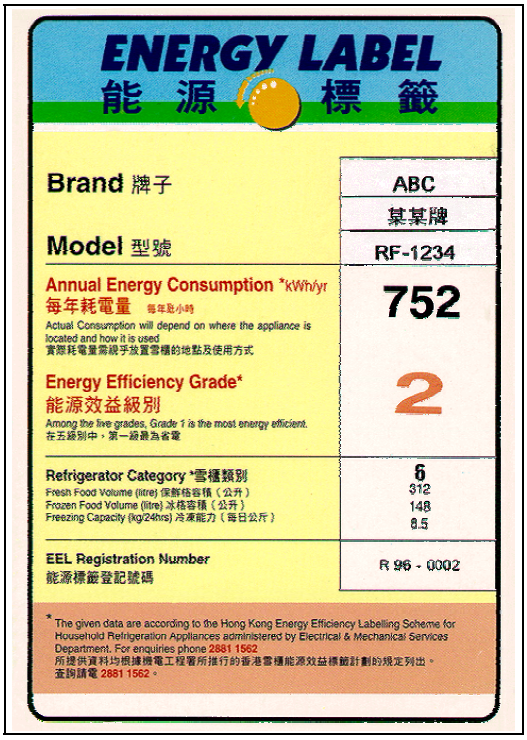
Program Summary
Implementing Agency: Department of Trade & Industry, with Department of Energy and the Fuels and Appliance Test Laboratory.
Program Type: comparative label, mandatory.
Appliances Labelled: room air conditioners.
Date Labelling Commenced: 1993.
Primary Colours: gold background, black writing.
Rating System: power (Watts), EER (kJ/hour/Watt), no categorical ratings.
Approximate Dimensions: 140mm high, 100mm wide.

Figure 10: Philippines air conditioner label

3.2.10 Hong Kong (China)

The energy labelling program for Hong Kong was set up in 1995 by the Electrical and Mechanical Services Department of the Hong Kong government. The government wished to avoid a regulatory framework for the program, so a voluntary program was instituted. The program has remained unaffected by the return of Hong Kong to China in 1997. The level of promotion of the scheme is modest and so far the participation rates are low (Cheng 1997).

The program covers refrigerators and air conditioners (which are by far the biggest residential electricity end uses in Hong Kong) and the labelling requirements specify ISO standards for energy consumption measurement. Although the data on the label is presented in a format which is similar to the European label, the colours and details are somewhat different. In particular, the range of possible efficiency grades is not shown, nor is this stated on the label.



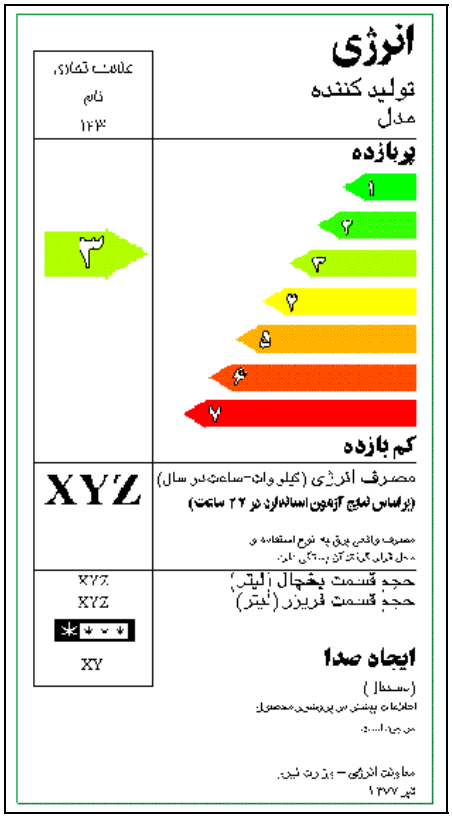
Program Summary
Implementing Agency: Electrical and Mechanical Services Department.
Program Type: comparative label, voluntary.
Appliances Labelled: refrigerators, room air conditioners.
Date Labelling Commenced: 1995.
Primary Colours: blue, orange, yellow and white background, black writing.
Rating System: energy (kWh/year), efficiency rating (grade) 5 to 1 (1 best).
Approximate Dimensions: 140mm high, 100mm wide.

Figure 11: Hong Kong refrigerator label

3.2.11 Iran

Iran has been developing an energy labelling program for refrigerators for some years. The intent of the program is to encourage local manufacturers to improve the efficiency of their products. At this stage, imports of refrigerators into Iran are rather restricted, although a number of local manufacturers have links with European companies with exports of limited volumes back into Europe. Market analysis of models available in 1997 has provided data which enabled the scheme to be developed (Heydari 1997). Two label configurations were considered during the development of the label - one based on a European design and one based on the Australian design, but with Persian text. In the end, the European design was chosen on the basis of existing market and manufacturer links into Europe (Heydari 1998). Interestingly, a test temperature of 32^{o}C has been recommended for the test procedure for energy consumption measurement, due to the hot climatic conditions.

The basis of the label has now been finalised and agreed with the Iranian government and is scheduled for implementation in April 1998. The use of Roman letters for grades in a middle eastern culture has little meaning so the label is graded from 1 (best) to 7 (worst). The text on the label is in Persian (Farsi) and is more or less a direct translation of the European refrigerator label, although the label set out is a mirror image of the European label. The label is expected to be in colour and similar in design to the European label, although the final details are yet to be announced. A black and white version as shown has also been proposed.



Program Summary
Implementing Agency: Standards and Industrial Research Organisation, Iran.
Program Type: comparative label, mandatory.
Appliances Labelled: refrigerators.
Date Labelling Commenced: April 1998.
Primary Colours: to be finalised, probably red-green like European label, possibly a black and white version as well.
Rating System: energy (kWh/year), efficiency rating (grade) 7 to 1 (1 best)
Approximate Dimensions: 250mm high, 110mm wide.

Figure 12: Iranian refrigerator label

3.2.12 Eastern Europe

Most Eastern European countries now use the European energy label in some form or another, usually with a local language template which is used in conjunction with the non-language data section of the label. Some countries also include additional information on the label. Few of the Eastern European countries have an effective mandatory program, although many are trying to harmonise as far as possible.

3.2.13 Israel

Israel is known to have some form of appliance energy labelling program, but no details are yet available.

3.2.14 South America

Chile introduced an energy labelling program for refrigerators in 1992. Since that time refrigerator energy labels have also been introduced for Argentina and Brazil (in 1997). Details of the programs are not yet available, but the label designs are said to be based on the European concept (Moreira, 1997).

3.2.15 Mexico

Mexico has an energy labelling program for air conditioners and refrigerators. Information recently received is in Spanish and a translation is not yet available. The label is in colour and the design is similar in concept to the European label, but the details are quite different.

Figure 13: Mexican air conditioner label

3.3 Proposed Labels

This section outlines a number of proposed energy labelling schemes.

3.3.1 Indonesia

Indonesia has been actively working on an energy label for refrigerators since 1996. The concept label has been finalised and the scheme, developed by the Centre for Energy Studies at the University of Indonesia, has been forwarded to the Indonesian Government for their consideration (Rinaldy 1998).

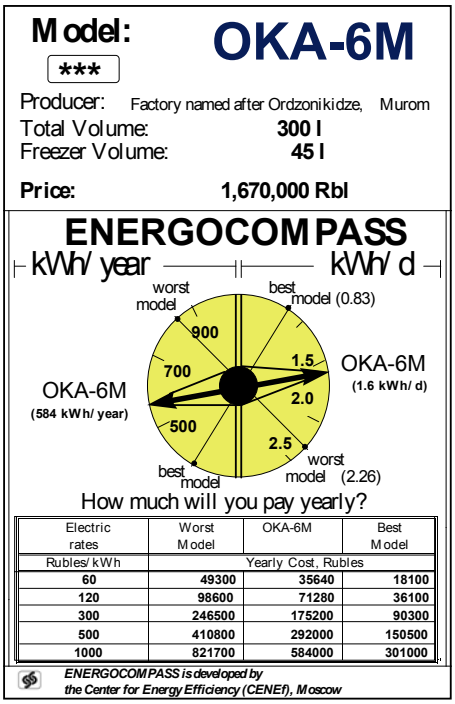
The label shows stars for efficiency (5 = best, 1 = worst - these are in a straight line - there is no dial) and relative energy consumption on a continuous scale - this is a hybrid of US and Australian style labels.

Figure 14: Proposed refrigerator label for Indonesia

3.3.2 Taiwan

Taiwan is said to be considering an energy labelling program to cover clothes washers and refrigerators, although details are not yet available.

3.3.3 Russia



Electric rates	Worst Model	OKA-6M	Best Model
Rubles/ kWh	Yearly Cost, Rubles		
60	49300	35640	18100
120	98600	71280	36100
300	246500	175200	90300
500	410800	292000	150500
1000	821700	584000	301000

In 1994, the Center for Energy Efficiency (CENEF) in Moscow developed a concept for an energy label for refrigerators. It is understood that this label has not yet been adopted in Russia and it appears more likely that a European version of an energy label for refrigerators may be adopted. The proposed CENEF label shows energy consumption per day and per year, together with a relative rating of best and worst (similar in concept to the US label, but using a circular format). Given the huge variation in energy prices in Russia and the rapid inflation, a grid to determine operating cost has been included for a very wide range of tariffs. The original label is of course in Cyrillic script - an English version is shown here.

Figure 15: Proposed refrigerator label for Russia

3.3.4 India

India is actively developing an appliance energy labelling program for water heaters, refrigerators and air conditioners. Details are still being negotiated between government and appliance manufacturers. Details may not be known until 1999.

3.4 Guides and Other Labelling Related Activities

This section provides a brief overview of energy labelling support activities.

3.4.1 Europe

Although Denmark did not had a program of energy labelling for appliances until the EC labels were introduced, they did have a system of providing comprehensive lists of appliances with their energy consumption since about 1950. These lists were compiled by the Association of Danish Electricity Utilities and their format was refined over the years. The appliances are grouped into categories, with separate lists for each type.

More recently, product listings and a database of appliances have been available on the World Wide Web through the site www.spareskab.dk which is compiled by

ELDA, who is contracted to operate the database. This database system is now used extensively on contract by other European countries through their information centres. The system allows information such as bar charts, life time costs and energy consumption to be sorted and tailored for local consumers in different parts of Europe.

The Netherlands also traditionally had lists of appliances and their comparative energy consumption, even before energy labelling in Europe. These lists were prepared by "EnergyNet" and made available to consumers and energy information centres in the Netherlands. EnergyNet is the Association of Energy Distributors in the Netherlands.
Appliance energy brochures are updated annually and are available in Dutch.

3.4.2 USA

There are three main sources of appliance energy guides in the USA.

3.4.2.1 ACEEE

The American Council for an Energy Efficient Economy (ACEEE) is a non profit group based in the USA that performs a wide range of research and analysis to promote the economic realisation of energy efficiency, both in the USA and around the world. They also play a very active political role both at the federal and state level in the USA. The ACEEE publishes annually a Guide to the most efficient appliance in the USA. The Guide covers the most efficient 5% or so of model available in the USA (generally only those models which are mass produced and widely available). The Guide only covers labelled appliances covered under the US energy labelling program. ACEEE also publish a Consumer Guide to Home Energy Savings.

3.4.2.2 California Energy Commission

The California Energy Commission has a web site which shows appliance energy data for a vast number of models in the USA. The site is interactive and allows consumer queries to be processed. See www.energy.ca.gov for more details.

3.4.2.3 AHAM

The Association of Appliance Manufacturers (USA) publishes lists of certified models (AHAM 1997). The 1st edition was January 1997. The listings are a summary of all models that have had their details such as volume and capacity certified by AHAM. The listing also shows detailed information by model such as kWh/year and annual operating cost (as per the energy label). Models are generally sorted by Brand and size. Certified listings are available for refrigerators and freezers, air conditioners and de-humidifiers.

3.4.3 Australia

Lists of current models on the market together with their energy labelling details (energy and star rating) are compiled annually in Australia, based on energy labelling registrations. The lists also show 10 year energy operating costs based on average national tariffs. Most Australian state governments now jointly print these brochures and distribute them to local retailers. The energy labelling lists of appliances in Australia can now also be found on the Internet at http://netenergy.dpie.gov.au

3.4.4 Philippines

The Philippines produces a large glossy "Guide to Energy Savings" which outlines in detail the different aspects of the Philippines air conditioner label and shows examples of how to calculate energy consumption and annual operating costs. The brochure also provides some technical details of the labelling program (eg test standards, implementation timetable) and provides sources of advice regarding correct sizing of an air conditioner and tips on how to operate the appliance in an optimal manner.

4. Evaluation of Energy Labelling Programs

4.1 Overview of Evaluation Approaches

It is not possible to directly measure the energy impact of energy labelling programs. The market changes brought about by labelling are relatively subtle, and are characterised by a gradual divergence between a "business as usual" trend line and a "with labelling" trend line. However, it is possible to build a conceptual (and hence a computer) model of the impact of labelling on consumer and supplier behaviour, and use it to estimate program impacts indirectly.

A typical reason for carrying out program evaluations is to try to determine whether it would be cost-effective to allocate more resources to them. For energy labelling, this is made more difficult by the complex relationship between the "fixed" aspects of the program (eg the label registrations and administration), the "variable" resources expended (eg annual advertising budgets), and the buyer and supplier response.

Nevertheless it is possible to build up a picture of buyer response by measuring the following factors over time, using market research techniques:

1. Priority given to energy in appliance choice. If consumers are unconcerned with energy for cost or environmental reasons, there is no point affixing energy labels. However, the appearance of the label on products itself helps promote this concern. When recent and intending appliance buyers in Australia were surveyed on the ranking they gave to star rating in their purchase criteria, the average ranking when unprompted was 11th. However, when the interviewer "prompted" them by reminding them about energy labelling (as the label itself would prompt them in the showroom) the average ranking increased to 4th (GWA et al 1993b).

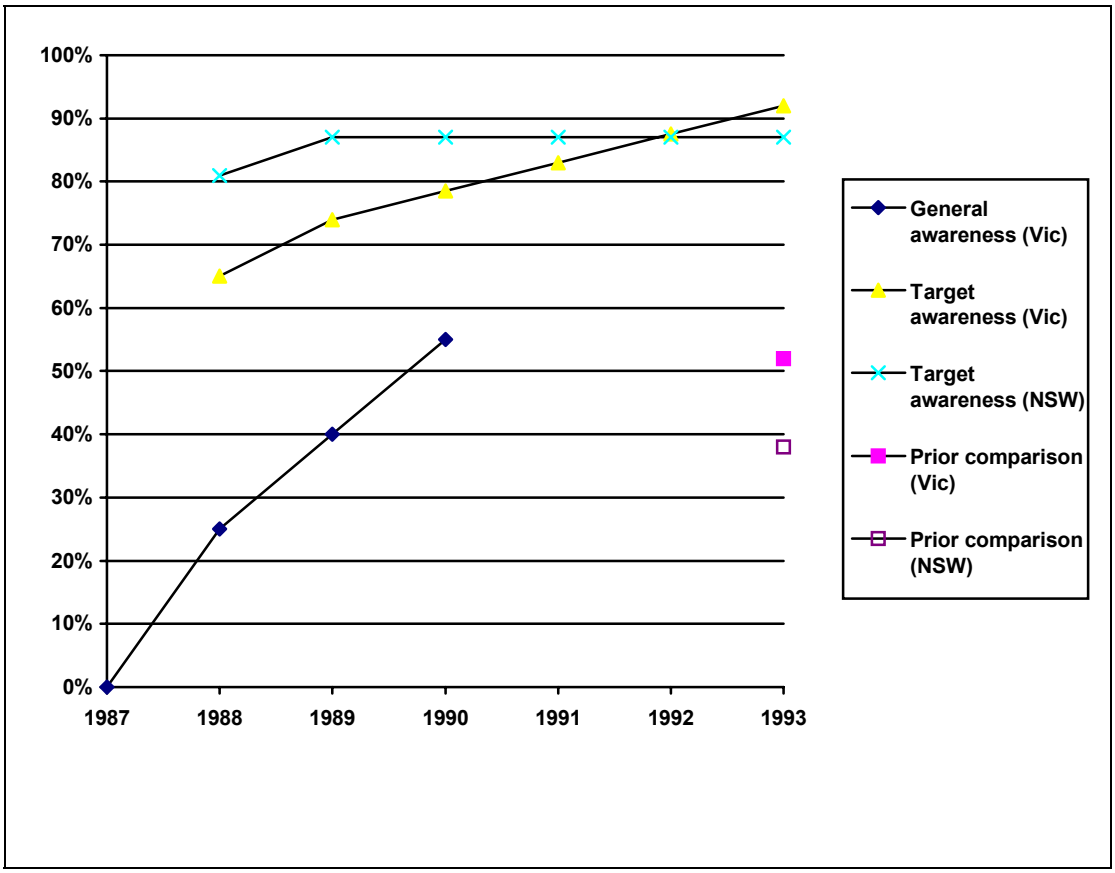
2. General awareness of energy labelling among the public. The trend for Victoria over the period 1987 to 1990 in shown in Figure 16.

3. Target audience awareness. Whatever the level of general awareness, it is more important that people who are actually in the process of buying an appliance are aware of energy labelling. Figure 16 shows that in 1988 awareness among recent and intending refrigerator buyers in NSW was 82% (within 2 years of the introduction if labelling in that State) and in Victoria it was 65% (within a year of introduction in that State). By the time of the last such survey, in 1993, 91% of Victorian appliance buyers and 87% of NSW buyers were label aware. The fact that awareness in Victoria overtook NSW is almost certainly due to the higher level of publicity support given to energy labelling in that State in the period 1989 to 1993.

4. Stated propensity to use the label in the purchase decision. When surveyed in 1993, some 52% of recent and intending appliance buyers in Victoria *said* that they had used or intended to use the information on the energy label in making their purchase. In NSW it was 38% (see Figure 16).

5. Extent of actual use. There have been no market surveys in Australia of the actual extent of use of labels. This is logistically very difficult since it would require the researcher to ask the buyer a number of key questions at, or very soon after the time of purchase, before recall fades and post-justification sets in: eg when did energy became an explicit factor in the search process, what specific models were short-listed and their price, star rating and other important features? Such information could in theory be obtained through simulated shopping experiments[3], but for practical purposes, it is not directly measurable, and needs to be inferred from other data. For example, dividing the total estimated energy "saved" by the program by the number of "label-aware" appliance purchases over the same period will yield an average kWh/yr saved in each label-aware purchase decision.

Figure 16: Trends in Consumer Awareness and Use of Energy Labels



4.2 Process Evaluations

"Process" evaluations are studies of the links needed to make labelling work: physical elements (eg the proportion of models displayed for sale which carry labels), program integrity (eg the proportion of labels which are found to be incorrect) and the buyer response steps described above.

[3] Simulated shopping may not be representative for some customers, as money "spent" is only fictitious (there is little risk so consumers may be less conservative than normal in their decisions).

4.2.1 Review of Past Label Evaluations

While a number of studies has examined consumer preferences and understanding of labels, most of these studies have been conducted in research settings, or via phone or mail surveys. Few have assessed consumer understanding of labels directly in the store environment. Most prior evaluations of energy labelling programs show a high level of awareness (Pirkey et al. 1982, Dyer and Maronick 1988, Hill and Larsen 1990, GFCV 1991). Generally, consumer awareness tends to increase over the life of the labelling program, and the vast majority of shoppers are aware of labels after they have visited the store to make a purchase. The following sections focus on consumer understanding, or cognition; and the extent to which labels have been linked to changes in consumer purchasing where this can be quantified.

Energy efficiency is generally low on the list of priorities for consumers purchasing appliances (excluding air conditioners). Studies in the US have found that energy efficiency is ranked as the fifth, sixth or seventh priority (Dyer and Maronick 1988, Brown and Whiting 1996). Studies in Australia and the UK have found energy efficiency to be a higher consumer priorities for some appliances (GFCV 1991, Strang 1996), but there is usually a big difference between prompted and unprompted responses.

4.2.2 Consumer Evaluations of the US Label

4.2.2.1 Background

The US labelling program is the longest-running US Federal energy efficiency program. It is generally seen as having some impact and as being integral to the overall US effort of testing, labelling, and standards.[4] To date, however, there has been no effort to quantify the energy impact of the EnergyGuide labelling program, nor any definitive study to demonstrate the labels' effectiveness (du Pont 1998). In fact, several studies have raised questions about the labels and consumers' ability to accurately comprehend their content. (Carswell 1989, BPA 1988)

The Dyer and Maronick (1988) study is the only complete evaluation of the effectiveness of the EnergyGuide labelling program. It consisted of a longitudinal series of three national samples of recent purchasers of refrigerators and clothes washers. The design was a quasi-experimental pre-post test design with an intervening experimental treatment which centred around the introduction of the EnergyGuide labels in 1980. The study was conducted in three "waves": a baseline in April-May 1979 (n=725); a first postwave in April-May 1982 (n=559); and a second postwave in April-May 1983 (n=573).

After the labelling program was initiated, energy efficiency ranked 6th as a consumer priority for clothes washers and 5th for refrigerators. Roughly half of the purchasers (45.2% for washers and 56.6% for refrigerators) were aware of the labels when asked afterward. One-third of the "label aware" washer buyers and roughly half of the

[4] Du Pont draws this conclusion on the basis of his interviews with U.S. policymakers.

"label aware" refrigerator buyers said that the label information affected their purchase in some way; however, a much smaller proportion of the label-aware buyers (11.1% for washers and 6.4% for refrigerators) said that they used the label for comparison purposes. Dyer and Maronick (1988) concluded that refrigerator purchasers seemed to be more aware of the labels than did purchasers of washing machines and also tended to rely on the labels to a greater extent in their purchase decisions.

The study did not show how much of an effect the label had on the purchase decision. The labels helped to increase consumer awareness, but it was not clear whether they actually affected the purchase decision directly. There are no known studies in the USA that have explicitly linked the EnergyGuide label with the decision to purchase a more energy-efficient appliance.

4.2.2.2 Detailed Interpretation of the US Label

Du Pont (1998)[5] conducted a comparative study of consumer attitudes in the purchase of appliances. The study assessed how consumers gather consumer information, how they prioritise when they shop, and what role energy efficiency plays in the purchase of home appliances. Some of his key results are summarised below. In the US, semi-structured interviews with 100 US consumers were conducted at four appliance stores in New Jersey and Delaware in March, November and December 1996 and January 1997. Du Pont also conducted participant observations by working as a sales trainee at a New Jersey branch of Acme Appliances, a regional appliance chain for two weeks in December 1996.

Table 2: Unprompted Purchase Decision Criteria in the US

Criterion (n=100)	% frequency listed among top 3
Price	63%
Features	55%
Size	41%
Quality	37%
Brand	31%
Colour	19%
Guarantee	13%
Delivery/Availability	13%
Efficiency	11%
Financing	3%
Other	6%

[a] Refrigerator-freezers were the main type of appliance purchased, and roughly half of the respondents purchased this type. Source Du Pont (1998).

Price, quality, size features and brand were by far the most commonly reported factors in the US. There also appears to be a second tier of decision criteria that are important in a smaller number of cases. These criteria relate less to the actual product

[5] "Energy Policy And Consumer Reality: The Role Of Energy In The Purchase Of Household Appliances In The U.S. And Thailand." Ph.D. Dissertation (draft), University of Delaware. March 1998.

itself than to the conditions under which the product is purchased: guarantee, financing, delivery/ availability. During customer observations in the US, du Pont noticed that these factors would often tilt the scale toward the purchase of a particular model.

In terms of consumer energy policy, the most important result from this study of priorities is that energy efficiency was not among the top-three criteria. It was ranked as the 9th priority for US consumers. Only one in 9 US consumers (11%) ranked efficiency within their top-three priorities (all unprompted).

In order to test consumer cognition of the label, a short section was added to the interview protocol in which respondents were asked to describe, in their own words, the meaning of two sample EnergyGuide labels, the old label and the new label introduced after a 1994 ruling by the Federal Trade Commission. This allowed the measurement of the length of time it took the consumer to understand each label as well as the extent to which they were able to accurately interpret the different aspects of information presented on the label: operating cost, efficiency, scale of energy use, and the table showing operating costs at different energy prices (for the old label only).
The findings are as follows:

Time. The level of detail on the EnergyGuide label was a turn-off to consumers, many of whom would not normally spend the time in an actual sales situation to try to understand it. The average consumer took more than 40 seconds to even grasp a basic meaning of the label.

Operating Cost. One-quarter of respondents (24%) could not use the label to determine the annual operating cost of the unit, and another one in six needed assistance to do so.

Relative Energy Use. One-third (32%) of respondents were not able to interpret the scale of relative energy use on the label, and one-quarter (24%) only had a partial understanding of the scale. For example, many consumers thought the scale showed the relative energy use for just a single model, or for one brand of models.

kWh/Cost Table. More than two-fifths of the consumers were unable to correctly interpret the table showing annual operating costs and different kWh rates, which is meant to assist consumers in determining the cost to operate the appliance in their particular service area (see the old US energy label).

Interpretation as Savings. One of the biggest flaws on the old label is the lack of clear labelling of the elements. This was borne out in discussions with consumers about the meaning of the large dollar figure on the label. Nearly one-third of the respondents (32%) thought that the dollar number referred to the amount that the consumer would *save* each year rather than the annual operating costs. Even after extensive prompting (to stimulate a closer look at the label and to get consumers to read the fine print more carefully), nearly one-quarter of respondents (24%) still believed that the label showed *savings*!

4.2.2.3 Old Label Vs. New Label

Since the US redesigned its EnergyGuide label (FTC 1994), the old label is being phased out, and in US appliance stores in 1997, there were about equal numbers of models with the old and new labels. A majority of consumers surveyed by du Pont (1998) said that the new label was easier to understand. The factors that contributed to this were the simpler design, and the greater prominence and clarity of the scale of relative energy use.

However, many respondents appeared confused by energy units (kWh) and expressed a preference for having dollars as a comparative measure. Du Pont also showed sample EnergyGuide labels to nine salespeople and asked which label was easier for consumers to understand. Eight of the nine responded that they preferred the old label, and the overwhelming reason was that having a dollar amount on the label makes it easier to explain and compare.[6] This supports the findings of a Canadian study, which found that "the notion of 'kWh' is unfamiliar and/or obscure to the majority of participants, although it is generally understood as a measure of energy consumption" (Patterson 1991: 27). [7]

4.2.3 Consumer Evaluations of the Thai Label

4.2.3.1 Background

Du Pont (1998) conducted an evaluation of the Thai appliance labelling program in 1997 for the National Energy Policy Office of Thailand. During March and April 1997, with a team of Thai survey researchers, he completed a survey of 971 consumers in Bangkok, Chiang Mai, and Khorat. 634 of these consumers had recently purchased either an air conditioner or refrigerator. The remaining 337 consumers had not recently purchased either appliance. Du Pont also conducted in-depth (semi-structured) interviews with 54 salespeople and an additional 90 consumers in these three cities. The purpose of these in-depth interviews was to gain a more detailed understanding of the appliance purchase process and to study consumer attitudes toward energy efficiency and awareness of the DSM appliance labelling programs.

Although the final report has not been issued, the preliminary findings are that:

- Well over 50% of recent purchasers of refrigerators and air conditioners asked to see models with an energy label or used the label explicitly in their decision process.
- Consumer awareness of the Thai energy conservation programs, and in particular the labelling program, was extremely high.

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[6] The old label has a large, bold dollar figure prominently displayed near the top of the label. The new label instead has a kilowatt-hour figure, in smaller point size, as the primary figure near the top of the label. It also has a dollar figure, representing estimated annual operating cost, in even smaller type near the bottom of the label.

[7] Despite the lack of consumer familiarity with kWh, Patterson concluded that "a scale based on energy consumption was the least confusing of all alternative measures" (Patterson 1991: 18).

- Most of the consumers surveyed mentioned TV as the medium through which they had learned about the programs. When asked to name the different programs, a large percentage of consumers volunteered the name *Han 2* (divide by 2) (XXX meaning?).
- The great majority of Thai consumers understood the basic meaning of the label and could use it to identify whether a model was energy-efficient.
- An informal survey of 24 stores in the three cities indicated that the percentage of floor models with energy labels was 57% for refrigerators and 26% for air conditioners.

Consumer priorities were measured in a broad-ranging interview in Thailand on "appliances." Since du Pont asked about priorities early in the interview, before mentioning energy use or energy efficiency, there is little chance of a response bias toward energy efficiency. Also, it was decided to pose the question in an unprompted format, simply asking, "What were the top three factors in the purchase of your appliance?" In asking the question, it was clarified which factors were the first, second, and third most important. Du Pont tallied the number of times any factor was mentioned among the top-three criteria. The resulting frequencies are shown in Table 3.

Table 3: Unprompted Purchase Decision Criteria in Thailand

Criterion (n=366)	% frequency listed among top 3
Brand	60.7
Price	53.8
Colour	39.3
Quality	35.0
Efficiency	28.4
Features	20.5
Guarantee	20.2
Durability	18.6
Financing	8.7
Size	6.0
Other	5.4

Source: Du Pont (1998)

Brand was extremely important in Thailand. But features appeared 6th on the list of priorities and was mentioned by just one-fifth (20.5%) of respondents. This likely reflects the fact that Thai refrigerators (and other appliances) are smaller, simpler, and have far fewer convenience features to distinguish one model from another (in comparison with the US for example). Since refrigerators in Thailand are much smaller (and more uniform in capacity), considerations such as size are less of an issue. More than one-quarter of Thai consumers ranked efficiency within their top-three priorities (28%).

4.2.3.2 Detailed Interpretation of the Thai Label

While the majority of Thai respondents were able to associate a 4 or 5 label rating as being energy-efficient, they did not have a detailed understanding of the label

elements. Table 4 shows that more than four-fifths of respondents felt that they either did not understand or only "somewhat" understood the label. Conversations with consumers revealed that they tended to just look at the numerical rating scheme at the top of the label and either to ignore, or become confused by, the detailed product information on the bottom half of the label.

Table 4: Thai Consumer Understanding of the Appliance Energy Label

Level of Understanding	Responses (n= 421)
Didn't understand	21.6%
Understood somewhat	62.5%
Understood very well	15.7%
Understood extremely well	0.2%
Total	100%

Source: Du Pont (1998)

4.2.3.3 Effectiveness of the Thai Label

Table 5 shows that the majority of Thai consumers buying both refrigerators and air conditioners bought a unit with an energy label. There has been no official study in Thailand to survey the prevalence of labels on floor models in Thai stores. Du Pont thus conducted an informal survey of 686 refrigerators and air conditioners on display in 24 stores in Bangkok, Chiang Mai, and Khorat to gauge the prevalence of the label. The table thus suggest that there might be a slight "pull" effect for refrigerators, since 62% of the consumers surveyed said they purchased an refrigerator with a label, and du Pont's informal survey showed that 57% of the refrigerator models on display had labels. There is clearly a large "pull" effect for the labelling program on air conditioners: 82% of the consumers surveyed said they purchased an air conditioner with a label, and du Pont's informal survey showed that only 26% the refrigerator floor models had labels.

The higher percentage for air conditioners probably reflects the higher degree of salience of energy in the air conditioner purchase decision, since a much small percentage of air conditioners observed in stores have labels. The data also indicate that the most of the labelled models being purchased are rated 4 and 5. For refrigerators purchased, more than two-thirds (67.6%) of the models were rated 5, and one-quarter (25.1%) were rated 4. For air conditioners, the ratio of 5s to 4s was higher: 79.7% of the air conditioners were rated 5, and 15.3% were rated 4.

Table 5: Effectiveness of the Thai Energy Label - Refrigerators

Refrigerator Purchasers	Responses (n=357)
Bought unit without label	37.6%
Bought unit with label, of which:	62.4%
Rated 5	67.6%
Rated 4	25.1%
Rated 3	5.8%
Can't remember	1.5%

Source: Du Pont (1998)

Table 6: Effectiveness of the Thai Energy Label - Air conditioners

Air Conditioner Purchasers	Responses (n=267)
Bought unit without label	17.8%
Bought unit with label, of which:	81.6%
Rated 5	79.7%
Rated 4	15.3%
Rated 3	2.3%
Can't remember	2.7%

Source: Du Pont (1998)

4.2.4 Display of Energy Labels in the EU

A major impact and process evaluation of the European energy labelling system is currently under way[8] which will include some assessment of the proportion of appliances that display energy labels at the point of sale. However, in 1997, the German consumers' organisation Stiftung Warentest undertook a survey of some 10 appliance retailers in 2 cities in Germany. The results of the survey, while being somewhat anecdotal due to the small sample size, are worrying as it was found that only about 60% of refrigerators and about 40% of clothes washers were correctly labelled (Sieber 1997). Note that the implementation dates for refrigerators and clothes washers were supposed to be January 1995 and April 1996 respectively. The author concludes that there is a slow process for legislation in Germany (the German government is yet to pass the required labelling legislation) and that there is as yet no effective enforcement.

The labels are generally affixed by the retailers (who are then supposed to place the appropriate language version of the label against the non-language data strip) and it appears that some find this quite an effort. Some models are shipped without the data strip, some have the data strips supplied loose in the packing while others have the data strip only affixed to the appliance by the manufacturer. It was noted during the survey that some appliances had the data strip affixed without the language explanations. Another problem is the quality of the data strip label, which is usually printed on a paper based sticker (as opposed to vinyl which is generally used for the language part of the label). These paper data strips get quite grubby in some stores, which detracts from the labels appearance and attractiveness.

4.2.5 Verification of the Accuracy of EU Energy Labels

The accuracy of the information presented on the energy label is the subject of much discussion in the European Union, especially as it is the responsibility of manufacturers to ensure that the information they supply is correct[9], while there is no automatic system of independent testing. Generally, manufacturers test their own products in certified test laboratories and report the testing results on the label while occasionally third party testing agencies are used. One of the difficulties is that it is

[8] *Evaluation of the first two years of the EU energy label on cold appliances,* a study being conducted by the Environmental Change Unit for DG XVII of the European Commission under the SAVE programme.

[9] The EU energy labelling and MEES Directives rely on self-declaration.

up to each member state to ensure that EU law is applied and enforced in their state, while the European Commission does not have the authority to initiate a centralised enforcement agency. Consequently, different enforcement regimes exist in each state, which means different systems of checking labelling compliance and different penalties for being in breach of national law.

An additional problem is the range of tolerances used in the energy and product characteristics measurement tests, which are perhaps too generous considering the increasing levels of reproducibility available from modern manufacturing processes and test laboratories. Some serious cases of inaccurate energy consumption reporting are known to have occurred for cold-appliances since the labelling scheme was introduced in the EU; however, thus far in all cases where manufacturers have been challenged they have re-labelled their products after third party testing.

In practice, offending manufacturers can be caught out either by random independent testing conducted by consumer groups or by competitor product testing conducted by other manufacturers. Independent testing of cold appliances has shown that generally manufacturers' reported values are optimistic but this is usually simply taking advantage of the 15% reported energy consumption tolerance in the EN153 norm (CEN standard). As yet there is no systematically gathered evidence to indicate how the accuracy of manufacturer reported energy consumption has changed over the period since the energy label has been introduced.

The trade associations of the manufacturers have privately admitted that there were some teething problems when the energy label was first introduced which may have caused some inaccurate declarations to be made. They claim that they are making progress in warning offenders, and that the accuracy of the declared information has now improved to an acceptable level.

As a result, the European appliance manufacturer's association CECED is in the process of negotiating an agreement with its members (under the eye of the European Commission) regarding the verification of data declared on energy labels (CECED 1997). This essentially allows policing by manufacturers of each other's products using in-house testing facilities. Where there is disagreement regarding the results, a third party test house is to be used and the costs are to be covered by the party whose claim is proved wrong. There are strict time lines imposed for re-labelling of products and alteration of information fiches.

4.3 Impact Evaluations

If process evaluations are used to determine that all the links required for energy labelling to work are in place, then it is reasonable to conclude that the program is effective. Even so, it is difficult to determine *how* effective, and how much energy is saved as a result of the program's introduction.

To assess the energy impact of the program for each labelled appliance type (better still, for each sub-category and size group), it is necessary to estimate two distinct trend lines: (a) the sales-weighted average efficiency trend, and (b) what the trend

would have been without labelling. The energy savings attributable to energy labelling is the difference between to these two cases. It is important to note that one of these cases will be based on "reality" (eg actual market changes with labelling in place) and one will be an estimated scenario based on the best available data (eg estimated market changes if labels were not in place). The "reality" case could be either with no labels (before labelling is introduced) or with labels (after a program has been in place for some time).

In practice it is hard enough to determine (a). Monitoring the average efficiency of all models on the market (the "market-weighted" average) will tell only part of the story. It is likely that suppliers will eliminate their least efficient models and introduce more efficient products in response to labelling, but if consumers show no preference for the more efficient, then the effect on "sales-weighted" average of purchases will be minimal. To monitor the sales-weighted trend, sales information is needed for every model on the market over a number of years. Australia now has such a monitoring program in place (EES 1997). Even where the total sales weighted trend is accurately known for all appliance types and sub-categories, changes may be due to a number of factors in addition to market pull from energy labelling. These can include:

- technology changes (improved manufacturing methods and components);
- effect of other energy programs such as minimum energy performance standards (MEPS or MEES).

Even so, market data will never be able to supply information about trend (b): what the sales-weighted average over the same period would have been *without* labelling. Given historical rates of technological change that occur in most markets, it would be misleading to assume that there would have been no improvement without labelling. If it is assumed that the underlying efficiency improvement over the same period would have been low (eg because industry would have been preoccupied with other concerns such as phasing out CFCs) then a higher impact can be claimed for the labelling program, and vice versa. In addition, the "*without* labelling" scenario becomes increasingly hypothetical after an energy labelling program has been in place for many years (eg in USA, Canada & Australia which have been around for 15 to 20 years). In these cases apportioning the actual changes in sales weighted energy consumption to energy labelling becomes quite subjective.

4.3.1 The Impact of European Energy Label

4.3.1.1 Background

Prior to the discussions concerning the EU energy label, the European cold-appliance industry was pre-occupied with the problem of phasing out the use of CFCs which had been used both as refrigerants and as the agents to blow the insulating foam. In 1989 manufacturers reduced the level of CFC in their foams by 50% which had a slight adverse effect on the quality of the insulation and hence led to increased cold appliance energy consumption. From 1990 until the end of 1992 the efficiency of European made refrigerators appears to have been relatively static, but in early 1993 the German industry settled the problem of CFC phase-out by opting to use hydrocarbons for the refrigerant (mostly R-600a - isobutane) and cyclopentane as the

foaming agent. Manufacturers from other EU countries either chose to use the hydrocarbon technology or the alternative zero ozone-depleting option of HFCs (normally R-134a as both refrigerant and foaming agent). At about this time the German industry appears to have made a concerted effort to improve the energy efficiency of their cold appliances which manufacturers from other countries subsequently followed.

The progression in market average energy efficiency data for Germany, France, the UK and the Netherlands is shown in Table 7 to Table 10 (Waide 1997a). The tables show the energy efficiency index where an index of 1 corresponds to the average energy efficiency index of cold appliances as sold on the EU market in 1990-2.

Table 7: Average energy efficiency index of new cold appliances - Germany

Cold appliance type	1989	1990	1992	1993	1994	1995
Larders, 0-stars and cellars	0.996	1.010	1.000	0.935	0.892	0.768
1-star refrigerators	1.016	0.979	0.987	0.930	0.966	0.888
2-star refrigerators	0.977	1.060	1.033	0.960	0.962	0.967
3-star refrigerators	0.965	1.023	0.977	0.869	0.885	0.823
4-star refrigerator-freezers	1.001	1.012	1.008	0.938	0.866	0.839
Upright freezers	0.893	0.917	0.928	0.892	0.810	0.842
Chest freezers	0.901	0.968	0.940	0.871	0.774	0.796
All cold appliances			0.944	0.878	0.833	0.798

Note: The efficiency index is computed according to the methodology prescribed for the EU label.

Table 8: Average energy efficiency index of new cold appliances - France

Cold appliance type	1984	1990	1993	1994	1995	1996
Refrigerators	1.228	1.128	1.126	1.029	0.890	0.861
4-star refrigerator-freezers	1.031	0.992	1.010	0.944	0.868	0.847
Freezers	1.356	1.123	1.128	1.088	1.040	1.046
All cold appliances	1.197	1.080	1.087	1.013	0.926	0.912

Note: The efficiency index is computed according to the methodology prescribed for the EU label.

Table 9: Average energy efficiency index of new cold appliances - UK

Cold appliance type	1991	1992	1993	1994	1995	1996
Refrigerators (UEC (kWh/year))	311.8	300.8	299.4	298.1		
4-star refrigerator-freezers	1.100	1.087	1.087	1.087	1.035	1.008[a]
Freezers (UEC (kWh/year))	491.0	471.4	459.4	459.4		

Note: The efficiency index is computed according to the methodology prescribed for the EU label. Only average unit energy consumption (UEC) data was available for refrigerators and freezers.
[a] An estimated value computed from the distribution of sales within each energy label class.

Table 10: Average energy efficiency index of new cold appliances - Netherlands

Cold appliance type	1990	1991	1992	1993	1994	1995
Refrigerators	–	0.963	0.963	0.950	0.896	0.821
4-star refrigerator-freezers	–	0.957	0.957	0.951	0.908	0.849
Freezers	–	1.048	1.048	1.040	0.997	0.957
All cold appliances	–	0.986	0.986	0.973	0.924	0.862

Note: The efficiency index is computed according to the methodology prescribed for the EU label.

This data clearly shows the large improvements in cold-appliance efficiency from 1992 to 1996. In Germany the efficiency of the market improved by 15.5% between 1992 and 1995; in France the efficiency of the market improved by 16.1% from 1993 to 1996; in the UK the efficiency of refrigerator-freezers increased by 7.3% from 1994 to 1996; while in the Netherlands the efficiency of the market improved by 12.6% from 1992 to 1995. It is of course difficult to interpret this shift in efficiency but it does seem certain that the advent of the energy label (which was due to be visible to EU consumers at the beginning of 1995 and from 1994 in Denmark) has had a significant impact. Furthermore, it is quite clear that manufacturers had already decided to respond to the energy label *before* it was in place and hence before it could act to influence consumer and retailer purchasing decisions. This shows that the impact of energy labelling is more complex than simple preferential consumer purchasing and that in reality manufacturers and retailers attempt to second guess the impact of labelling on their image and sales.

German manufacturers took the opportunity to improve the energy efficiency of their products at about the same time or immediately after they converted their production facilities to non ozone depleting refrigerants and foaming agents. Aware that the energy label would be introduced within a short period they appear to have decided to focus their efforts on raising the average energy efficiency gap between their products and those of their competitors. Generally, German-made cold-appliances are higher priced than their foreign competitors and they have traditionally been marketed on their higher quality. Probably, German manufacturers reasoned that they could not afford to risk their products having lower classifications under the energy-labelling scheme than their competitors and hence raised the efficiency of their products. Manufacturers from other countries, and most notably Italy, appear to have followed the German lead presumably to prevent their products from being left too far behind.

Ironically, of all the EU member states it is the two largest cold-appliance manufacturing nations, Italy and Germany, who have not formally implemented the EU energy label in their national legislation and hence are currently in breach of EU law[10]. However, here the similarity between the two nations stops because in Germany the label has been widely seen in shops since 1994 while in Italy the label is rarely seen, even today (Waide 1997b). The reason appears to be that German manufacturers are happy to label their products because they generally have comparatively good ratings while equally German retailers are happy to supply the information to the consumers.

It is interesting to compare the efficiency purchasing trends in the two countries too. In Germany, if one compares the distribution of the cold-appliances offered for sale as a function of their energy-label class against the same distribution for the number of appliances actually bought, one finds that consumers prefer to buy the more efficient appliances. In other words, the sale-weighted average efficiency is higher than the market-weighted average (see Figure 17).

[10] Germany is believed to have just passed legislation implementing the energy label in early 1998, while Italy is also thought to be about to pass energy labelling implementation legislation now that a three year block in implementing any EU directives in Italy has been overcome.

In Italy, where the label appears only rarely, consumers tend to buy preferentially (yet almost certainly in ignorance) the sale-weighted average efficiency is *lower* than the market-weighted average (see Figure 18). This behaviour may be explained by a combination of factors including that German consumers are generally acknowledged to be more sensitised to energy and environmental issues than average EU consumers while Italian consumers are perhaps less so. Also, the visibility of the energy label may be supporting this tendency. The situation is more ironic when one considers that Italians have far more to gain financially through efficient cold appliances because their climate is hotter, and hence cold appliance energy consumption will be higher, and Italian residential electricity prices are the highest in Europe.

Figure 17: Energy efficiency of German refrigerators -1994

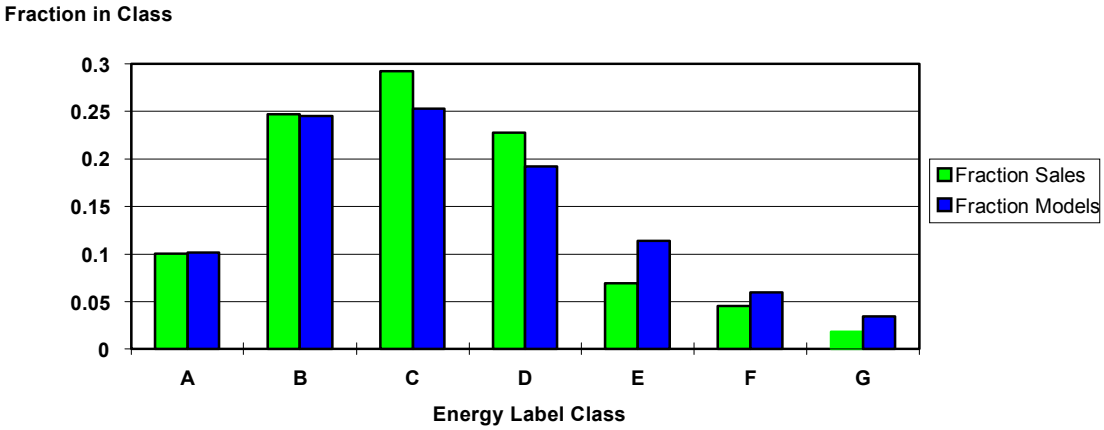
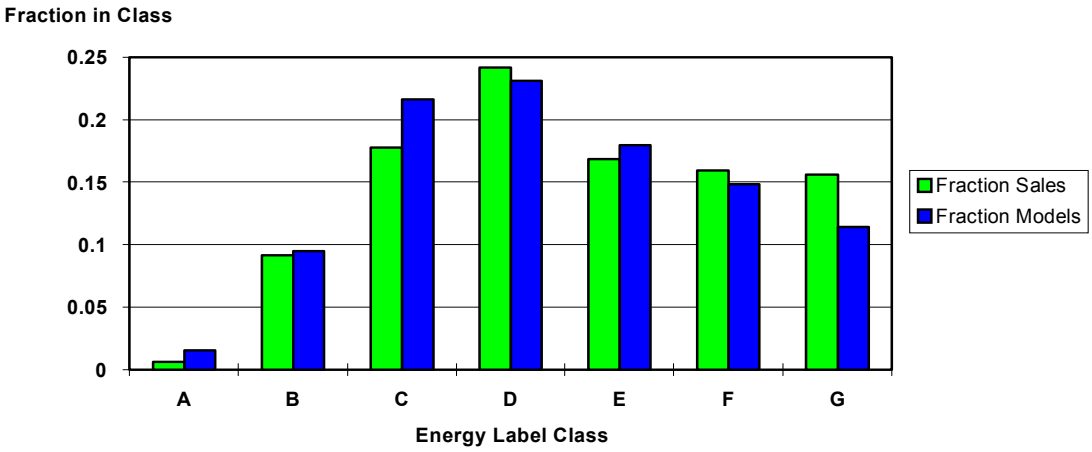


Figure 18: Energy efficiency of Italian refrigerators - 1994



More explicit evidence of the direct impact of the energy label on consumer purchasing patterns is provided by a series of cold appliance sales data from France, see Figure 19 to Figure 22 (from Waide 1997).

Figure 19: Energy efficiency for French cold appliances - 1993

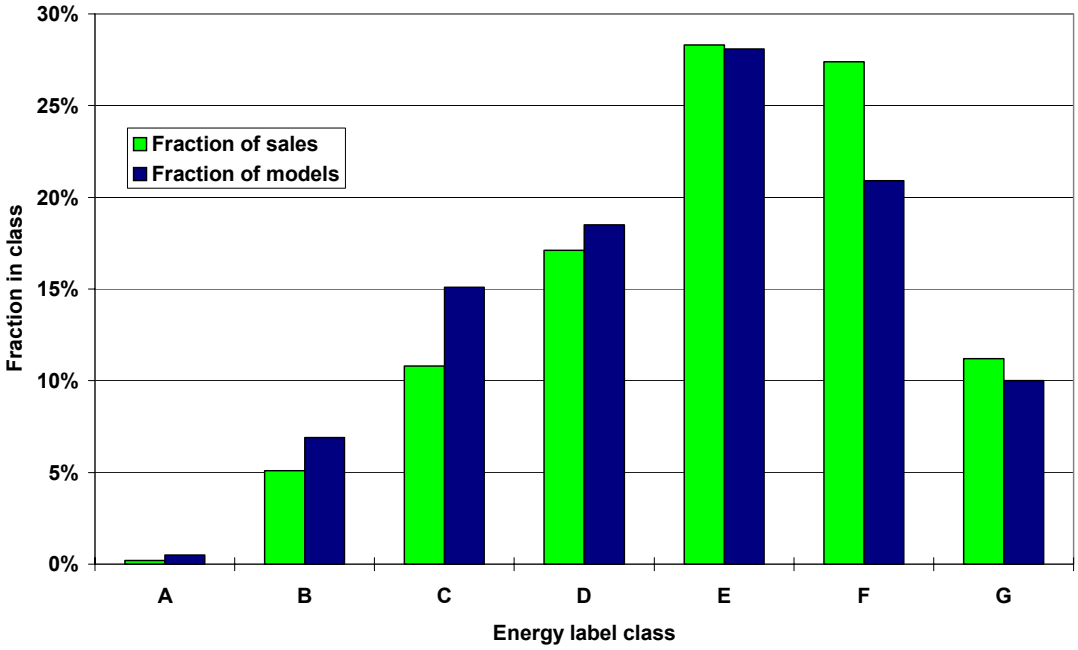


Figure 20: Energy efficiency for French cold appliances - 1994

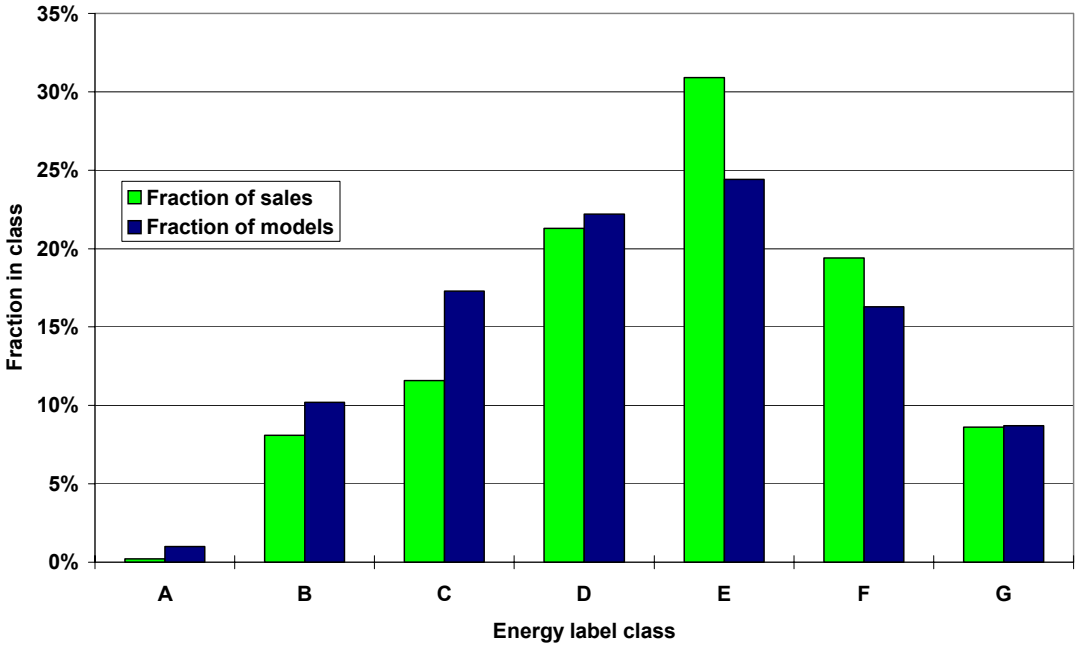


Figure 21: Energy efficiency for French cold appliances - 1995

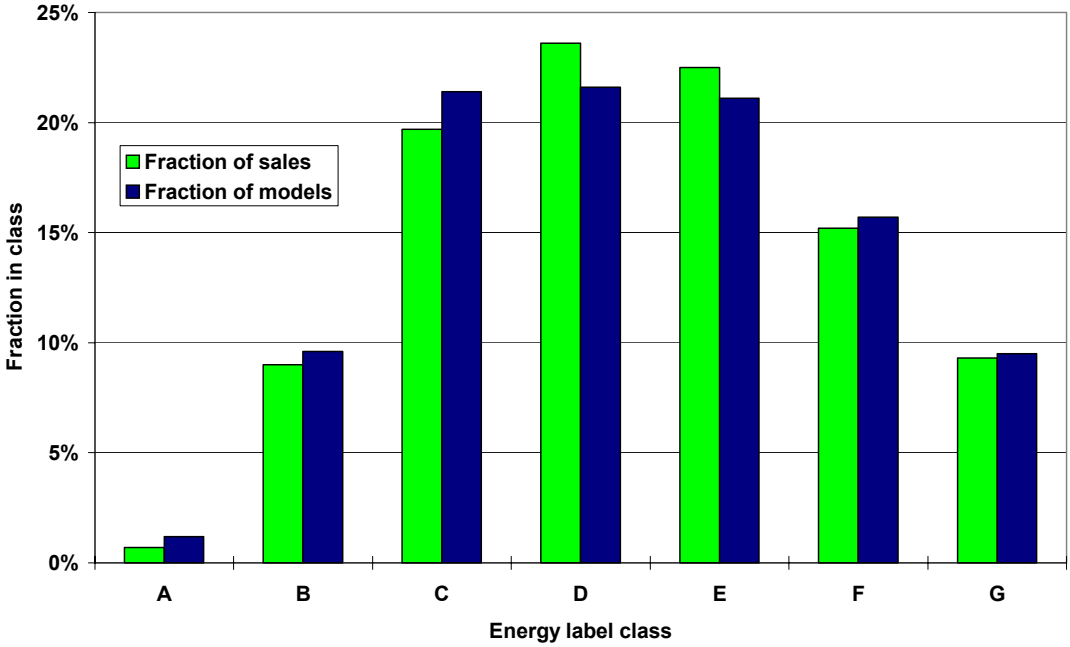
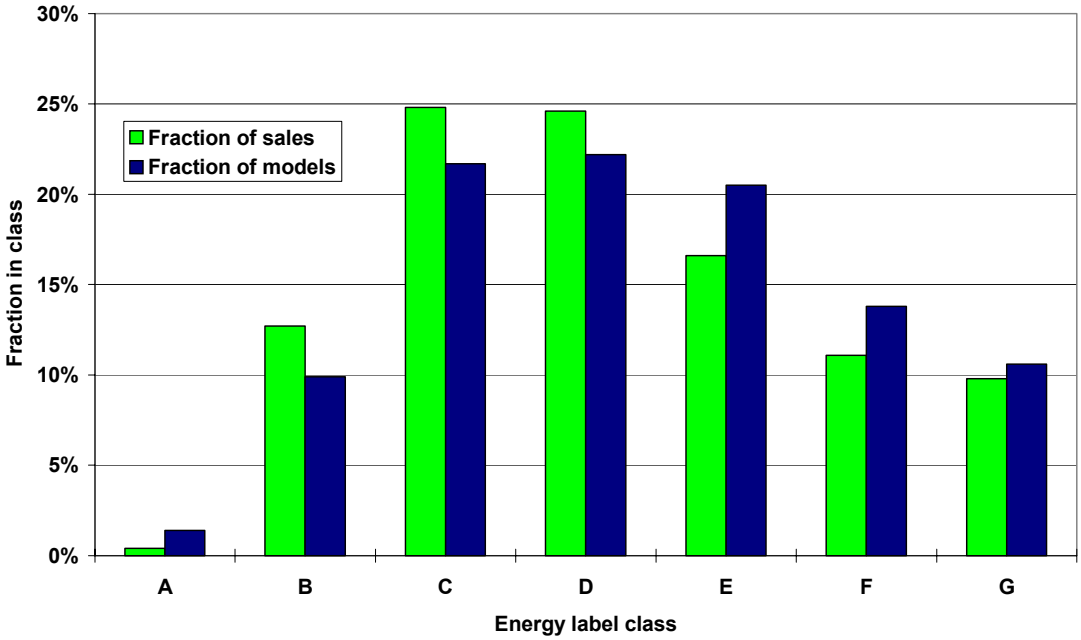


Figure 22: Energy efficiency for French cold appliances - 1996



This data shows a progressive improvement in the average efficiency of the French cold appliance market from 1993 to 1996, with a notable jump from 1994 to 1995 (the year the label was first introduced). Exactly the same progression has been seen in the markets of other EU countries such as the Netherlands. However, an interesting aspect of these graphs is to show how consumers have moved from generally buying models which were on average less efficient than those that they were offered, in 1993 and 1994, to buying models which are on average more efficient than those they

were offered in 1996. In 1995 there was little difference between the average efficiency of the models offered for sale on the French market and those actually bought. This was the year the energy label was first introduced in France and coverage was quite patchy. Label coverage had significantly improved in 1996. This data seems to show real consumer 'pull', as distinct from any manufacturer led 'push', as a result of being presented the information on the energy label, although the manufacturer push is also clear.

When the same data is analysed by cold appliance type it appears that consumer pull can be seen across all of the ten cold appliance product categories, except for chest freezers. This exception may be a result of there being a significant bi-polarity in the chest freezer energy efficiency distribution associated with whether models are 'super insulated' or have 'standard' insulation that is also associated with a significant price increment. For the other cold appliance categories there is very little systematic price difference with efficiency class except for the class A models which are almost always appreciably more expensive, and profitable, than equivalent models in the other efficiency classes. This price-efficiency relationship is likely to explain why the relative sales of A class appliances continues to lag behind the market offer in France bucking the trend seen for B and C class appliances.

A study of trends in UK cold appliance energy consumption from 1989 to 1996 was published in 1997 by the Environmental Change Unit of Oxford University (ECU 1997). The study used the GfK model sales database (and other data sources) to track sales weighted efficiency of various product types over the period. It would appear that the energy efficiency for refrigerators, and upright freezers improved well above the historical trend just before and after energy labelling was implemented. The efficiency trend for chest freezers is improving also, but the sales weighted data shows considerable variation from year to year so the trend is difficult to evaluate. The energy consumption of refrigerator-freezers did not improve very much over the analysis period, but apparently this is because there is a strong trend towards frost free appliances within this segment. Frost free models are significantly more energy intensive in Europe than non-frost free models. There may also be size impacts occurring, although this was not explicitly stated in the report. The report concludes that the *energy consumption* decreased by 0.75% over the period from the beginning of 1995 to the end of 1996 (2 years). This is a rather modest reduction, but if the sales share of product types had remained constant (ie share of frost free models remained static), then the average energy consumption of new models would have reduced by 4.4% over the same period. Table 11 shows the increase in market share of models with a high energy rating (A to C) and the energy consumption trends for each type of refrigerator from beginning of 1995 to the end of 1996.

Table 11: Refrigerator Energy Trends - UK Q1 1995 to Q4 1996

Appliance Type	Sales Share Increase of Energy Ratings A to C	Energy Consumption Change
Cyclic refrigerator-freezer	19%	-1.6%
Frost free refrigerator-freezer	-4%	-5.2%
Standard refrigerator	2%	-5.2%
Larder refrigerator	17%	-12.7%
Chest freezer	1%	-3.7%
Conventional upright freezer *	19%	-4.6%
Frost free upright freezer	0%	+0.1%

Source: Table 2.4, ECU (1997)
Note *: Includes energy ratings A to D

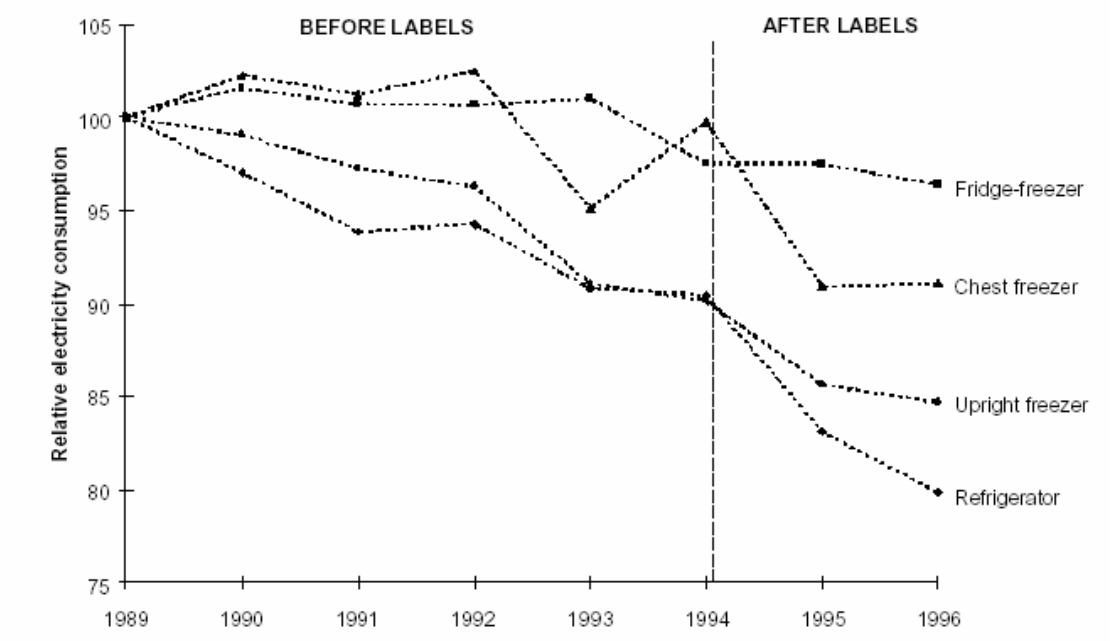


Figure 23: Relative electricity consumption in cold appliances, GB, 1989 – 1996
(source ECU 1997)

Cold appliance sales and efficiency data is currently being analysed for most EU countries from 1994 to 1996 and a comprehensive report detailing the results is expected in the summer of 1998[11].

A parallel study is underway to evaluate the impact of the energy label scheme for cold appliances[12], which is also expected to report in the summer of 1998. One area

[11] *Monitoring of energy efficiency trends of European domestic refrigeration appliances*: a study being conducted by PW Consulting for ADEME on behalf of DG XVII of the European Commission. SAVE contract N° XVII/4.1031/D/97-021.
[12] *Evaluation of the first two years of the EU energy label on cold appliances,* a study being conducted by the Environmental Change Unit for DG XVII of the European Commission under the SAVE programme.

being examined is the coverage of the energy label, which has been the subject of much discussion in the EU. A series of random inspections were made at 10 different shops in each EU country to assess whether the label was being displayed and if it had been correctly applied. The results of this inspection indicate a significant difference in coverage by EU country but overall it was found that the label was correctly displayed on 56% of the models on sale (Sieber 1997). See also Section 4.2.4.

Figure 24 shows the forecast energy consumption of the entire EU stock of cold appliances under various policy actions up to the year 2020. These include a range of energy labelling and MEPS scenarios for refrigerators and freezers. The scenarios are:

- the static efficiency scenario (no improvement in cold appliance efficiency after 1995);
- the basecase scenario (this corresponds to the impact of energy labelling and natural market forces only);
- the EU MEPS-Directive scenarios where 'the -15% standard' is introduced in either 1998, 1999 (as will happen) or 2000;
- the EU MEPS-Directive scenarios followed by a second round of standards designed to improve average new model efficiency levels by 20% introduced in either 2002, 2003 or 2004;
- a second round of efficiency standards introduced in 2002 set at the position of least life cycle cost.

Average, minimum and maximum cumulative electricity consumption and electricity savings estimates for these scenarios are given in Table 12.

Table 12: EU forecast cold-appliance energy consumption - various scenarios

Scenario	Cumulative consumption from 1996 to 2020 (TWh)			Cumulative energy savings from 1996 to 2020 (TWh)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
Static efficiency from 1995	2708	–	–	(-278)	–	–
Base case (with energy labelling)	2430	–	–	0	–	–
-15% in 1998	2299	2344	2253	131	86	177
-15% in 1999	2311	2354	2267	119	76	163
-15% in 2000	2323	2364	2281	107	66	149
-15% in 1998/extra –20% in 2002	2169	2248	2090	261	182	340
-15% in 1999/extra –20% in 2003	2194	2270	2118	236	160	312
-15% in 2000/extra –20% in 2004	2218	2290	2146	212	140	284
-15% in 1999/LLCC in 2002	1949	–	–	481	–	–

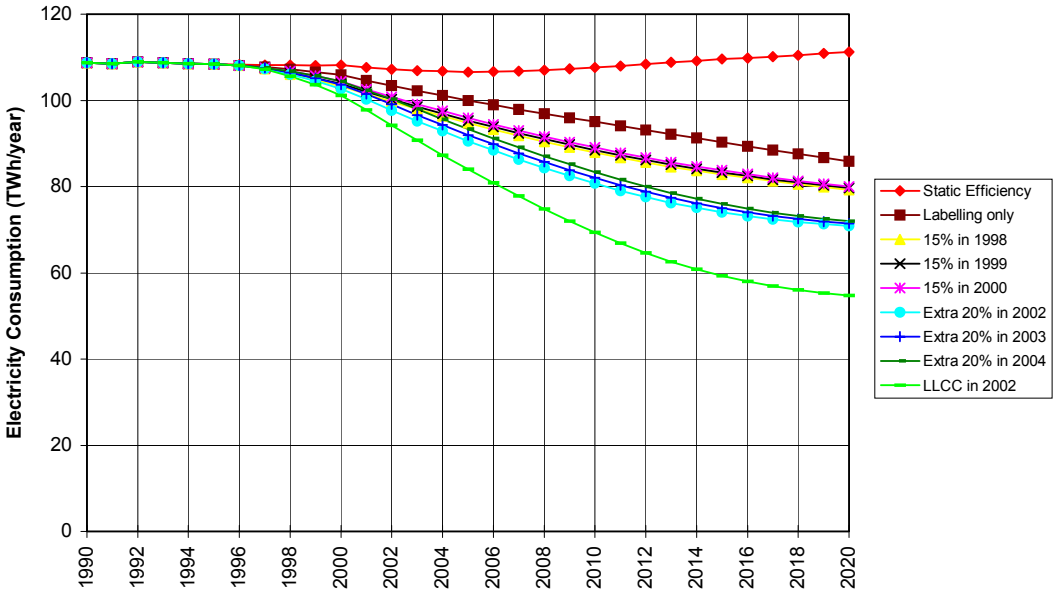
[a] Savings are calculated relative to the base-case scenario.

Large savings are forecast from the energy labelling of cold appliances compared to a static efficiency scenario.[13] However, the "static efficiency" case is an artificial

[13] Overall the combination of market forces and the energy label is forecast to result in electricity savings of 278 TWh over the period 1996 to 2020 compared with a frozen or static efficiency scenario[13]. The value of this avoided-electricity to consumers is ~39 billion ECU (> US$40 billion) if

reference case, since there would most likely have been a "business as usual" (BAU) improvement in efficiency even without labelling. The BAU trend line would have been somewhere between the "static efficiency" case and the labelling-only "baseline scenario".

Figure 24: EU forecast cold-appliance electricity consumption - various scenarios



4.3.1.2 Consumer Response to the introduction of the EU Label in Denmark

Prior to the formal introduction of the European energy label for refrigerators, a pilot project was held in Denmark in an attempt to assess the consumer impact of the label at the time of its introduction (DTI 1994). The project arranged to track the sales weighted efficiency trend in a set of 32 retailers within one retail chain which planned to introduce the energy label earlier than the scheduled implementation date for the rest of Europe, while a control group of retailers without any energy labels was also tracked in Denmark for the same period. Staff in the retailers which introduced the labels undertook some training sessions on how to explain and interpret the label. They were also provided with supporting literature for use with customers in the stores.

In essence, the results were that the sales weighted efficiency of appliances sold in the retailers with energy labels increased significantly over the survey period as shown in Figure 25, but so did the control group. This effect in the control group was unexpected, but later inquiries revealed that there was a mutual purchasing function for the buying groups for the control stores and the stores with labelled appliances. Thus the increase in supply and sales of refrigerators with higher efficiency ratings in

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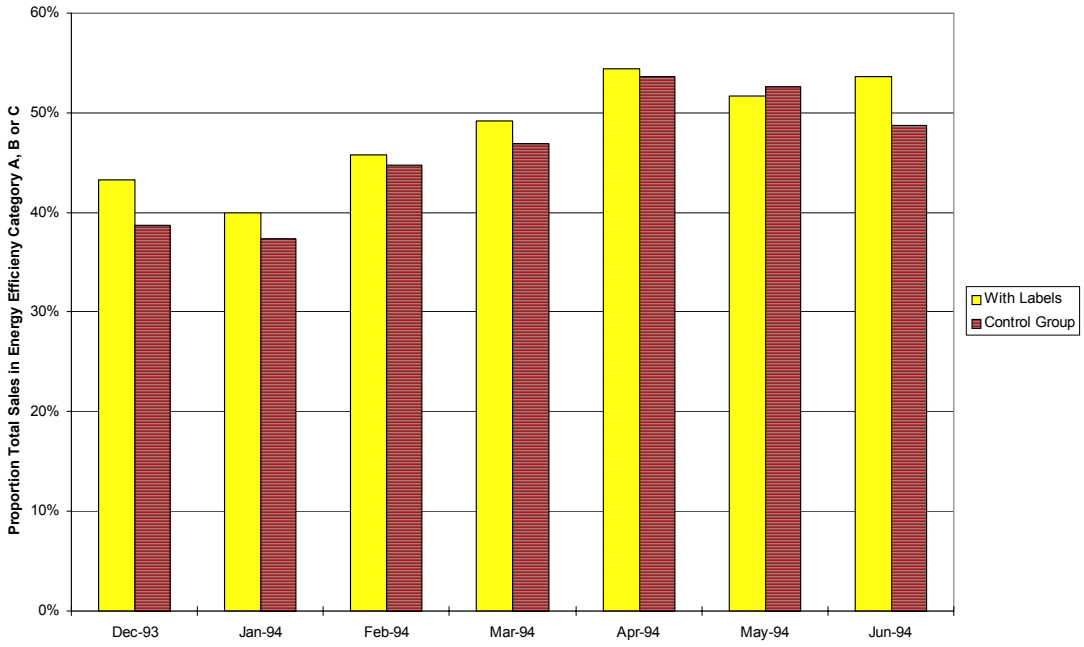
one assumes constant real electricity prices.

both chains was probably attributable to the introduction of energy labels into just one of the chains. The buying group as a whole responded to the new market pull signals.

Interestingly, a survey of consumers indicated that 91% of customers exhibited a greater interest in energy after the introduction of energy labels (which is not surprising, as there was limited data available before this time, mainly through government listings). Some 74% of the customers stated that the new energy label had some influence on their choice of model. (DTI 1994) This latter figure is rather high and may be the result of the newness of the program at that time (ie some novelty value) and the special training undertaken by the retail staff. Also, as a rule, Danish consumers generally exhibit more concern about energy consumption and the environment when compared with some other countries within the European context.

Anecdotally, it would appear that the energy label had a significant impact on the efficiency mix of products offered for sale in retailers in Denmark at the time of the label introduction. However, because of the previously unknown mutual links between the buying chains of the retailer which introduced the labels and the control group, it was not possible to accurately quantify this change. But an increase in sales share of the higher efficiency grades A, B and C from around 40% to over 50% in a period of 6 months is significant.

Figure 25: Sales of Efficient Refrigerators - Denmark 1993/94



Source: DTI (1994)

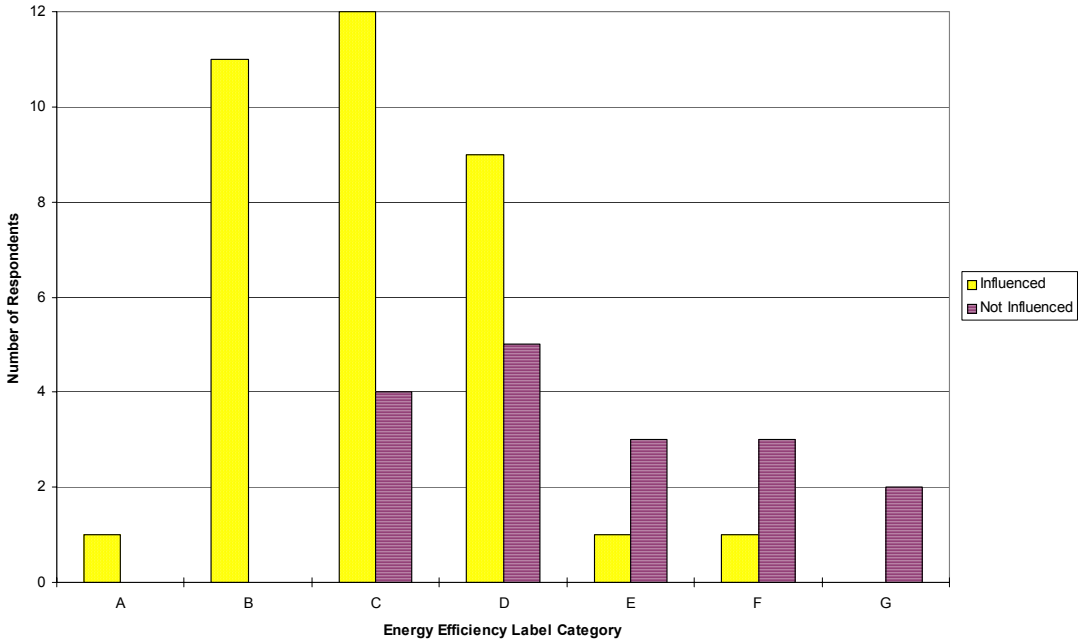
4.3.1.3 Recent Consumer Response to the EU Label in the UK

As part of the European Commission's Save program, the Environmental Change Unit (ECU) at Oxford University undertook a survey of some 100 recent refrigerator and freezer purchasers in the Oxford region during 1996 (ECU 1997). While the sample size is small, the results for consumer attitudes are broadly consistent with

previous surveys undertaken in 1993 and 1989. The main purpose of the survey was to attempt to determine the degree of influence that the energy label had on appliance purchasing decisions. In the Oxford survey, some 52 out of 100 consumers said that they remembered seeing the energy label on the appliance. Of the 52 consumers who noticed the energy label, 35 said that they *were* influenced by the energy label while 17 said that they *were not*. When the efficiency of the appliances actually purchased is examined separately for each of the "influenced" and "not-influenced" groups, a marked energy efficiency is visible. In fact, ECU (1997) claim that, on average, the efficiency of the models purchased by the influenced group were 20% more efficient than those purchased by the non-influenced group. Figure 26 shows the actual purchase mix of energy ratings for both influenced and non-influenced consumers. This data suggests that the energy label, at least in the UK, is having a significant market pull effect.

The report goes on to find that two sample segments were more likely to be both influenced by the energy label and to purchase a more efficient appliance - these were groups called "concerned professionals" and "thrifty elders" within the survey. Similarly two other sample segments were more likely to be both not-influenced by the energy label and to purchase a less efficient appliance - these were groups called "strugglers" and "younger aspirants". This data supports the view that the label does have an impact on consumer purchasing patterns.

Figure 26: Purchase mix of influenced and non-influenced consumers - UK 1996



Source: Figure 3.4 after ECU 1997 and Boardman 1997

4.3.2 Impact of the Thai Energy Labels

4.3.2.1 Refrigerators

At the time of the label introduction in Thailand, just one refrigerator model was rated at level 5. This was a model that had been brought to market in early 1993 in anticipation of the Thai DSM program. Once the labelling program began, however, the shift in the market was dramatic. When the program began in the first quarter of 1995, 32% of the participating refrigerators (i.e. refrigerators for which manufacturers requested labels) were rated at level 3, 55% were rated at level 4, and just 13% were rated at level 5. By the final quarter of 1996, more than 1.6 million labels had been supplied to manufacturers, and more than 70% of participating models were rated at level 5. (EGAT 1997B) Figure 27 tracks the number of labels sent to refrigerator manufacturers during 1995 and 1996. Clearly, there was a marked shift, as manufacturers upgraded the efficiency of their units: in 1996, more than half of the labels issued were for the highest efficiency rating, level 5. Figure 28 shows that the average energy use of participating models (models for which the manufacturer requests a label) has decreased by 14% since the program's inception.

When analysing this data it is important to bear in mind that the program is a voluntary one. Manufacturers therefore have the option of not requesting labels for their less efficient models.

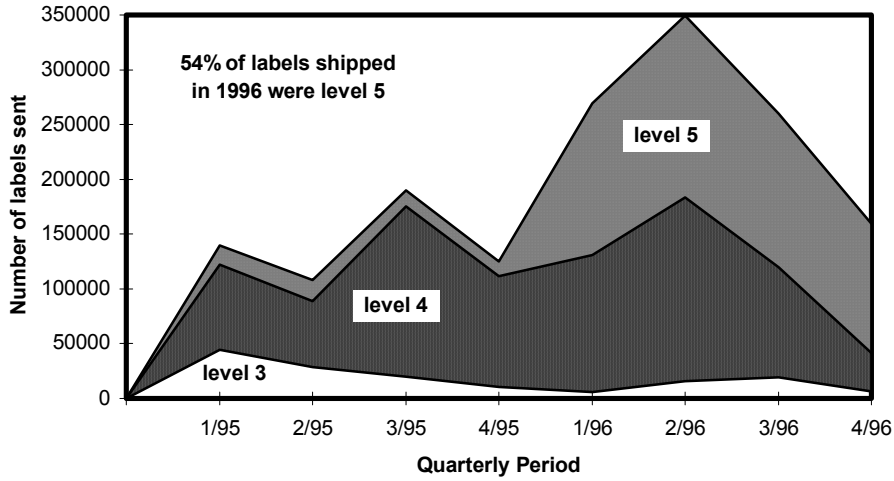
The lack of historical and total market data makes it difficult to interpret either the absolute impact of the labelling program or the potential for further improvements in refrigerator efficiency. Annual sales of refrigerators in Thailand in 1993 were an estimated 700-800,000 units. (IIEC 1995) The DSM Office estimates that the refrigerator labelling program reduced peak demand by 31 MW through May 1997. (Yim, 1997) These estimates are based on changes in the ratio of labels issued to participating manufacturers, and the DSM Office has neither a reliable estimate of the efficiencies of non-participating models, nor of what percentage of refrigerators in the market as a whole have labels.

It is also worth mentioning that while the labelling program is apparently succeeding in increasing the efficiency of models available in the marketplace, there remains significant additional potential for cost-effective improvements . For example, initially, it was thought that the major efficiency improvements in refrigerators would come from increasing the wall insulation and improving gasket seals on the door, since Thai refrigerators typically have very thin walls, (about 30 to 40 mm in thickness). Thus far, however, only one manufacturer has introduced a new model with thick wall insulation.[14] The other manufacturers have been content to increase the efficiency of models by substituting higher-efficiency compressors. This suggests

[14] According to Angsuputiphat (1997), this thick-walled model has not been accepted into the mainstream market because of resistance among wholesalers and retailers to a new type of product. In contrast, this thick-walled model is one of the most popular refrigerator models sold by Singer (Thailand), which bypasses the regular retail chain and sells directly to consumers through its many rural outlets around the country.

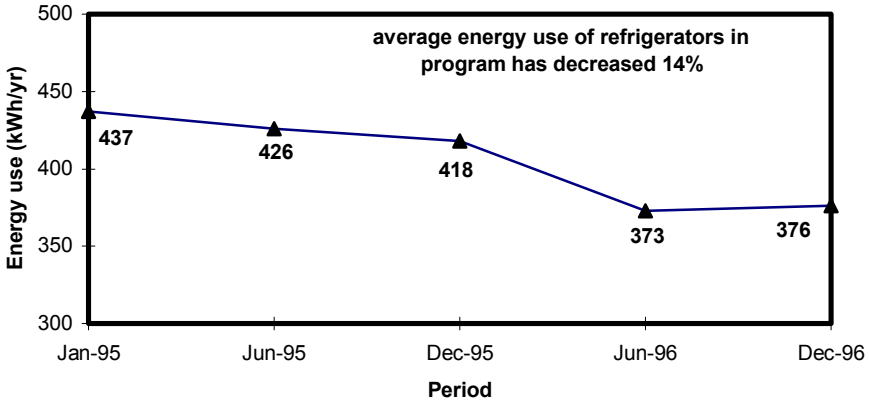
that substantial additional efficiency gains are possible through improving refrigerator wall and door insulation.

Figure 27: Refrigerator Labels Sent to Thai Manufacturers



Source: DSM Office, EGAT

Figure 28: Average Energy Use of Refrigerators in Thai Labelling Program



Source: DSM Office, EGAT

4.3.2.2 Air Conditioners

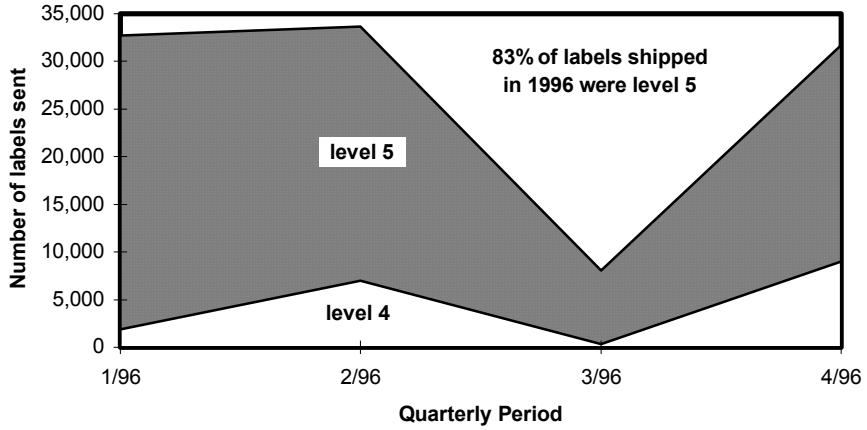
Figure 29 shows the number of labels sent to manufacturers participating in the air conditioner labelling program. EGAT distributed 106,000 labels for air conditioners during 1996. This is roughly 25% of annual refrigerator sales. None of these labels were for models rated at 3; just 17% of the labels were for models rated 4; and 83% of the labels were for models rated 5.

Figure 30 shows a slight increase (~4%) in the average efficiency of air conditioners participating in the labelling program during its first year. The DSM Office estimates that the labelling program resulted in peak demand savings of 28 MW through May 1997. (Yim, 1997) Again, this estimate is based on inadequate market data. It was derived by tracking changes in the ratio of the number of labels shipped to

manufacturers, and The DSM Office is not yet able to track either the number of units actually sold or changes in shipment-weighted average efficiencies of the market as a whole.

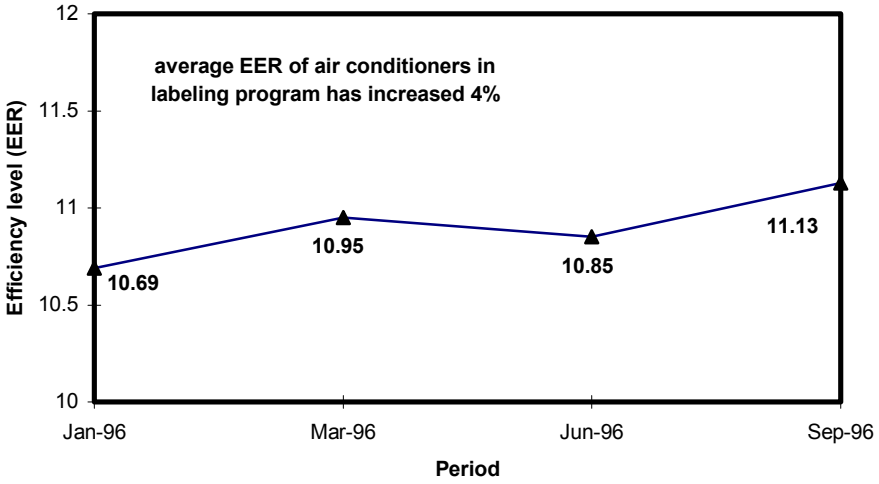
The air conditioner testing and labelling program has highlighted a gap in quality between imported air conditioners and most locally produced models. Locally manufactured and assembled units tend to be less efficient and of lower-quality. Since their units cannot compete on quality, they compete on price. Another, unintended impact of the air conditioner program has resulted from the associated publicity and marketing efforts, which have increased the appeal of air conditioners to the Thai public. Preliminary projections suggest that air conditioner demand may increase significantly compared to previous projections. (Lemoine, 1996)

Figure 29: Air Conditioner Labels Sent to Thai Manufacturers



Source: DSM Office, EGAT

Figure 30: Average Energy Efficiency Ratio Air Conditioners in Thai Labelling Program



Source: DSM Office, EGAT
Note: Air conditioner EER in Thailand is in imperial units - Btu per hour per Watt.

4.3.3 Philippines Air Conditioner Labelling and Standards Program

In the Philippines, energy labelling and minimum energy performance standards for air conditioners were introduced together in 1994. There has been only a cursory assessment of the impact of the MEPS program at the time of its introduction and a formal assessment of the impact of the energy labelling program has yet to be undertaken (IIEC 1995). The impact of MEPS was assessed as the change in those models on the market in 1992 which did not comply (pre-MEPS) to full compliance in 1993 after MEPS was introduced. Prior to MEPS, less than 20% of air conditioners on the market would have met the MEPS levels proposed for 1993. Data analysis by the Philippines Fuels and Appliance Test Laboratory and reported by IIEC (1995) estimates that the energy consumption of small air conditioners (under 3 kW cooling) declined by an average of about 3% after MEPS, while for larger units (over 3 kW) the improvement was more marked at about 8%.

5. Development of Energy Labels

The following section reviews the processes used to develop and/or revise the major label designs. In the case of Europe, some consumer research was used before the decision-making process passed to government officials. In the case of the USA and Thailand, decisions about layout, rating thresholds etc. appear to have been made entirely by utility and government officials.

5.1 Development of the European Energy Label

The design of the current EU energy label evolved from work done by the university of Leiden for the Dutch government and the European Commission. In 1991 the University of Leiden conducted two sets of consumer trials to explore the most effective label design[15] (de Loor & Zeelenberg, 1991). Their criteria was to determine which of five generic label designs presented the energy consumption of a particular appliance in the manner that was most likely to be used in consumer purchasing decisions. The five labels examined were:

- EC-Label – a product information label (non comparative) that was proposed by the EC as the appropriate means of labelling in their 1979 framework directive (EEC 79/530),
- US-label – a label based on, but not identical to, the label that was then used in the USA,
- Leiden Star – designed by the University of Leiden but influenced by the Australian label,
- Leiden Horizontal – designed by the University of Leiden and using a graduated horizontal efficiency scale,
- Leiden Vertical – designed by the University of Leiden and using a graduated vertical efficiency scale.

The first trial, using 75 randomly selected people from the Leiden area, tested consumers' evaluations of the label layout including: comprehension of the information on the label, the informational content of the label, salience and appeal. These four notional factors for evaluating the labels were determined from factor analysis of the variance of consumer responses to nine 11-point bipolar scales, with the following extremes:

- non-understandable/understandable
- easy/difficult
- bad/good
- clear/unclear
- boring/interesting

[15] This section draws heavily from: M. de Loor and M. Zeelenberg (1991*) Energy-labelling: report of two laboratory experiments* Report no. E&M/R-91/26, the Centre for Energy and Environmental Research, Faculty of Social and Behavioural Sciences, the University of Leiden, the Netherlands.

- conspicuous/inconspicuous
- non-informative/informative
- appealing/non-appealing
- non-persuasive/persuasive

The *understanding* factor was found to be the most important and comprised the individual dimensions understandable/non-understandable, easy/difficult, and clear/unclear. The next most important factor was called *salience* and comprised the dimensions boring/interesting and conspicuous/inconspicuous, the third factor, *information*, consisted of the sole dimension non-informative/informative, and the fourth factor, *appeal*, comprised the sole dimension appealing/non-appealing. Results are shown in Table 13.

Table 13: Subject evaluation scores for 4 factors for each of the five generic labels

Factor	EC-label	US-label	Leiden star	Leiden Vert.	Leiden Hori.
Understanding	8.80 (2.27)	8.37 (2.29)	8.43 (2.56)	8.89 (2.07)	8.95 (1.96)
Salience	4.83 (2.78)	6.55 (2.57)	7.07 (2.81)	6.06 (2.76)	6.56 (2.56)
Information	8.16 (3.00)	8.36 (2.80)	6.87 (3.22)	8.16 (2.94)	8.23 (2.66)
Appeal	6.24 (3.50)	6.53 (3.30)	6.30 (3.77)	6.60 (2.48)	6.69 (3.23)

Notes: Total scores are out of 11. Values in brackets are standard deviations.
Source: de Loor and Zeelenberg (1991)

A score of 6 or more was considered to indicate a positive result and all the labels achieved this for all factors except salience for the EC-label. In addition, the Leiden Star label was found to has a statistically significantly poorer result for information than the other labels. However it needs to be remembered that the star label did not show all possible ratings (total stars were 7 and this was not shown or communicated to the participants) and as the label was fictitious, it had not been sighted previously so the participants had no context for interpretation of the stars (ie 1 = poor, 7 = best). Note that the salience of the star label was the highest.

The study findings above need to be seen as consumer interpretation from a "cold start" - that is without the presence of any ongoing program support such as advertising, labelling brochures or guides. In a program context the level of understanding and information may be somewhat different to that shown in these experiments.

Informational recall was also tested in this trial and in particular to see how well consumers could remember the absolute energy consumption value shown on the labels. The results were best for the Leiden vertical label and poorest for the 'US label'; see Table 14 for more details.

Figure 31: The Five Energy Labels Tested by the University of Leiden.
(after de Loor and Zeelenberg, 1991)

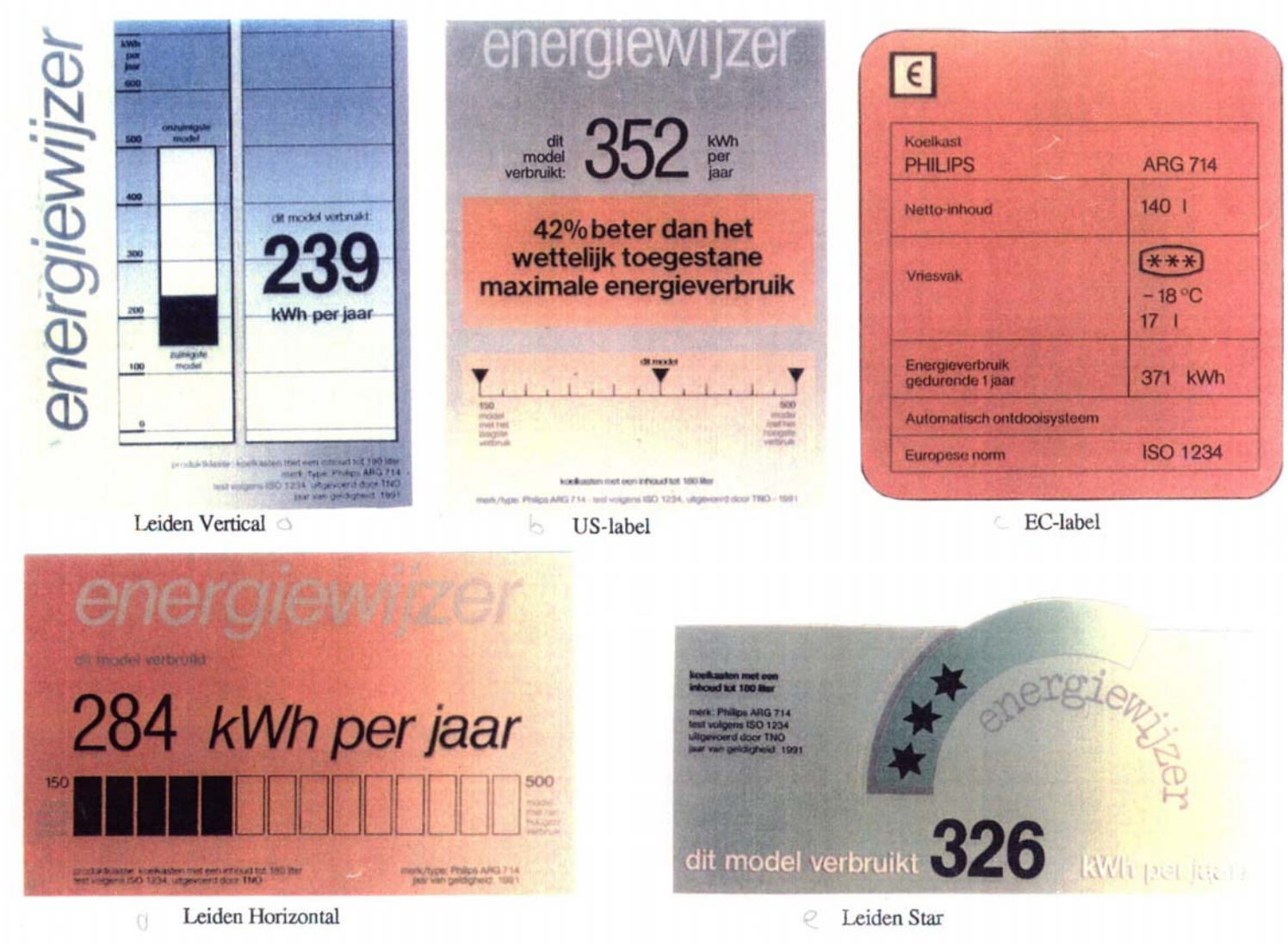


Table 14: Label Recall - Five Generic EU Labels

Factor	EC-label	US-label	Leiden star	Leiden Vert.	Leiden Hori.
After the first slide	46.7%	42.9%	60.0%	76.5%	42.9%
After the last slide	26.7%	7.1%	33.3%	41.1%	28.6%

Source: de Loor and Zeelenberg (1991)

The second trial investigated how accurately and quickly information was acquired from the labels to try and assess the functionality of the labels in a point of sale situation. This trial used 65 randomly selected people from the Leiden area. The results showed that the response time was significantly (statistically speaking) faster for the Leiden vertical label than all the others except the Leiden star label. The response times for the EC-label were shown to be significantly slower than for all the others. The accuracy scores were very similar and statistically inseparable between the labels.

Taken as a whole this research seemed to indicate that the Leiden vertical label was slightly more effective than the other label designs and that the EC-label was ineffective. Thus a decision was taken to focus on development of the vertical design; however, at this point the development of the EU label design ceased to be based solely on consumer research and began to be conducted by design agencies receiving guidance from an energy labelling design committee.

One issue that was much discussed for the EU cold appliance energy label was whether or not to include monetised annual running costs on the label. Some early sample labels were produced including this information but their impact does not appear to have been assessed. Overall the energy labelling committee considered that it was too problematic to include running costs as the price of electricity varied so much between and even within EU states[16].

The subsequent development of the European label was put largely into the hands of joint government/industry working groups and the changes over the period from 1992 to 1994 were incremental in nature.

5.2 Development of the Thai Energy Label

In 1994, the Thai DSM Office developed a label design for its voluntary energy labelling program. The same basic design is being used for both refrigerators and air conditioners. The label was designed by DSM Office officials without any formal survey or testing of consumer response. It consists of a dial-type display at the top with a scale that has a numerical rating from 1 to 5, 5 being the most efficient. The label is based on the design of the Australian and Korean energy labels. The Korean label is very similar, except that its rating system goes from 5 to 1, with 1 being the most efficient. The Australian label has a star, instead of a numerical, rating system, with 6 stars being the most efficient.

[16] Germany has some 800 utilities for example.

5.2.1 Refrigerators

In early 1994, EGAT approached the five manufacturers of household refrigerators and quickly gained their cooperation for a voluntary energy labelling program for the largest category of Thai refrigerators, which range in size from 4 to 6 cubic feet (mainly single door units of about 150 to 200 litres). The efficiency scale on the new energy labels ranges from level 1 to 5, with level 3 as the average and level 5 as the most efficient. A selection of the models in this size range was tested during the late 1994 to establish the average efficiency level. Models that fell within 10% of the mean are rated at level 3; models that are 10-25% more efficient than the mean are rated at level 4; and models that are more than 25% more efficient than the mean are rated at level 5.

The key to the energy labelling program is that it is voluntary. There is no "penalty" for having an inefficient unit, since the manufacturer is not required to apply a label. Rather, the manufacturers of energy-efficient units rated at level 4 or 5 have an incentive to put the label on the product and market it as an energy-efficient model. However, poorer efficiency products will certainly carry no label and there is intense price competition between these products, which may limit the effectiveness of the label.

5.2.2 Air Conditioners

A similar labelling program for air conditioners began in early 1996. The negotiations with air conditioner manufacturers were more difficult than those with the refrigerator manufacturers because of the diverse and fragmented nature of the Thai air-conditioner industry, which consists of 55 manufacturers, many of which are small, local assembly operations. Efficiency testing of air conditioners began in late 1995. Air-conditioners produced by multinational corporations received the highest ratings. These firms launched large promotional campaigns touting the energy-saving benefits of their air conditioners. Unlike the refrigerator market, air conditioner manufacturers chose to place energy labels almost exclusively on the most efficient units, those with a rating of level 5. Thus, consumers were typically faced with a choice between buying a unit with a label (i.e. a rating of level 5) or a unit with no label (i.e. an "invisible" rating of 4, 3, or worse).

5.2.3 Possible Changes to the Thai Label

The DSM Office realises that soon, nearly all of the single-door refrigerators in the market will be able to meet the number 5 rating. As this happens, the impact of the label will diminish. Thai officials have discussed two possible options for revising the label so that it can continue to be an effective "market pull" tool. One option would be to extend the rating system to 9, so that additional improvements to air conditioners and refrigerators would earn models a rating of 6, 7, 8, etc. Another would be to retest all of the models in the market and set a new mean value, thus requiring additional improvements for models to achieve a 4 and 5 rating. While the Thai official said that it would be difficult to convince manufacturers to agree to

retesting of models, they felt that the first option, extending the scale past 5 up to 9, would be even less desirable because of the high level of public recognition of the 5 rating (Sitthiporn Ratanopas and Banpot Sangkiaw, DSM Office, personal communication, March 1997).

5.3 Revision of the US Energy Label

In 1994, the Federal Trade Commission revised the EnergyGuide labels (FTC 1994). The new label was designed to deal with problems arising from discrepancies in annual operating cost that appeared on labels when the national average electricity price changed from year to year. The new label design was based on interviews with 120 consumers conducted in early 1991. In this research study, consumers were shown three alternative label designs and asked which they preferred.[17]

Based on the results of this research, as well as data submitted from a Canadian study that showed that consumers prefer energy units to dollars (Patterson 1991), the FTC decided to revise the label so that annual energy use (in kWh) rather than average annual operating cost, was the most prominent value and main comparative indicator. It is understood that following recent research by du Pont, the US DOE is considering funding a study to evaluate different appliance energy label options and to recommend an improved label design for the US (Nadel, personal communication, March 1997).

At the same time, the US DOE and EPA are expanding the use of the Energy Star endorsement label to consumer appliances, including those which carry a comparative label, via a program called the *Energy Star Retailer Initiative.* This consists of promotional activities with utilities, sales training, regional and point-of-purchase advertising and promotion, and labelling of products that meet the specified criteria. After a two-year pilot phase, during which the concept was tested in four US cities, and the results assessed using focus groups, the program has expanded to include more than 900 retailers nationwide. Preliminary data from 30 stores over a three-month period indicate that overall sales of Energy Star products increased by 27 % (Bodner 1997).

The US Federal Trade Commission is discussing with manufacturers the possibility of allowing manufacturers to print a small, green Energy Star logo directly onto the US EnergyGuide label for models that meet the Energy Star criteria (James Mills, U.S. Federal Trade Commission, October 1997).

5.4 Revision of the Canadian Energy Label

Patterson (1991) conducted a study of energy label designs for the Canadian government. This study, which consisted of three phases, included 18 focus groups across Canada, mostly with consumers (one was with retailers). In Phase I, the

[17] One flaw in the study was that the sample of the existing EnergyGuide label that researchers used was for a dishwasher. This is the most complicated label design because it has two operating costs and two tables, one for gas water heating and one for electric water heating.

researchers tested labels that used efficiency as a scale, and these labels received poor reviews. Participants were confused by the concept of having higher efficiency - and thus lower energy use and operating cost - at the right hand end of the scale. In Phase II, the researchers used two focus groups to test three types of scales - efficiency, dollars, and energy use. They tested the following factors:

- which scale is easiest to understand?
- extremity orientation (e.g., low to high or vice versa?)
- representation (best way to depict elements)
- calibration (quantification of measure, gradation, etc)
- adequacy of information (is the information understood, complete, clear?)

The focus group participants found the notion of a kilowatt-hour very confusing, and many of the participants said they did not know what it means: "The notion of 'kWh' is unfamiliar and/or obscure to the majority of participants." (p 27) The researchers also found problems with using dollar symbols on a scale: it was not clear whether the dollars represented operating costs or savings. (Note that they did not show the participants scales which clearly labelled the dollar units as either "costs" or "savings".) Because of this potential ambiguity, they concluded that energy was the least potentially confusing of the alternative scale measurements.

In Phase III, the researchers tested four different label designs with energy consumption as the scale metric. The label preferred by most of the participants, and which as selected as easiest to understand, looks like a car speedometer.

There was some inconsistency in the report's justification for not radically changing the form of the Energuide label.. The author stated that, "The majority of participants in most groups were unfamiliar with the EnerGuide label." (p 25) On the next page, he writes that the label "does appear to have a certain notoriety that warrants maintaining its present form (increases the recognition factor)."

6. Conclusions

6.1 Summary of Overseas Experiences

6.1.1 Effectiveness of Labelling

Energy labelling appears to have had some impact on the operation of the appliance market in every country in which it has been introduced. The following types of impact have been observed in one or more countries:

- the priority which appliance buyers give to energy efficiency among their purchase criteria increased;

- the average efficiency of the range of products on the market increased (in Thailand, where labelling is voluntary, the average efficiency of labelled products increased, but this could have been because suppliers only volunteered their more efficient models for labelling);

- appliance buyers showed greater preference for the more efficient products.

The best documented programs (apart from the Australian program, for which the documentation has not been reviewed in this paper) are the Europe Commission program, the US and Canadian programs (which started as separate programs, but are now effectively harmonised), and Thailand.

The European program is relatively recent, but has been well researched and monitored. Although evidence is still inconclusive, both suppliers and consumers appear to have responded (to different degrees in different countries). There is a wide range of anecdotal evidence that energy impacts are significant and that savings appear to be ongoing. However, some of the implementation aspects of the program (such as compliance levels, accuracy of the labels etc.) appear to be lacking, at least in the short term.

Although they are the oldest programs, the energy impact of the US *EnergyGuide* and Canadian *EnerGuide* does not appear to have been satisfactorily evaluated. They are the only programs so far where the original labels have been substantially redesigned to improve consumer comprehension (in response to previously poor levels). The effectiveness of the programs is uncertain, and is complicated by the fact that the US also has a very active MEPS program and the *Energy Star* endorsement label is now used for many of the same products as the *EnergyGuide* label.

The Thai label, and the extensive publicity campaign with which it was launched, appears to have greatly increased the level of consumer interest in energy efficiency. However, the impacts on actual sales-weighted efficiency trends have not yet been accurately established. The label only appears on a limited proportion of showroom stock and due to the limited range of ratings available (most models are now "5"), it is probably functioning more as an endorsement label than a comparison label.

6.1.2 Labelling Formats

It is difficult to assess to what extent the format and design of the label itself contributes to the effectiveness of the labelling program. The original EnergyGuide design, locating the models' running on a comparative scale with the most and least efficient in its class, was found to be confusing. However, it is not clear which element caused the difficulty: the scale or the "$ running cost" (said to be sometimes misunderstood as "$ saved"). There is evidence that consumers find the details of comparative scales difficult to remember when comparing products in different locations. It is also unclear whether the US label would have been better understood if it had received more publicity support.

The Thai experience suggests that with adequate publicity, the actual design of the label may well be less important. People will become familiar with it and learn how to use it if they see it on TV often enough. But the Thai message (buy an appliance with the rating "5") is simple and powerful and provides strong support for the argument of a simple absolute categorical rating system.

There is evidence that program support measures such as guides (at the point of sale or distributed prior to retail visits), Internet access and databases of products, will assist informed consumers (those seeking third party independent data sources) to select a more energy efficient appliances. While these consumers are likely to be a minority, even in OECD countries, they will create market pull for higher efficiency products and entice manufacturers to respond with product improvements. Marketing of the program is important as well, but to be most cost effective, the target audience needs to be narrowed to those consumers who are considering the imminent purchase of an appliance. Program support measures such as guides, marketing and consumer advisory services and all enhance the effectiveness of an energy label and it is important to consider these aspects when reviewing the operation of a scheme.

However, if the label has to do its own communication work without external assistance, then the following conclusions may be drawn:

- Most consumers would prefer $ running costs somewhere on the label, but no labelling program appears to have satisfactorily resolved how to do this, given that energy prices vary regionally and over time and that there is potential confusion between operating costs and savings (and in some cases purchase costs);

- Comparative labels using an absolute reference scale (eg "A to G" or "1 to 5", or in Australia's case 1 to 6 stars) appear to be more effective than the US style label, which uses a continuous scale where the extremes represent the actual market spread. It appears much more difficult for a consumer to recall information on the energy consumption value for the model (together with the end points of the reference scale) for comparative purposes in comparison with a simple rating value used in absolute scale systems (eg "C" or "3 stars"). The US situation may be partly a reflection of poor support for the program in addition to the difficulties associated with the intrinsic label design;

- There is a strong case for separating the label elements to minimise confusion for the consumer. The most important elements (such as the rating category) need to be clearly delineated, with the most important aspects (3 maximum) highlighted.

- While being generally complementary in nature, endorsement labels appeal to a distinct market segment that want to know which products are "the best" without having to wade through detailed analysis.

It is impossible to form a judgement whether endorsement labels would be more effective than comparative labels: in the US they have recently started to be used together, and this may turn out to be the most effective approach.

6.1.3 Evaluations

A review of past evaluations of energy labelling programs indicates the need to redirect research efforts in three areas: First, there is a need for field studies that assess consumer preferences and understanding of labels directly in the store environment. Such research can provide a more accurate indicator of consumer preferences since it more closely simulates the environment a consumer is in when she actually makes the appliance purchase decision.

Second, there is a need for more in-depth interviews and participant observation to assess consumer decision-making, both in the retail environment and elsewhere. Such research can help improve policy by identifying the factors necessary for a successful program impact. For example, consumer research performed for the US Fuel Economy Information Program revealed that most consumers narrow down their search of automobile models to a few models in a certain size (and therefore efficiency) range before they go to the store. As a result of this research, policy makers realised that it was important for consumers to have access to information on fuel economy *before* they go to the store, since once they are in the store they have typically already narrowed down their list of options. Such in-depth interviews also can aid in the interpretation of and provide insight into the results of large-scale surveys.

Finally, there is a need to link the label to actual behaviour and to quantify the extent to which the label influences consumers to purchase more energy-efficient models. The example of the US Fuel Economy Label is revealing: if only a tiny percentage of consumers rely on the label to purchase a slightly more efficient car, the program will save consumers hundreds of millions of dollars a year. Unfortunately, research that links energy labels to the actual efficiency of purchased appliances has been the exception rather than the rule.

The effective implementation of an energy labelling systems is also critical to a program's success. It is therefore important to track key variables such as consumer awareness, compliance levels in stores (proportion of appliances carrying labels) and the effectiveness of other support elements such as guides.

It is important to track the sales weighted market trends of appliances which carry energy labels as this provides good quantitative evidence of the impact of the program. However, care needs to exercised when interpreting the results as market changes may be partly due to other factors (eg technology changes). Evaluation of benefits and costs associated with energy labelling is important in terms the justification of the program.

6.1.4 Types of information commonly found on labels

The purpose of an energy label is to convey key information to a consumer to assist them in a purchase decision. It therefore stands to reason that there are likely to be key differences in the type of information that it is necessary to convey to the consumer, depending on their socio-economic, physical and cultural context. Differences in language and to a lesser extent, literacy, are also key factors that will influence the design and presentation of an energy label within a particular culture.

A key (but by no means obvious) difference between energy labelling programs is the assumptions that lie behind the calculation of the energy consumption and related performance data shown. Many energy labels have built into them assumptions about the frequency and duration of use for the calculation of energy consumption and related parameters. For example in the case of clothes washers, the data shown on some energy labels is based on an assumed number washing loads per year. Such estimates are usually based on surveys and data collected from the country or region where the energy label is to be used. In the case of Europe, the energy and water consumption is shown on a per wash basis leaving the consumer to calculate a typical annual energy consumption, should they wish to do so. This was presumably done as washing frequency varied considerably across the European Union.

It is argued by some analysts that the energy label will/should be of most economic value and most interest to customers who use their appliances most intensively, so it may be appropriate for values on the label to be calculated for a higher than average frequency of use - also, large “annual” figures for energy consumption and cost will have a greater influence on consumer decisions than small “daily” numbers. For example, 10 year running cost data (expected minimum appliance life) is shown on energy labelling brochures in Australia. This demonstrates the potential contradiction between energy labels as a consumer information program and as a policy measure for increasing energy efficiency.

The economics of energy efficiency is a key area of consumer interest with respect to energy labelling. Most consumers express interest in the cost of energy used to operate an appliance. However, conveying this information through an energy label has many problems including variations in energy tariffs within a country and in time. In addition, consumers can easily confuse cost information shown on energy labels as it is often unclear whether the figures relate to the cost of energy or the savings (Patterson, 1991). Some consumers also mistakenly believe values on an energy label to be related to the appliance purchase price. These problems prompted the US to change from a label that primarily showed energy cost data to one that shows energy with some costs.

The selected program or type of operation on the appliance for the purposes of energy labelling will also dramatically affect the data on the energy label. For example, in the case of clothes washers again, the "typical" program used in Europe for cotton garments in the 1980's was a 90oC wash. By the 1990's, 60oC was more common and this is the wash program now specified for the European energy label. The trend towards lower washing temperatures in Europe continues, and a program with a 40oC wash temperature is now quite commonly used. This mirrors documented trends towards lower wash temperatures in Australia over the past 15 years. In 1995 about 45% of wash loads were "warm" (nominally 40oC) while over 50% were "cold" (ie: no internal heating or external hot water - nominally 15oC to 20oC) (Harrington 1997, Harrington & Wilkenfeld 1997). This is a significant trend, as for a typical clothes washer around 80% of the total energy is water heating (or the energy embodied in external hot water drawn into the machine). As the Australian clothes washer standard, for the purposes of the energy label, specifies a warm wash, there is now a substantial discrepancy between the energy shown on the energy label and the actual in-use energy consumption in many households. Such trends, although gradual, make it quite a challenge to keep the information on an energy label up to date and accurate. Incidentally, the trend to cooler washing temperatures also undermines the case for minimum energy performance standards for clothes washers, since as wash temperatures fall, so do the real energy differences between models, and between vertical axis/impeller machines and drum machines.

The appliance most commonly labelled is the refrigerator, including refrigerator-freezers and separate freezers. In most cases the energy shown on a refrigerator is for continuous operation for 1 year, although many parts of Asia seem to prefer a monthly energy consumption figure (possibly due to monthly electricity billing cycles). While there is little scope for variations in discretionary use (these are limited to door openings and external food loads), the actual test procedure can have a substantial impact on the measured energy consumption. The two main test procedures used in the world today for the determination of energy consumption of refrigerators are ISO and the US AHAM (and a number of closely related procedures eg the one used in Australia and New Zealand is modelled on the AHAM test). The biggest single difference between these procedures is the ambient test temperature which is 25oC for ISO Temperate (most commonly used climate rating) and 32oC in AHAM (and ISO Tropical). While many analysts argue about which of these procedures is more relevant for their local climate and usage conditions (with respect to energy labelling), both procedures are deficient in that they do not provide sufficient data to enable a refrigerator's performance to be predicted across a range of external temperatures - climate is the single most important influence on a refrigerator's energy consumption.

The test procedures used to determine the energy consumption (and where relevant, the performance) of an appliance can also have a large influence on the measured energy consumption. Factors such as ambient temperatures (for refrigerators and air conditioners), minimum wash temperatures (dishwashers and clothes washers) and initial moisture content (clothes dryers) are all critical. While some of these parameters are specified in international standards, these do not always suit regional or national requirements for energy and performance testing. Often a national

standard will contain test conditions that are specific to and reflective of local climate and or consumer usage patterns.

One of the most obvious differences between energy labels results from differences in language. The European Commission has successfully managed to achieve a harmonised energy label across its 15 member states by using a model specific data strip that contains only non-language performance information. This is affixed to a language specific background which explains these performance measures. In fact the European appliance energy label is now being used in many parts of Eastern Europe, even though these countries are not yet members of the European Union. Labels that resemble the European energy label are being considered for use in places like Iran, although the differences in language and alphabet (eg direction of script) may complicate layout.

If an energy label is to have a significant impact on the purchasing decision of consumers, it is important for it to be supported with an information program that reinforces the message that energy is an important characteristic to consider in the purchasing process. Information programs can take the form of brochures or lists, advertising campaigns, retailer support programs and various forms of direct marketing. Such information campaigns need to be tailored to reach consumers in the most appropriate form and at the most appropriate time. Receiving information after an appliance has been purchased or when a consumer is not considering the purchase of an appliance is of little value. Clearly, such an information campaign also needs to be designed to suit the literacy levels of consumers and information sources that they commonly used. Therefore the energy label and the information programs that support it are necessarily very culturally and language specific.

7. References

ADEME 1994, *Study on Efficient Washing Machines, Dishwashers and Driers* - Experimental Analysis linking Energy and Water Consumption with Performance, Background report Number 3, by ADEME and Fabric Care Research Institute, France for the Group for Efficient Appliances (Europe), July 1994.

Agbemabiese, L., K. Berko, et al. 1996, Air Conditioning in the Tropics: Cool Comfort or Cultural Conditioning? in *ACEEE Summer Study on Energy Efficiency in Buildings*, Asilomar, CA, American Council for an Energy-Efficient Economy.

AHAM 1996, *Fact Book*, 1996. Chicago, IL, Association of Home Appliance Manufacturers.

AHAM 1996, *Home Appliance Saturation and Length of First Ownership Survey* (Final Report). Chicago, IL, Association of Home Appliance Manufacturers. Prepared by NFO Research, Inc.

AHAM 1997, *Directory of Certified Refrigerators and Freezers*, Association of Home Appliance Manufacturers, Chicago, Edition Number 1, January 1997

Anderson, C. D. and J. D. Claxton 1982, "Barriers to Consumer Choice of Energy Efficient Products, in *Journal of Consumer Research,* 9 (September): 163-170.

Axelrod, R. 1973, Schema Theory: An Information Processing Model of Perception and Cognition, in *American Political Science Review* 67(4): 1248-1266.

Balme, R. 1992, How Well Do Mayors Assess Citizens' Spending Preference, in *Research in Urban Policy (Volume 2, Part A)*. T. Clark. Greenwich, CT, JAI Press.

Beales et al 1981, Consumer Search and Public Policy, in *Journal of Consumer Research*, Volume 8, June 1981, authors H Beale, MB Mazis, SC Salop and R Staelin.

Bernard, H. R. 1994, *Research Methods in Anthropology: Qualitative and Quantitative Approaches,* Thousand Oaks, CA, Sage Publications.

Bettman, J. R. 1979, *An Information Processing Theory of Consumer Choice*. Reading, MA, Addison Wesley.

Boardman 1997, Cold Labelling - the UK Experience of Energy Labels, by Brenda Boardman, in *The Energy Efficiency Challenge: European Council for an Energy Efficient Economy Summer Study*, Spindleruv Mlyn, Czech Republic, 9-14 June, 1997.

Bodner, L. 1997, *Energy Star Appliances and Windows*. Presentation for Energy Efficiency Product Labelling Training and Study Tour for Latin America and the Caribbean, Washington, DC, D&R International.

BPA 1988, The Evaluation of Phase 2 of the BPA Appliance Energy Efficiency Promotion Campaign: Promotion of Energy-Efficient Refrigerators-Freezers. Portland, OR, Prepared by Columbia Information Systems for the Bonneville Power Administration.

Brown 1993, *Energy Labels and MEPS for Domestic Appliances - Issues Now Facing the Regulators and the Appliance Industry*, Richard A. Brown, paper presented to the ESAA Conference, 3 August 1993, Sydney.

Brown and Whiting 1996, *Consumer Attitudes Toward Energy Efficient Appliances: A Look at the Impact of the Energy Star Retailer Program*. Washington, DC.

Busch, J. 1990, *From Comfort to Kilowatts: An Integrated Assessment of Electricity Conservation in Thailand's Commercial Sector*, Ph.D. Thesis, Energy and Resources Group, University of California, Berkeley.

Byrd-Bredbenner, C. 1994, "Designing a Consumer Friendly Nutrition Label." in *Journal of Nutrition Education* 26(4): 180-190.

Carswell, L. K., J. J. Langel, et al. 1989, *Environmental Labelling in the United States: Background Research, Issues, and Recommendations*. Menlo Park, CA, Applied Decision Analysis. Prepared for U.S. Environmental Protection Agency.

Casey-McCabe, N. and J. P. Harris 1995, Energy Labelling: A Comparison of Existing Programs. in *Proceedings of the 1995 ECEEE Summer Study, European Council for an Energy-Efficient Economy*. Mandelieu, France,

CECED 1997, *Agreement about the verification of data declared on energy labels*, European Appliance Manufacturer's Association (CECED), July 1997.

Clark, R. 1977, *Edison: The Man Who Made the Future*. New York, G.P. Putnam's Sons.

Clark, T. 1991, The International Mayor: Cross-National Results from Sample Surveys of Mayors Conducted as part of the Fiscal Austerity and Urban Innovation Project, Department of Sociology, University of Chicago.

Claxton, J. D., J. N. Fry, et al. 1974, "A Taxonomy of Pre-purchase Information Gathering Patterns." in *Journal of Consumer Research* 1(December): 35-43.

Cowan, R. S. 1992, The Industrial Revolution in the Home. in *Technology*. Milton Keynes, UK, Open University Press.

Daamen, D. D. L., W. H. Weenig, et al. 1992, Energy Information on Domestic Appliances. The Netherlands, Centre for Energy and Environmental Research, Faculty of Social and Behavioural Sciences, Leiden University.

Dalimi 1998, personal communication with Dr Rinady Dalimi, Centre for Energy Studies, University of Indonesia, Jakarta.

de Loor and Zeelenberg 1991, *Energy-labelling: report of two laboratory experiments,* Report no. E&M/R-91/26, the Centre for Energy and Environmental Research, Faculty of Social and Behavioural Sciences, the University of Leiden, The Netherlands.

DEA 1994a, *Act on Standards for Energy Efficiency in Energy Consuming Equipment*, Danish Energy Agency, Act no. 94, 9 February 1994.

DEA 1994b, *Energy Efficiency Standards for Washing Machines and Dishwashers for Household Use*: Draft Executive Orders, 15 August 1994.

DEFU 1994, *Study on Efficient Washing Machines, Dishwashers and Driers* - Statistical Analysis - Wet Appliances, Background report Number 2, by Danish Technological Institute for the Group for Efficient Appliances (Europe), July 1994.

Directive 94/2/EC, *Implementing Council Directive 92/75/EEC with regard to energy labelling of household electric refrigerators, freezers and their combinations*, directive date 21 January 1994, Official Journal of the European Communities, 17 February 1994.

Directive 95/12/EC, *Implementing Council Directive 92/75/EEC with regard to energy labelling of household washing machines*, directive date 23 May 1995, Official Journal of the European Communities, 21 June 1995.

Directive 95/13/EC, *Implementing Council Directive 92/75/EEC with regard to energy labelling of household electric tumble driers*, directive date 23 May 1995, Official Journal of the European Communities, 21 June 1995.

DTI 1994, *Pilot Program for Introduction and Use of the EU Energy Labelling of White Goods in Retail Trade*, Danish Energy Agency, Association of Danish Utilities, NESA, Copenhagen Energy, Snehvide A/S and Danish Technological Institute, EU Save Program report XVII/4.1031/93-007.

Du Pont 1998, *Energy Policy And Consumer Reality: The Role Of Energy In The Purchase Of Household Appliances In The US And Thailand*, Ph.D. Dissertation (draft), University of Delaware. March 1998.

Duffy, J. 1995, U.S. Appliance Efficiency Standards: Background and Current Status. (Background memo.). College Park, MD, University of Maryland.

Duffy, J. 1996, *Energy Labelling, Standards and Building Codes: A Global Survey and Assessment for Selected Developing Countries*, International Institute for Energy Conservation, Washington, DC.

Dunlap, R. K. 1991, "Public Opinion in the 1980s: Clear Consensus, Ambiguous Commitment." in *Environment* (11-15, 32-37).

du Pont, P. and D. Lord 1996, Reality Check: Comparing Policymaker Perceptions

with Consumer Energy Behaviour. in *ACEEE Summer Study on Energy Efficiency in Buildings*. Asilomar, CA, American Council for an Energy Efficient Economy. 8: 8.27-8.37.

Dyer, R. F. and T. J. Maronick 1988, "An Evaluation of Consumer Awareness and Use of Energy Labels in the Purchase of Major Appliances: A Longitudinal Analysis." in *Journal of Public Policy and Management* 7: 83-97.

ECU 1997, *Decade: Transforming the Cold Market*, by the Environmental Change Unit, Oxford University, for the European Commission Save Program, Contract XVII/4/1031/Z/95-008, May, 1997.

EGAT 1995, General Information. EGAT Power Development Plan (PDP 95-01). Bangkok, Electricity Generating Authority of Thailand, System Planning Department.

EnerGuide 1996, *Energy Consumption Ratings of Major Household Appliances*, Natural Resources Canada.

Eulau, H. and K. Prewitt 1973, *Labyrinths of Democracy: Adaptations, Linkages, Representation, and Policies in Urban Politics.* Indianapolis, IN, Bobbs Merrill.

FDA Consumer 1995, "Food Label Changes Eating Habits." in *FDA Consumer* 29(3): 5.

FTC 1994, "Rule Concerning Disclosures Regarding Energy Consumption and Water Use of Certain Home Appliances and Other Products Required Under the Energy Policy Act; Final Rule." *Federal Register* 59(126): 34014-34066.

Fujii, H. and L. Lutzenhiser 1992, "Japanese Residential Air Conditioning: Natural Cooling and Intelligent Systems." in *Energy and Buildings* 18(3-4): 221-234.

GEA 1993, *Study on Energy Efficiency Standards for Domestic Refrigeration Appliances*, Group for Efficient Appliances, Commission of the European Communities, March 1993.

GEA 1994a, *Study on Efficient Washing Machines, Dishwashers and Driers*, Group for Efficient Appliances (Europe), Interim Report, July 1994.

GEA 1994b, *Study on Efficient Washing Machines, Dishwashers and Driers* - Basic Assumptions, Test Methods and Consumer Behaviour, Background report Number 1, Group for Efficient Appliances (Europe), July 1994.

Geller, H. and S. Nadel 1994, "Market Transformation Strategies to Promote End-Use Efficiency." in *Annual Review of Energy and the Environment* 19: 301-346.

GFCV 1991a, *An Evaluation of the Electricity Energy Labelling Scheme*, Gas and Fuel Corporation of Victoria and Quadrant Research, for the State Electricity Commission of Victoria, November 1991.

GFCV 1991b, *An Evaluation of the Gas Energy Labelling Scheme*, Gas and Fuel Corporation of Victoria and Quadrant Research, August 1991, report 21/91 P426.

Greening, L., A. Sanstad, et al. 1996, Retrospective Analysis of National Energy Efficiency Standards for Refrigerators. in *ACEEE Summer Study on Energy Efficiency in Buildings*. Asilomar, CA, American Council for an Energy-Efficient Economy. 9: 9.101-9.109.

Grubler, A. and N. Nakicenovic 1991, *Long Waves, Technology Diffusion, and Substitution*. Laxenburg, Austria, International Institute for Applied Systems Analysis.

Guthrie, J. F., J. J. Fox, et al. 1995, "Who Uses Nutrition Labelling, and What Effects Does Label Use have on Diet Quality?" in *Journal Of Nutrition Education* 27: 163-172.

GWA 1991a, *Review of Residential Appliance Energy Labelling*, George Wilkenfeld & Associates with Test Research and Artcraft Research, for State Electricity Commission of Victoria, September 1991.

GWA 1991b, *Residential Appliances in Australia - An Assessment of Market and Technology Developments with particular reference to energy efficiency*, George Wilkenfeld & Associates, for State Electricity Commission of Victoria, June 1991.

GWA 1992, *Household Refrigeration Energy-Efficiency in Victoria (Australia) - Technology Costs and Prospects*, George Wilkenfeld & Associates, for the State Electricity Commission of Victoria, August 1992.

GWA 1993, *Benefits and Costs of Implementing Minimum Energy Performance Standards for Household Electrical Appliances in Australia*, George Wilkenfeld & Associates with Lawrence Berkeley Laboratories, for Australian and New Zealand Minerals and Energy Council, Final Report, Sydney, July 1993.

GWA 1994, *Minimum Energy Performance Standards for Refrigerators and Freezers - Review of Manufacturer Recommendations to the Working Party*, George Wilkenfeld & Associates, for State Electricity Commission of Victoria, April 1994.

GWA et al 1993, *Evaluation of the National Energy Management Program*, George Wilkenfeld & Associates, Economic & Energy Analysis and others, for Department of Primary Industries and Energy, November 1993.

Harrington 1994, Comparison of Household Refrigerator Efficiency Standards in the USA with those Proposed for Australia and Europe, Lloyd Harrington, informal paper presented to the *ACEEE Summer Study*, Pacific Grove, California, 28 August to 3 September 1994.

Harrington 1997, Tracking Appliance Energy Efficiency Trends in Australia, paper presented to *The Energy Efficiency Challenge: European Council for an Energy*

Efficient Economy Summer Study, Spindleruv Mlyn, Czech Republic, 9-14 June, 1997.

Harrington 1997, Appliance Energy Labels from Around the World, paper presented to *The First International Conference on Energy Efficiency in Household Appliances*, 10-12 November, 1997, Florence, Italy.

Harrington and Wilkenfeld 1997, Appliance Energy Labelling in Australia, in *Energy & Buildings*, July 1997, Volume 26/1, Lawrence Berkeley Laboratories, USA.

Harris et al 1996, Energy Efficient Product Labelling: Market Impacts of Buyers and Sellers, in *ACEEE Summer Study Proceedings*, Volume 9, Asilomar, California, August 1996, authors: JP Harris and N Casey-McCabe.

Heydari 1997, Energy Efficiency Labelling of Household Refrigerator-Freezers in Iran, paper presented by Ali Heydari to the IIEC *Forum on Asia Regional Cooperation on Energy Standards and Labelling*, 14-16 July, 1997, Bangkok.

Heydari 1998, personal communication with Ali Heydari, Shariff University of Technology, Teheran, March 1998.

Hill, N. W. and R. P. Larsen 1990, Evaluation of the Federal Fuel Economy Program: Interim Report. Argonne, IL, Argonne National Laboratory.

Houston, D. A. 1983, "Implicit Discount Rates and the Purchase of Untried, Energy-Saving Durable Goods." in *Journal of Consumer Research* 10(September): 236-246.

Hughes, T. P. 1983, *Networks of Power: Electrification in Western Society, 1880-1930*. Baltimore, Johns Hopkins University Press.

IIEC 1995, *Standards and Labelling - the Philippines Residential Air Conditioner Program*, Peter Rumsey and Ted Flanigan, for the International Institute for Energy Conservation, Washington DC, September 1995.

IPC 1991, *National Energy Survey*, International Pacific Consulting and Harrison Market Research, Sydney, 9 August 1991.

Kempton, W. 1993, "Will Public Environmental Concern Lead to Action on Global Warming?" in *Annual Review of Energy and Environment* 18: 217-245.

Kempton, W. and C. T. Payne 1997, Cultural and Social Evolutionary Determinants of Consumption. in *Consumption and the Environment: The Human Causes*. P. Stern, T. Dietz, V. Rattan, R. Socolow and J. Sweeney. Washington, DC, National Academy Press.

Kempton, W. and L. Montgomery 1982, "Folk Quantification of Energy." in *Energy--The International Journal* 7(10): 817-827.

Kempton, W., J. S. Boster, et al. 1995, *Environmental Values in American Culture*.

Cambridge, MA, MIT Press.

Kuusela, H. 1996, Factors Affecting the Acquisition of Domestic Appliances and Energy Saving. *LINNKI: Research Program on Consumer Habits and Energy Conservation. Summary Report*. Helsinki, University of Helsinki.

Lave, J., M. Murtaugh, et al. 1984, The Dialectic of Arithmetic in Grocery Shopping. in *Everyday Cognition: Its Development and Social Context*. B. Rogoff and J. Lave. Cambridge, MA, Harvard University Press: 67-94.

Lebergott, S. 1993, *Pursuing Happiness: American Consumers in the Twentieth Century*. Princeton, Princeton University Press.

Lemoine, Y. 1996, Personal communication, adviser to Thailand's DSM Office.

Ling, R. and H. Wilhite 1992, An Ethnographic Examination of the Role of Energy Efficiency in the Sale and Purchase of Large Household Appliances in Scandinavia. in *ACEEE Summer Study on Energy Efficiency in Buildings*. Asilomar, CA, American Council for an Energy-Efficient Economy: 10.111-10.120.

Marcus, A. I. and H. P. Segal 1989, *Technology in America: A Brief History*. New York, Harcourt Brace Jovanovich.

Mareira 1997, Energy Labelling Programs in South America, by Professor Guilherme Moreira, Cidade University, Sao Paulo, paper presented to *The First International Conference on Energy Efficiency in Household Appliances*, 10-12 November, 1997, Florence, Italy.

Maronick, T. 1991, Summary of Findings from EnergyGuide Copy Test, Memorandum to Nancy Sachs and James Mills, Federal Trade Commission, Washington, DC.

McMahon, J. 1991, Appliance Energy Labelling in the USA. *Consumer Policy Review*. 1: 87-92.

McMahon, J. 1997, Personal communication.

McMahon, J. and S. Pickle 1995, Appliance Efficiency Standards. Part 2 of 2: Policy Process and Consumer Gains. in *Center for Building Science News*: 6.

McMahon, J., S. Pickle, et al. 1996, Assessing Federal Appliance and Lighting Performance Standards. in *ACEEE Summer Study on Energy Efficiency in Buildings*. Asilomar, CA, American Council for an Energy Efficient Economy. 9: 9.159-9.165.

Mills, J. 1997, personal communication, US Federal Trade Commission.

Morrill, J. 1993, “New Standards Begin, But Will Rebates Continue?” in *Home Energy* (January/February): 34.

MTIE 1997, *Energy Efficiency and Conservation in Korea*, Ministry of Trade, Industry and Energy, Korea, May 1997. Also paper: *Current Status of Energy Efficiency Standards and Labelling in the Republic of Korea*, presented to APEC Steering Group on Energy Standards, Vancouver, March 1997.

Mumford, L. 1964, "Authoritarian and Democratic Technics." *Technology and Culture* 5: 1-8.

Nadel, S. 1991, Utility Conservation Programs. *State of the Art of Energy Efficiency: Future Directions*. E. Vine and D. Crawley. Washington, DC, American Council for an Energy Efficient Economy.

Nadel, S. and D. Goldstein 1996, Appliance and Equipment Efficiency Standards: History, Impacts, Current Status, Future Directions. in *ACEEE Summer Study on Energy Efficiency in Buildings*. Asilomar, CA, American Council for an Energy Efficient Economy. 2: 2.163-2.172.

NEPO 1997, *Minimum Energy Performance Standards and Energy Labelling for Thailand* (Discussion Paper). Bangkok, Prepared by Energetics Co. for the National Energy Policy Office.

NEPO 1997, Terms of Reference. Thailand: Energy Efficiency Standards Regime. Bangkok, National Energy Policy Office.

Noble, D. F. 1983, "Present Tense Technology (Part Three)." in *Democracy* 3(4): 71.

NRC 1996, *Guide to Canada's Energy Efficiency Regulations*, Natural Resources Canada, May 1996.

Olshavsky, R. 1973, "Customer-Salesman Interaction in Appliance Retailing." in *Journal of Marketing Research* X(May): 208-212.

Orlowski 1990, *Energy Labelling of Gas Appliances in Australia*, Paul Orlowski, Gas and Fuel Corporation Victoria, paper presented to Osaka Gas R&D Forum, November 1990, Japan.

Parker, D. S., J. S.F. Barkaszi, et al. 1996, Central Air Conditioner Usage Patterns in Low Income Housing in a Hot Humid Climate. in *ACEEE Summer Study on Energy Efficiency in Buildings*. Asilomar, CA, American Council for an Energy Efficient Economy. 8: 8.147.

Patterson 1991, *Focus Testing of Alternative EnerGuide Labels*, prepared by Createc Market Research for Groupe Communication Canada, June 1991.

Patterson, P. 1997, Personal communication, Office of Transportation Technologies, Department of Energy.

Pirkey, D., B. McNutt, et al. 1982, *Consumer Response to Fuel Information: Alternative Sources, Uses, and Formats*. Passenger Car Meeting, June 7-10, Troy, MI,

SAE, Warrendale, PA.

Pylvanainen, E. 1995, *Energy Labelling -- Can the Consumers Be Influenced?* (Draft). Helsinki, Finland, National Consumer Research Center.

Rainer, L., S. Greenberg, et al. 1996, You Won't Find These Leaks with a Blower Door: The Latest in "Leaking Electricity" in Homes. in *ACEEE Summer Study on Energy Efficiency in Buildings*. Asilomar, CA, American Council for an Energy Efficient Economy. 1: 1.187-1.191.

Redinger, R. and R. Staelin 1981, Refrigerator Energy Labels. in *Consumers and Energy Conservation: International Perspectives on Research and Policy Options*. J. D. Claxton, D. D. Anderson, J. R. B. Ritchie and G. H. G. McDougall. New York, Praeger: 286-292.

Robinson, R. 1988, *The International Transfer of Technology*. Cambridge, MA, Ballinger Publishing Co.

Rogoff, B. 1984, Introduction: Thinking and Learning in Social Context. in *Everyday Cognition: Its Development and Social Context*. B. Rogoff and J. Lave. Cambridge, MA, Harvard University Press: 1-8.

Rohmund, I., J. S. McMenamin, et al. 1994, U.S. Electricity Forecast: Results and Decomposition. in *ACEEE Summer Study on Energy Efficiency in Buildings*. Asilomar, CA, American Council for an Energy Efficient Economy. 7: 7.206-7.212.

Rosenberg, N. 1985, *The International Transfer of Industrial Technology: Issues and Practice, Past and Present*. Paris, OECD.

Ruderman, H., M. Levine, et al. 1997, Energy-Efficiency Choice in the Purchase of Residential Appliances. in *Energy Efficiency: Perspectives on Individual Behaviour*. W. Kempton and M. Nieman. Washington, DC, American Council for an Energy-Efficient Economy: 41-50.

Salisdisouk 1997, Standards and Labelling in Thailand, paper presented by Nophdol Salisdisouk to the IIEC *Forum on Asia Regional Cooperation on Energy Standards and Labelling*, 14-16 July, 1997, Bangkok.

Sieber 1997, Implementation of the EU Energy Label in Europe, by Peter Sieber, Stiftung Warentest, paper presented to *The First International Conference on Energy Efficiency in Household Appliances*, 10-12 November, 1997, Florence, Italy.

Strang, V. 1996, *Environmental Values and the EU Energy Label*. Oxford, UK, Environmental Change Unit, University of Oxford.

Sustainable Energy Budget Coalition 1996, America Speaks Out on Energy: A Survey of Public Attitudes on Sustainable Energy Issues. Takoma Park, MD.

TLFS 1993, Load Forecast for the Thailand Electric System. Volume 1: Load

Forecast Summary. Bangkok, Thailand Load Forecast Subcommittee.

TLFS 1993, Load Forecast for the Thailand Electric System. Volume 2: Load Forecast Methodology, Basic Data, and Load Forecast Results by Sector by Utility. Bangkok, Thailand Load Forecast Subcommittee.

TLFS 1996, Load Forecast for the Thailand Electric System. Unpublished Forecast Data. Bangkok, Thailand Load Forecast Subcommittee.

TNO 1991, *Calculation of the Consequences of Energy Consumption Standards for the Market Supply of Domestic Refrigerators and Freezers*, by PEJ Vermeulen and RJMJ Weijers, TNO Environmental and Energy Research, for NOVEM, Netherlands, April 1991.

Turiel, I. 1997, "Present Status of Residential Appliance Energy Efficiency Standards: An International Review." in *Energy and Buildings,* July 1997, Volume 26/1, Lawrence Berkeley Laboratories, USA.

Turiel, I. and S. Hakim 1996, Consensus Efficiency Standards for Refrigerators and Freezers -- Providing Engineering/Economic Analyses to Aid the Process. in *ACEEE Summer Study on Energy Efficiency in Buildings*. Asilomar, CA, American Council for an Energy Efficient Economy. 9: 9.207-9.215.

Turiel, I., D. Berman, et al. 1991, US Residential Appliance Energy Efficiency: Present Status and Future Policy Directions. in *State of the Art in Energy Efficiency: Future Directions*. E. Vine and D. Crawley. Washington, DC, American Council for an Energy-Efficient Economy.

US DOE 1995, Energy Savers Retailer Initiative: Test Phase Program Report (Draft). Washington, Office of Building Technologies, U.S. Department of Energy.

Verplanken, B. 1990, *Effects of Energy Labelling: Two Experiments*. The Netherlands, Centre for Energy and Environmental Research, Faculty of Social and Behavioural Sciences, Leiden University.

Waide 1997a, *Analysis of the Energy Efficiency of 1994 Domestic Refrigeration Appliances: Part B*, by Paul Waide, PW Consulting for TNO and European Commission DG-XVII, Contract No. 4 - 1031/E/95-005 SAVE, January 1997.

Waide 1997b, Refrigerators: Developments in the EU market, Paul Waide, PW Consulting, paper presented to *The First International Conference on Energy Efficiency in Household Appliances*, 10-12 November, 1997, Florence, Italy.

Waide, P. 1997, Personal communication.

Waide, P. 1997, *Status of Efficiency Standards and Labelling for European Appliances*, Prepared for the Thailand National Energy Policy Office under contract to the International Institute for Energy Conservation.

Weenig, W. H. and M. Maarleveld 1993, *Impact of Energy Information Labels on Consumer's Choices of Refrigerator*. The Netherlands, Centre for Energy and Environmental Research, Faculty of Social and Behavioural Sciences, Leiden University.

Westbrook and Fornell 1979, Patterns of Information Source Usage Among Durable Goods Buyers, in the *Journal of Marketing Research*, Volume XVI, August 1979, pp 303-312.

Wilkenfeld, G. 1997, *Energy Labelling and Standards: International Experience*. Seminar on Efficiency Standards and Labelling, Bangkok, Conducted for the Thailand National Energy Policy Office.

Wilkenfeld, G. 1997, Evaluating the Impact of the Australian Household Appliance Energy Efficiency Program. paper presented to *The First International Conference on Energy Efficiency in Household Appliances*, 10-12 November, 1997, Florence, Italy.

Wilkenfeld, G.L. 1993 *Australia's approach to improving efficiency of appliances*, CADDET Newsletter, September 1993.

Wilkie, W. L. 1994, in *Consumer Behaviour*. New York, John Wiley & Sons.

Williams, K. C. and R. L. Spiro 1985, "Communication Style in the Salesperson-Customer Dyad." in *Journal of Marketing Research* XXII(November): 434-442.

Wolman, H. 1992, Local Government and the Citizen: Citizen Participation and the Mental Maps of Political Elites. Presented at the European Consortium for Political Research, Limerick, Ireland.

World Bank, T. Thailand, Promotion of Electricity Energy Efficiency, Mid-Term Review. Washington, DC, Asia Alternative Energy Unit, Asia Technical Department, The World Bank.

Yim, A. 1997, Adviser to EGAT's DSM Office.

Zabala 1997, Philippine Energy Efficiency Standards and Labelling Program for Room Air Conditioners, paper presented by Arturo Zabala to the IIEC *Forum on Asia Regional Cooperation on Energy Standards and Labelling*, 14-16 July, 1997, Bangkok.