Evaluating the impact of energy labelling and MEPS – a retrospective look at the case of refrigerators in the UK and Australia

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Abstract
Refrigerators and freezers in Australia have been subjected to mandatory energy labelling since late 1986. Minimum energy performance standards (MEPS) were introduced in 1999 and were upgraded in 2005 (to match US 2001 levels). The UK, under the European Directive for energy labelling, has required energy labelling for refrigerators and freezers since January 1995 and MEPS, through a separate European Directive, were introduced in September 1999.

Estimating the impact of programmes such as these that operate over very long periods provides special challenges. The existence of the program itself is now part of the base case scenario and it becomes increasingly difficult to estimate the scenario that would have occurred if labelling had not been introduced. Other external factors such as changes in technology and changes in product type (e.g. share of frost free) or attributes (volume) also complicate the analysis as these factors also have an indirect impact on energy consumption.

Initially, data which had been collected on sales weighted trends in appliance efficiency for refrigerators and freezers in Australia was examined. A detailed methodology to assess the impacts of these programmes' elements was developed and an impact assessment for energy labelling, MEPS 1 and MEPS 2 was undertaken. The impact of MEPS against an existing labelling backdrop was fairly straight forward. However, assessment of the long-term impact of energy labelling proved more difficult and new and innovated approaches were necessary.

Subsequently, the methodology was refined and then applied to the UK market over the period 1995 to 2005. The paper compares and contrasts the results from the analyses in each country.

The methodology now forms a sound basis for further evaluations in other countries to add to the international pool of data. The paper also provides lessons learnt in terms of data requirements and analysis systems that will assist others who wish to replicate the work.

Introduction

EFFICIENCY POLICY AND MARKET TRANSFORMATION

Refrigerators and freezers in Australia have been subjected to mandatory energy labelling since late 1986. Minimum energy performance standards (MEPS) were introduced in 1999 and were upgraded in 2005 (to match US 2001 levels). The UK, under the European Framework Directive for energy labelling (92/75/EC), has required energy labelling for refrigerators and freezers since January 1995 (implementation directive 94/2/EC) and minimum energy performance standards (MEPS) through a separate European Directive (96/57/EC) were introduced in September 1999.

The objective of mandatory energy efficiency standards and energy labels, in both Australia and UK, is to improve the energy efficiency of new products, and are the corner stone of market transformation policy. Other polices can be used to support the increased effectiveness of these policies, especially in the long term. This applies to the development of more efficient appliances through technology development, procurement, and also rebates and endorsement labels to provide market pull for

more efficient products. This process of market transformation is well described elsewhere (e.g. Boardman *et al*, 1997)

Prior to any program implementation, it is usual to undertake an appraisal of the market and to benchmark current performance. In the UK, this appraisal takes the form of a Regulatory Impact Assessment. In cases such as energy labelling and MEPS, these studies have not been very detailed for the UK (at a technical or economic level), since all member countries are required to implement applicable EU legislation in a timely fashion. The EU detailed appraisal was undertaken by the Group for Efficient Appliance (GEA, 1993), using an approach similar to US engineering analysis of the likely impact of standards. While some market assessment of current products was undertaken, this was limited to a small number of products in a limited number of markets (few UK models were assessed).

A similar process is undertaken in Australia. Regulatory Impact Statements (RIS), which set out the proposed regulations and costs and benefits for all stakeholders, are required to justify any new regulations. These include a detailed market assessment and estimates for energy savings. However, as these are the primary regulatory justification in Australia, substantial detail is normally provided as part of the RIS process. Most RIS's now separately assess the impacts in Australia and New Zealand, as most regulations are harmonised.

After implementation, it is common to evaluate the effectiveness of policies, to assess if the outcomes of the appraisal were achieved. Evaluating the longer-term impact of these two efficiency policies is the aim of this paper, along with lessons from the two different datasets to improve future appraisals and evaluations.

Estimating the impact of programmes such as these that operate over very long periods provides special challenges. The existence of the program itself is now part of the base case scenario and it becomes increasingly difficult to estimate the scenario that would have occurred if labelling had not been introduced. Other external factors such as changes in technology and changes in product type (e.g. share of frost free) or attributes (volume) also complicate the analysis as these factors also have an indirect impact on energy consumption.

EVALUATION INTRODUCTION

To ensure government policy is introduced and implemented optimally, it is good practice for evaluations of policies and programmes to be undertaken. An evaluation will examine the outturn of a policy measure, and compare it with what was expected of the policy measure.

Evaluations may be undertaken after the policy has been implemented (for one-off events like MEPS) or while it is still running (particularly for ongoing programmes such as energy labelling, but also for programs that span a defined period). The method of undertaking the evaluation is similar to the economic appraisals of policy measures done a-priori, except that it is based on what actually happened, rather than what was expected to happen.

A good evaluation should review the performance measures and the monitoring data which can be used to assess the impact of the measure.

In terms of evaluation in the UK (see, for example, the Treasury green book, HM Treasury 2003), it is common to use terms such as outcomes, outputs, targets. The desired 'outcome' of standard and label policies is more efficient refrigerators sold. The 'output' measure is the energy efficiency index[1] (or the subsequent energy label classification for mandatory MEPS). The target of the policy is the reduction of the average energy efficiency index, or removal of products greater than a certain value.

The Treasury Greenbook, goes on to suggest that a good evaluation should include the following:

- An assessment, quantified where possible, of what happened;
- A comparison with the target outturn (or outcome);
- A comparative assessment of one or more counterfactuals (i.e. alternative outturns given different states of the world, or different management decisions).

The results of an evaluation should summarise:

- Why the outturn differed from that foreseen in the appraisal;
- How effective the activity achieved its objectives, and why;
- The cost effectiveness of the activity; and
- What the results imply for future management or policy decisions.

It is also common to evaluate 'distributional impacts', or the costs or benefits of interventions across different groups in society. For UK climate change policy it is common to examine the impact on treasury (government), manufacturers (industry), and consumers.

PREVIOUS EVALUATIONS ON COLD PRODUCTS

There have been very few evaluations of existing policy implementation which apply to refrigeration appliances. In Australia, the first detailed long-term evaluation was undertaken by EnergyConsult (2006), and forms the basis of part of this paper. This paper reports the first longer-term evaluation of standards and labels for refrigeration appliances in the UK.

WHAT IS IN THIS PAPER

- Evaluation of Australian standards and labels
- Evaluation of UK (revised approach)
- Comparisons and lessons learned
- Recommendations for improved evaluation of product policy

Methodological approach applied to Australian data

The approach used by the 2006 Australian study was to make re-projections after the introduction of each new policy. The energy savings resulting from three regulatory options were

1. Under the European energy labelling scheme, the Energy Efficiency Index (EEI) is the ratio of energy of a particular product to the energy consumption of a standardised 'average' product of the same type and size. Hence a lower EEI is in fact a higher efficiency product. In contrast, a higher star rating index, which is used for energy labelling in Australia, means a higher energy efficiency.

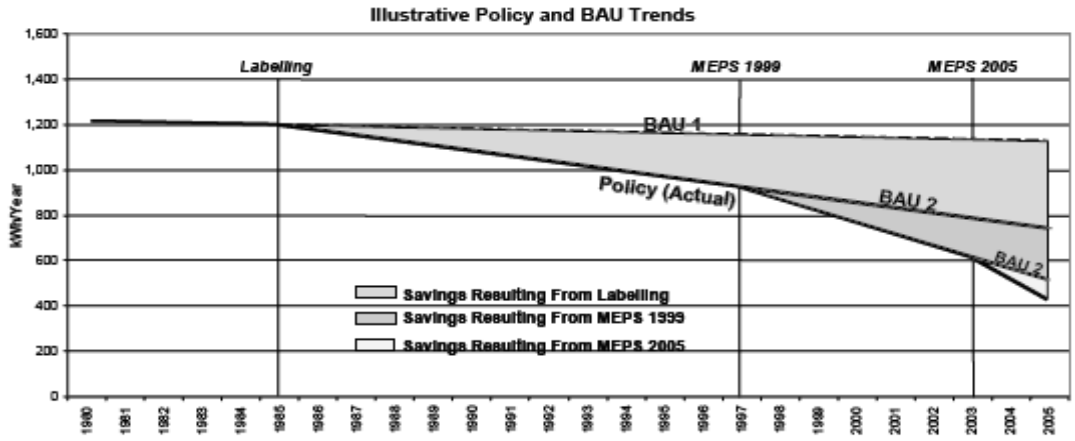

Figure 1: Policy savings for Australian refrigeration appliances (kWh/year)

estimated separately based on the assumption that a policy implementation changes the previous trend and sets a new trend so that the pre-policy trend becomes BAU trend (business-as-usual) and post policy trend becomes the policy trend. However, when a new policy is implemented in addition to previous policy or as a replacement of older policy, the previous policy trend becomes BAU trend and the policy trend is determined by the new values. Hence the resulting savings for each policy implementation can be estimated separately as illustrated in Figure 1. As can be seen from the figure, the savings are a function of difference between the policy (actual) value and the BAU for a given year. Hence, the savings due to implementation of labelling between the period 1986 and 1997 can be estimated simply as a function of difference between the policy and BAU1 values. However, the savings due to labelling between 1997 and 2003 are the function of Policy – BAU1 – BAU2, where as the savings due to MEPS 1999 for the same period would be Policy – BAU2.

The main findings of such an approach, detailed results of this study:

1. Projections made in Regulatory Impact Statements are relatively accurate for this product group with respect to MEPS. The projections made in the two domestic refrigerator Regulatory Impacts Statements for MEPS have largely been supported by the findings of this retrospective analysis. The original estimates were based on conservative assumptions resulting in more modest impacts being predicted but they remain robust economic analyses upon which Ministers took informed decisions at the time. They underestimated the benefits or impacts of the two regulations which, with the benefit of hindsight, should have been expected because low-end assumptions were used as a means of garnering widespread stakeholder support for the regulatory proposals.

2. Future RIS impacts and benefit cost analysis should be conservative – Future projections in Regulatory Impact Statements should continue to adopt assumptions which accord with the "worst case scenario" based on plausible but conservative assumptions. For example, the findings on pricing confirm that little evidence exists to support the plausible assumption that more efficient products should result in higher prices within the range of efficiency levels examined for MEPS. Over the seven year period studied in detail, no correlation between efficiency changes resulting from MEPS and corresponding price could be established from the data leading to a conclusion that the improved efficiency of domestic refrigerators and freezers was delivered by a competitive market to the consumer at no discernable change in cost trend over the MEPS implementation period. This conclusion, however, should not lead to future economic analysis predicting no price impact as a result of MEPS; far from it. The assumption of a 1.6 % to 8 % increase in product prices was reasonable and should, in all probability, be used in any future regulatory impact statement associated with this product. However, as data sets improve, these estimates can be refined for future MEPS analyses.

3. Ongoing detailed analysis of the Australian market for refrigerators, which examines actual prices and sales for more than 90 % of all sales on the market, shows that price and efficiency are very weakly linked (apart from some perverse groups such as side by sides which show a correlation between higher price and lower efficiency). Even with the implementation of stringent MEPS in 2005, which resulted in an average sales weighted reduction in energy consumption of 25 % for refrigerators and 30 % for freezers (from calendar 2003 to calendar 2005), there was no measurable impact on price.

Price and efficiency analyses are of some interest when assessing potential economic impacts, but any observable correlations between these parameters only apply to the efficiency range for products currently on the market. In the case of MEPS 2005 in Australia, when the levels were finalised in late 2000, no products on the market at the time would have met the requirements. There was a justifiable concern at the time that an average 30 % to 40 % reduction in energy as a result of the proposed MEPS could drive prices up beyond the observed price-efficiency trends on the market at the time, so conservative assumptions were adopted. As it happened, suppliers were able to meet the requirements without any observable price impact. However, other factors such as increased market competition (and reduced internal profitability) could account for the suppression of prices during this period.

The implied conclusion from the study results, that unlimited efficiency can be delivered at no marginal cost, is a dangerous one. While it may be valid for moderate increases in efficiency as a result of regulation where there are room for improvements, there will become a point where even modest

increases in efficiency may drive prices up in a dramatic fashion (especially where stringent MEPS and other tools for increasing efficiency have been in operation for some time).

4. Projected impacts from MEPS often occur earlier than anticipated. Timing of projected impacts should consider the fact that industry typically responds some years before a new regulatory requirement takes effect. While registrations occur well ahead of any new regulatory requirements, the sales volume of such products can be slower to reach the market. However this effect should be considered on a product by product basis, as the lead time for response is highly dependent on the level of stringency of the MEPS, sales volume, product life and the adaptive nature of the industry.

5. One of the limitations of this type of study is its dependence on data. This type of retrospective analysis can only be confidently undertaken where detailed information is available about the product and marketplace (e.g., model energy usage, sales data, prices and product performance data are available) and agreement is reached on the methodology of the study.

6. Alternative methodologies may provide useful insights – Based on the comparative findings for this product, scope exists to use a model-weighted approach as a simple retrospective analysis tool, especially given the difficulties and cost associated with attempting sales weighted analysis (where the data does not exist). This more affordable methodology could provide some timely comparisons from which to broadly compare pre and post regulation impacts. Product energy and performance characteristic data is required for retrospective analysis. The data are usually contained in registration databases associated with energy efficiency programs and include energy performance test results, model identification, size/price and other attributes. An obvious limitation is that a full estimate of market impact for a new energy program is more difficult for a product that has not previously been regulated as good market data at a model level are usually difficult to obtain (as well as attributes of each model).

7. Such a retrospective study should be repeated every few years, to benchmark developments in this product which would also potentially verify the early trends for Australian MEPS 2005 and validate the on-going projected energy savings.

Methodology applied to UK evaluation

OVERVIEW OF UK EFFICIENCY POLICY

There are various policy measures, beyond MEPS and energy labels, which effect the efficiency of refrigeration products sold in UK, these are listed in Table 1.

Other measures in EU and other EU member states may also have an impact on the products sold in the UK, especially as a single market. For example there have been major subsidy programmes in the Netherlands and Denmark which will have pulled the development of best practice appliances. Also, more recently, the TopTen project (www.topten.info) has developed new class leaders in Europe which will assist future efficiency measures in UK/EU.

All of these measures also, take place on a background of manufacturers developments, such as phasing out CFCs (requirement of the Montreal Protocol and regulation 3952/92), and responding to consumers demands.

UK DATA AND EVIDENCE AVAILABILITY

Standards and labels for the EU as a whole were appraised by the Group for Efficient Appliances (GEA, 1993), where their approach was based on an engineering analysis on levels of efficiency improvement (similar to the analysis undertaken in the US – e.g. LBNL 1995). However, the ultimate levels chosen for standards in Europe were lower than those originally proposed by the GEA, as agreed by the EU Commission, Council and Parliament. A separate regulatory impact assessment was undertaken for the UK, however, this is not very detailed since the UK was obliged to implement EU legislation irrespective of the impact or outcome. An appraisal was done by an EU/UK funded project to examine the likely impacts of the 1999 minimum energy performance standards (Boardman *et al*, 1997, and an initial evaluation Scheillerup 2001).

Data on sales have been collected by a marketing company, along with the attributes on the energy label. Unlike Australia, there is no central deposit of energy label information, the information on the energy label is self-declared, and this is collected separately by GfK (and initially with low market coverage). The European appliance manufacturers' association does have a central database, though this is not public. Having a central deposit, similar to the Australian approach would greatly assist policy appraisal and evaluation. In addition it would assist with

Table 1: Energy efficiency measures for domestic refrigeration

Policy	Description
EESoP (1994-2001)	Subsidy for efficient appliances, e.g. fridgesavers (small number of measures)
A-G label 1995	Mandatory, EU since 1995 (significant impact)
Eco-label	EU Eco-label, endorsement label on energy and other environmental impacts (not widely used)
EEC 2002-2005	Energy efficiency commitment on energy suppliers, to install efficient measures/appliances into people's homes.
CECED VA	EU appliance manufacturer association voluntary agreement, running to 2008 (eei=0.53) (overlaps with other policies, though removes C-rated products from the market)
Label A+, A++	2004 (some effect, build on effective EnergyPlus programme)
EEC 2005-2008	Follow on from EEC 2002-2005, subsidy for efficient appliances
EST ESR	Endorsement of most efficient appliances by the Energy Saving Trust
Energy Plus	Bulk purchase (small effect in UK, though develop top?)
Energy Plus 2	Innovation (brought very efficient appliances to EU market)
Quick wins '07	Government procurement, A-rated is the target (low impact in UK)
MEPS 1999	Eliminate lower efficiency products from the market

market surveillance and enforcement, and allow consumer to make more informed choices if these data were available in databases (e.g. through websites). Lack of such a central database is a clear omission in energy efficiency policy.

Simple evaluations have also been undertaken for some other policy measures, e.g. the Energy Efficiency Standards of Performance and latterly the Energy Efficiency Commitment, which is the UK's major efficiency programme which indirectly provides rebates and subsidies to the efficient appliances.

CHANGES TO METHODOLOGY FOR UK ANALYSIS

Initially, the same approach was used to estimate the savings as used in the Australian analysis. Improvements in overall all-cold appliance efficiency can be masked by changes in volume and features (such as frost-free for fridge-freezers and fridge-freezers) for each product sold. So for the evaluation projections, any counterfactuals have to be accounted for in the 'historic' projections. That is, the average consumption figure on new products, for the projection made before 2006, should be corrected for the actual size and proportion of frost-free that were actually sold. In addition, increased numbers being owned means consumption may not be decreasing as fast as would be expected from the increase in efficiency alone. This too should be amended in the analysis, to reflect what actually happened, rather than what was projected to happen.

Ideally, the trends within each type of refrigerator or freezer should be tracked individually – to some degree this eliminates many of the problems of more general overall market analysis for complex products like refrigerators and freezers, which are in fact made up of many distinct product sub-groups. For example, where frost-free products are separately evaluated from products that use direct cooling, there is no need to account for the overall differences in average sizes or apparent efficiency differences between these product types. Of course, within a product type, there will be changes in volume and perhaps some features over time, but these changes are usually small and gradual and their energy impact can be corrected where necessary. Changes in market share between products can distort trends or even provide conflicting information. For example when looking at UK refrigerators as a whole (both standard with an ice-box and larder-without an ice box), there is a significant improvement in efficiency. However, part of that improvement is due to the dramatic increase in sales of larder style refrigerators (accounting for 85 % of refrigerator sales in 2005, from 59 % in 1999. The appraisal in 1997 made a projection of 75 % as larder in 2005). So evaluating impacts is a complex process that requires not only attributes such as energy and price to be forecast as a result of energy policies such as labelling and MEPS, but also market share changes into the future.

Using this approach to correct for counterfactuals, it is still challenging to robustly attribute energy savings to specific measures. There may be other policies, or drivers, in place or it may not be fair to attribute all the changes to these specific policies. To really attribute savings, requires an understanding of what is happening in the market place, and how actors are responding to different policy measures.

Interviews with stakeholders can provide insights into the motivation of various actors, and to which policies they are responding to.

UK ANALYSIS RESULTS

Initially, the same approach was used to estimate the savings as used in the Australian analysis. This gave new reference (or BAU) projections prior to the implementation of the new policy. For example, the projection for chest freezers is shown in Figure 2 below. For the BAU scenario for chest freezers, the assumed slight increase in efficiency was equivalent to a slight increase in volume. This may be seen as an overestimate of the likely BAU.

By correcting for trends that actually happened (in this case change in size), it is possible to make an estimate of the energy savings attributable to labels and to MEPS. This is done by running the 'corrected' data through the stock models developed for the policy appraisals. This is still a crude analysis due to the uncertainties listed above, especially attribution issue, but does

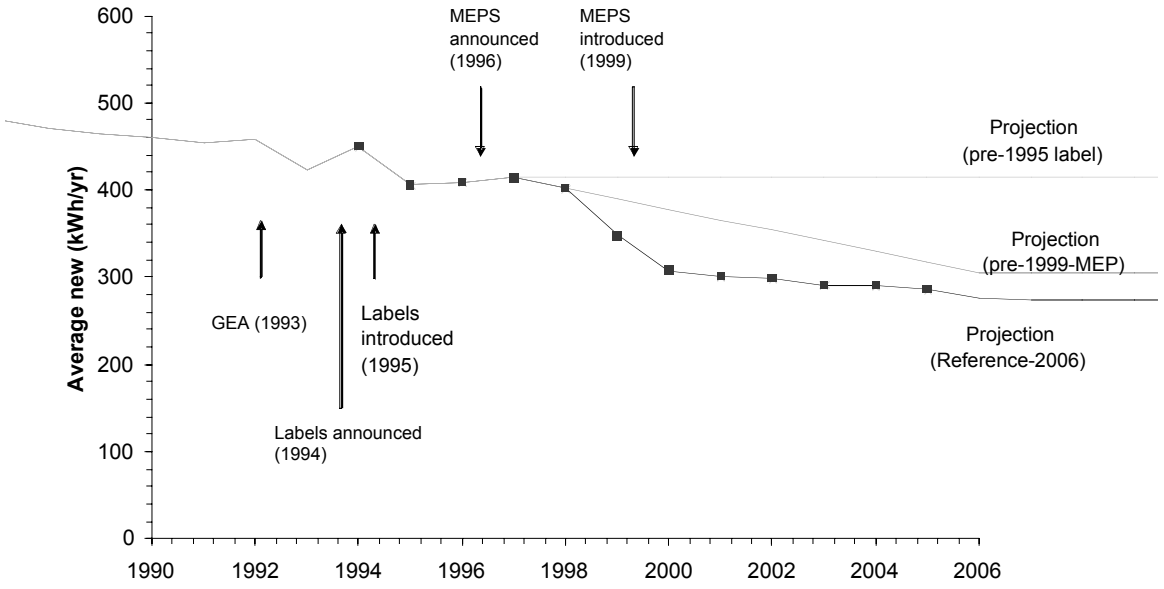

Figure 2: Average new energy consumption (kWh/year) of chest freezers sold in the UK

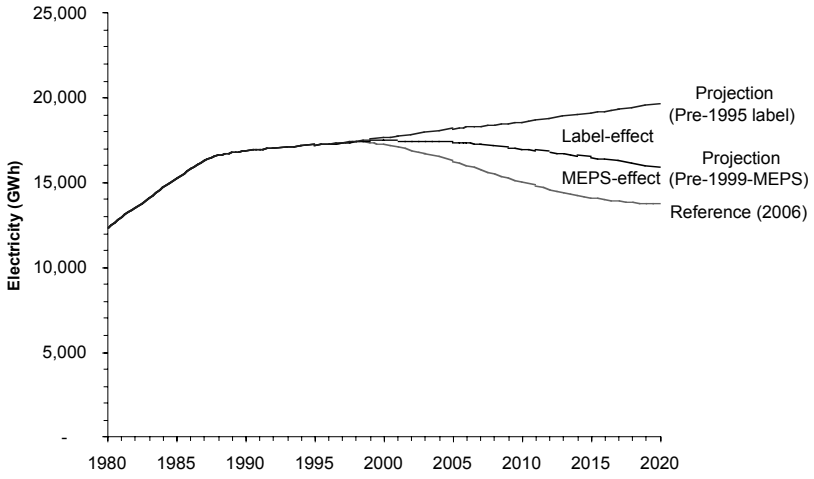

Figure 3: Energy scenarios from different starting points (pre-label, per-MEPS, 2006 reference)

provide a strong indication of the energy savings. These are shown in Figure 3.

UK EVALUATION SUMMARY

UK cold products sold are substantially more efficient than 1994, and more so than would have been expected without the introduction of energy labels and MEPS. Energy savings beyond what was expected (using 1994 reference case for efficiency and 2006 values for remainder) gives substantial reduction in energy, equating to over 2 TWh in 2006, and projected to realise savings of 3.5 TWh by 2010 (per annum, not cumulative). This will also deliver significant carbon reductions and financial benefits to consumers.

These savings are realised through the supply chain putting more products on the market in response to the legislation. Some of this response is in anticipation of consumer demand for products labelled with higher efficiency levels. This demand from consumers was borne out by early surveys of consumer response to the label. A consumer response survey in 1995, the year of introduction of the energy label, suggested that around one third of consumers were influenced by the label, purchasing appliances that were 7 % more efficient than would otherwise be the case (Boardman *et al* 1997).

The minimum efficiency performance standard improved the efficiency of sold products by over 10 % in one year with no increase in purchase price. The cumulative effect of this policy should mean savings of around 2TWh per annum in 2010 due to this policy.

Later legislation (post 2001) could also be included in the analysis where significant efficiency improvements have been made, though it is increasingly difficult to attribute fairly to separate policy with multiple initiatives. The EU-wide voluntary agreement to remove least efficient from market, and move the fleet average, has been assisted by revised energy labels, continued rebates around EU, and EEC in the UK. For instance, initial returns from the British energy suppliers, for the first year of the second phase of EEC (2005-2008), suggests that 1.2 million refrigeration appliances have been supported through this policy route. This is almost a half of all refrigeration appliances sold (Ofgem, 2006).

Comparisons of the two analyses, lessons learned

The main message from the evaluation of both policies is that they have both realised significant energy savings, and that they are very cost-effective policy instruments.

The main purpose of this paper is to explore the issues surrounding good evaluation. They cover issues surrounding data availability and quality, modelling, and attribution.

DATA ISSUES

Without appropriate data**,** evaluation analysis is difficult. The main issues arising from the data are as follows: preferences, on the following:

- Tolerances on data declared on the energy label (or for MEPS) could be significant in the UK datasets, where there is manufacturer self-declaration and 'allowable' tolerances (the industry makes use of the tolerances and are taken as allowances through poor definition and little verification and enforcement). This is potentially a one-off offset to the impact evaluation, though has been the subject of intense debate. Australia has avoided this by requiring the submission of detailed test reports for all models.
- A centralised listing of all models available on the market over time is an essential piece of data for any analysis. Such a listing needs to include key parameters such as energy consumption, volumes by compartment type and any relevant features such as defrost type, configuration, number of doors and so forth. In Australia, all models sold on the market must be registered with a regulator and all relevant data submitted, including supporting test data (as noted above). In Europe, there is no central register of products that is available for analysis. CECED hold an internal database of models with some key attributes, but this is not public. This seems to be a major impediment for ongoing market evaluations for all products covered by labelling and MEPS in Europe.

- For analysis of the change in efficiency or other variables, it is preferable to use sales-weighted data. A short analysis of the Australian data suggests that models-weighted analysis will not introduce a significant error. A model weighted approach can be further refined where market share by brand is known (which is more readily available than individual model sales data in many markets).

STOCK MODELLING ISSUES

Since the energy consumption of cold appliances is not measured in situ, with sufficient detail and regularity, the evaluation of energy savings from policy measures is dependent on the use of stock models. There are issues with such models and include the following:

- Stock and sales volume data issues (the main issues concern definitions, and data quality, for instance are all sales recorded destined for the domestic sector?). In Australia, some 10 % or so of 'domestic' sales could end up in the non-domestic sector – this varies by product type) (although this is not that important if the models are driven by stock estimates from ownership surveys, and the sales of new products are only assessed to estimate the attributes of new items that are entering the stock in a particular year – it does not matter that some of the sales go elsewhere).
- Need to account for counterfactuals, which means having reliable data on sales of features over time (e.g. frost-free, size): a separate analysis of each product type simplifies this issue.
- The stock models assume a fixed lifespan in the modeling. There is some evidence to suggest that lifetimes of products in the home are shortening. Robust stock models with time varying lifespan would need to be developed to reflect this.
- The energy consumption of a refrigeration appliance as installed in a consumer's home is assumed to be the same as the energy label. For the UK this could be an overestimate (where houses are generally cooler than the testing protocol conditions of 25°C, but there is the addition of food loads and door openings). In Australia, the testing condition is warmer again (32°C), but ambient conditions are on average warmer than Europe. All refrigerator testing procedures, including ISO/EN (used in Europe) and AS/NZS (used in Australia) have issues when attempting to replicate in-situ energy consumption of refrigerators and there are severe limitations in comparing the relative energy efficiency of products in the two countries because of disparities in the test methods[2] used.
- Refrigeration appliances may also deteriorate over time (i.e. use more energy as they get older). This has not been included in the evaluation (nor usually in appraisals) and the available data on this issue is very limited.
- Neither analysis include the effect of reduced heat from the appliances when more efficient products are purchased: in the UK this will mean some additional heating is required by the heating system (reduced overall energy savings), whilst in Australia, likely that cooling load is reduced (extra energy savings could be claimed), although this varies by season and by region.

ATTRIBUTION ISSUES

Perhaps the most challenging part of such evaluations is the attribution of policy measures to specific outcomes. It is usually very difficult to attribute the cause of a particular policy to the effect. This is especially true where there are multiple policies and actors that are responding to these as a whole but may also be specifically responding to one particular policy.

The impact of MEPS is usually easier to detect in data series, especially if there is significant improvement in efficiency or consumption (this is relatively clear in the UK for the 1999 MEPS, and very clear in Australia in 2005). However, this is not always the case, especially if other, well targeted, market transformation policies, have meant a smoother transition towards more efficient polices. In could be argued that a smooth transition is an indication of successful policies, though the substantial improvement in 2005 Australian levels, can be considered successful since it was realised without increase in purchase costs trends, suggesting there was room for cost-effective efficiency improvement in that market prior to 2005.

A similar difficulty is present when trying to estimate the effects of the BAU efficiency/energy use of appliance types. There may be some improvements in efficiency, even without any government policy measures, this is sometimes referred to as the autonomous rate of improvement.

The longer-term effect of labels is more difficult to attribute, but has been done by removing other parts of policy. To really understand the reasons efficiency levels have improved, the analysis should be complemented by additional types of evidence gathering. This should include surveys of consumers to understand their motivations for purchasing, what is triggering manufacturers to change the production line, and also retailers to understand their purchasing policies.

Conclusions

The main message from the evaluation of both policies is that they have both realised significant energy savings, and that they are very cost-effective policy instruments. For the UK, energy savings beyond what was expected gives substantial reduction in energy, equating to over 2 TWh in 2006, and projected to realise savings of 3.5 TWh by 2010 (per annum, not cumulative), compared to basecase with energy labels or MEPS. The impact of Energy Labelling for refrigerators and freezers in Australia on energy is significant, with savings rising from 20 GWh in 1986 to over 750 GWh pa in 2005 (noting that the population is roughly one third of that in the UK). MEPS in 1999 achieved annual energy savings of just under 700 GWh pa in almost nine years, which is almost equivalent to annual savings attributed to energy labelling after 20 years.

2. There are a range of differences in these two test methods that make comparisons difficult, if not impossible. Both use a single ambient to determine energy. Ambient temperature variations are by far the largest factor in affecting in situ consumption and neither procedure has the ability to correct for actual ambient. ISO/EN use target internal tempatures of +5°C/-18°C for fresh/freezer while AS/NZS uses +3°C/-15°C. More importantly, freezer temperatures determined under ISO/EN are based on maximum test package temperatures and in fact bear little relation to the average freezer temperature, which is a key driver for energy consumption. See Harrington (2001) for more details.

One of the key conclusions from the historical analysis of the MEPS impacts in both 1999 and 2005 in Australia was that there have been significant changes in market share for different types of refrigerators and freezers over the past 20 years, but that regulatory programmes appear to have no observable impact on the trends in market share (at least in the cases evaluated to date). It is conceivable, however, that regulations could impact on market share of product or technology types if MEPS levels were quite stringent for a particular type and weak for another type. However, this makes little policy sense in most cases. Some appliance types, like clothes washers, have two main product types which have substantial inherent differences in water and energy efficiency – a very stringent MEPS level could, for example, eliminate all vertical axis (top loading) machines and leave only drum machines. But even for this fairly clear cut product type there are some consumer consequences that may not be desirable in all cases (e.g. inability to do low temperature washing, inability to utilise external hot water sources, very long programme times).

To develop improved evaluation approaches will require underlying data to be continually collected, with appraisals made each year (or at least with the introduction of new policy measures). The underlying models could be improved to account for the quality of the data. For the UK, this data collection could be substantially improved if there was a requirement for a central deposit for energy label data. Such a central deposit would also assist market surveillance and enforcement, and allow consumers easier access to products available (say through a website).

The main approach demonstrated here provides a method to attribute savings to different policies that are implemented through time – the first policy is compared against a base case, and a new base case drawn up, then subsequent policies are compared against the new base case. The main difficulty of the analysis is attribution of savings to specific policies where the policies overlap in time and where actors may be responding to multiple policies. Other techniques need to be considered to provide additional evidence on attribution. This could include more qualitative approaches such as semi-structured interviews with stakeholders.

This paper describes an ongoing project to improve the evaluation of refrigeration appliances, which will result in a report available on the AGO and MTP websites during 2007, following discussion at the ECEEE summer study.

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