Energy consumption of whitegoods - what is improving and what is not: analysis of 15 years of data in Australia

EEDAL 2009, Paper 177, Final Version 1, 1 May 2009

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Topic
Topics related to Policies and Programs: 10. Program monitoring and evaluation.

Keywords
Sales weight efficiency, product sales, efficiency trends.

Abstract

Australia has had an energy labelling program for white goods since the mid 1980's. Since 1993, market data on total sales for refrigerators, freezers, clothes washers, clothes dryers and dishwashers has been purchased. Information on model number and actual price was provided and this has been cross matched with the regulator data which has detailed attribute data. Since 2003, sales data on air conditioners has also been available. The sales data tracks model number, units sold and actual price paid, and covers 95% of the retail market for whitegoods and 70% of the air conditioner market.

The paper explores the changes that have occurred over the past 15 years. In this period refrigerator-freezer energy consumption has continued to decline at around 3% per annum despite increases in frost free share (now 80% of all products sold) and slight increases in volume. For clothes washers, there has been a dramatic shift from vertical axis to European style drum machines (horizontal axis) over the past 5 years (from a base of 15% to over 50% in 2007), mainly driven by water efficiency rebates and mandatory water efficiency labelling which were introduced in 2006. However, within each product type, there has been little change in efficiency.

For dishwashers, the energy and water consumption has continued to decrease at an amazing 4% per annum over the study period. Air conditioners have also increased in efficiency over the study period, mainly in response to MEPS. However, dryers are a product where there has been little movement in product performance in recent times.

Introduction

This paper provides an in depth look at appliance performance trends in Australia over the calendar years 1993 to 2007 inclusive. The whitegoods market grew significantly over this period: the analysis covers 2.55 million appliances sold in 2007 with a total retail value of just over EURO 1.0 billion. Generally, there has been a significant improvement in the energy efficiency for all products as a result of mandatory energy labelling except for clothes dryers. In the case of refrigerators and freezers, additional improvements have occurred as a result of Minimum Energy Performance Standards (MEPS) which were initially introduced in 1999 and subsequently upgraded in 2005.

Generally, sales of all appliance types have been increasing. This is a result of increasing numbers of households, increasing penetration and ownership of some appliance types (especially dishwashers), and the replacement of products as they are retired.

The Base Data

In 1995, Energy Efficient Strategies (EES) was first commissioned to undertake an analysis of appliance retail sales data purchased by the Australian Government in order to track energy efficiency trends of major appliances which were regulated for energy efficiency (energy labelling). As additional information has accumulated over time, it has been possible to determine trends in product attributes and energy efficiency to a very high degree of certainty. This paper summarises 15 years of appliance efficiency trends. It is proposed to purchase annual data for the foreseeable future so the data set will be extended from year to year.

From 1993 to 2000 a data set that covered approximately 70% to 80% of total appliance sales in Australia was provided. From 2003, additional retailers were added and the market coverage climbed to over 90%. From 2001, sales data for all models was supplied for each appliance.
This study covers six major household electrical appliances:

- Refrigerators;
- Freezers;
- Dishwashers;
- Clothes washers;
- Clothes dryers;
- and Air conditioners (from 2003 only)

The methodology used is to match the brand and model details for each product listed in the data sets provided to the national registration database. The data contained in the energy labelling registration database is much more detailed and accurate than the limited information provided with the sales data for each model. In recent years sales data for around 1000 models for each product have been provided (2,500 for air conditioners).

A separate sales database is then created for each appliance type and for each year. The appliance attributes which are required for analysis in these yearly sales databases are imported from the master registration database which has been checked for completeness for each record used in the analysis. An analysis database imports the relevant sales weighted information and compiles sales weighted information of interest for each year. This data is available at the national and state level. National trend data for all the years analysed is then compiled onto a single listing for further analysis. The key elements are included below.

Refrigerators

Energy labelling for refrigerators was introduced in 1986 and the labelling algorithm was revised in 2000, a further algorithm revision will be introduced in 2010. MEPS for refrigerators was first introduced in October 1999 and new stringent MEPS levels (based on US 2001 levels) were introduced on 1 January 2005.

Market Trends: Total sales increased at 5.0% per annum over the 15 year period to around 950,000 units in 2007. Side by side (Group 5S) refrigerators sales more than doubled from 2003 to 2007 (to 15% share) although 2 door frost free refrigerator/freezers (top and bottom freezers) – Group 5T and 5B - still dominate the market with 62% of total sales. Single door refrigerators with a short-term freezer compartment (Group 3) and two-door cyclic defrost refrigerator/freezers (Group 4 = European style refrigerator freezers) have virtually disappeared from the market. Average fresh food and freezer volumes now appear to be stable after freezer volumes increased during the 1990’s. Prices (within each Group) have generally remained stable or declined in real terms over the analysis period.

Energy: Energy consumption decreased at an average of 3.3% per annum from 1993 to 2007 (see Figure 1). Energy efficiency (taking account of changes in volume) increased at 4.2% per annum over the period. The average star rating (2000 system) increased from 1.76 in 1993 to 3.88 in 2007. The relative fall in energy from 2003 to 2007 was 32% for refrigerators, which is primarily a response to new MEPS levels introduced on 1 January 2005. In 2003, 88% of refrigerators sold did not pass 2005 MEPS levels while in 2007, 2% of models sold failed to meet 2005 MEPS[1].

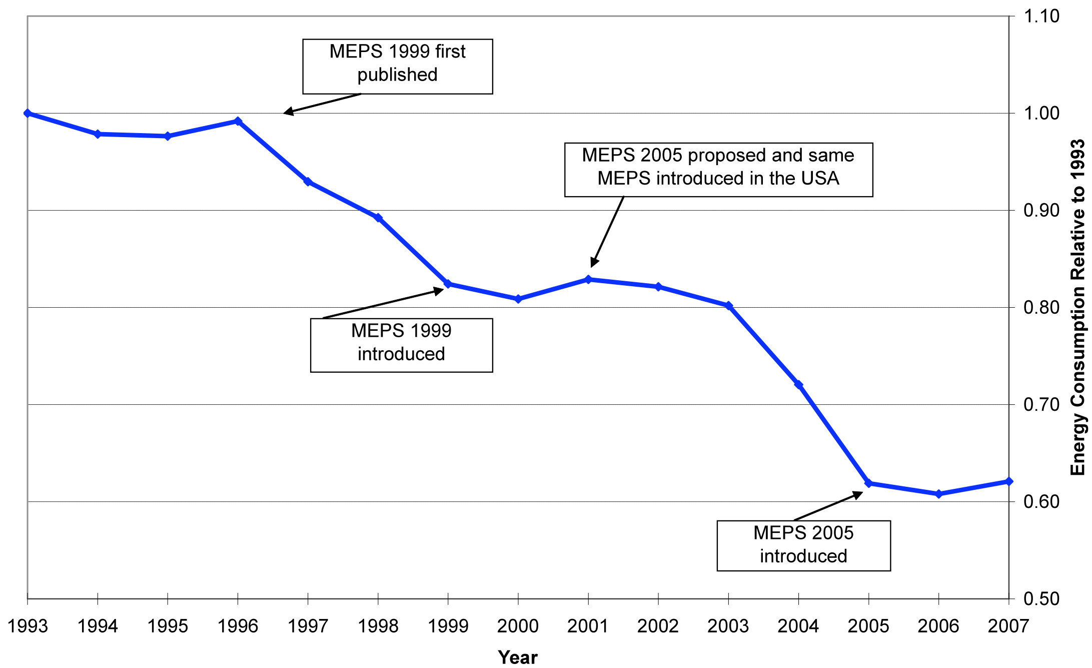

Figure 1. Energy Consumption of Refrigerators

The spectacular decrease in energy from 2003 to 2005 (sales weighted) is in response to stringent MEPS levels introduced in on 1 January 2005. The energy savings from MEPS 1999 are more than originally estimated and savings from MEPS 2005 are in line with the estimated savings. It has been separately estimated that an average refrigerator sold in 2005 consumes less than 40% of an average refrigerator sold prior to the commencement of energy labelling in 1986 [1]. Analysis has been completed to assess the impact of MEPS on the purchase prices of refrigerators (and freezers), there was found to be no correlation between the impact of MEPS and changes in purchase prices [4].

Freezers

Energy labelling for freezers was introduced in 1986 and the labelling algorithm was revised in 2000. MEPS for freezers was first introduced in October 1999 and new stringent MEPS levels (based on US 2001 levels) were introduced on 1 January 2005.

Market Trends: Total sales grew at an average of 6.8% per annum to a total of 215,000 units in 2007, although the majority of this increase occurred in the years 2004 to 2007 (sales before this date were fairly static). The average volume of freezers is fairly static overall. The sales of frost free vertical freezers (Group 7) is continuing to slowly increase while manual defrost vertical freezers (Group 6U) increased very sharply in 2004 and has remained stable since. Chest freezer (Group 6C) sales constitute nearly 45% of the market and their share has been fairly steady. Prices (within each Group) decreased or were stable in real terms over the analysis period.

Energy: Energy consumption decreased at an average of 3.7% per annum from 1993 to 2007, with the most significant decline occurring in 2005 (see Figure 2), linked to the introduction of the

[1] MEPS regulations in Australia apply to manufacture and import, not sales.

more stringent freezer MEPS in January 2005. Energy efficiency (taking account of changes in volume) increased at 3.0% per annum over the period. The average star rating under the new star rating system (2000) increased from 1.48 in 1993 to 3.5 in 2007. It is interesting to note that energy consumption of freezers drops prior to the implementation of increased MEPS levels. This is due to the lead time given to industry which allows redesigned products to be registered and placed on the market earlier than the implementation date. A similar trend is also visible for refrigerators.

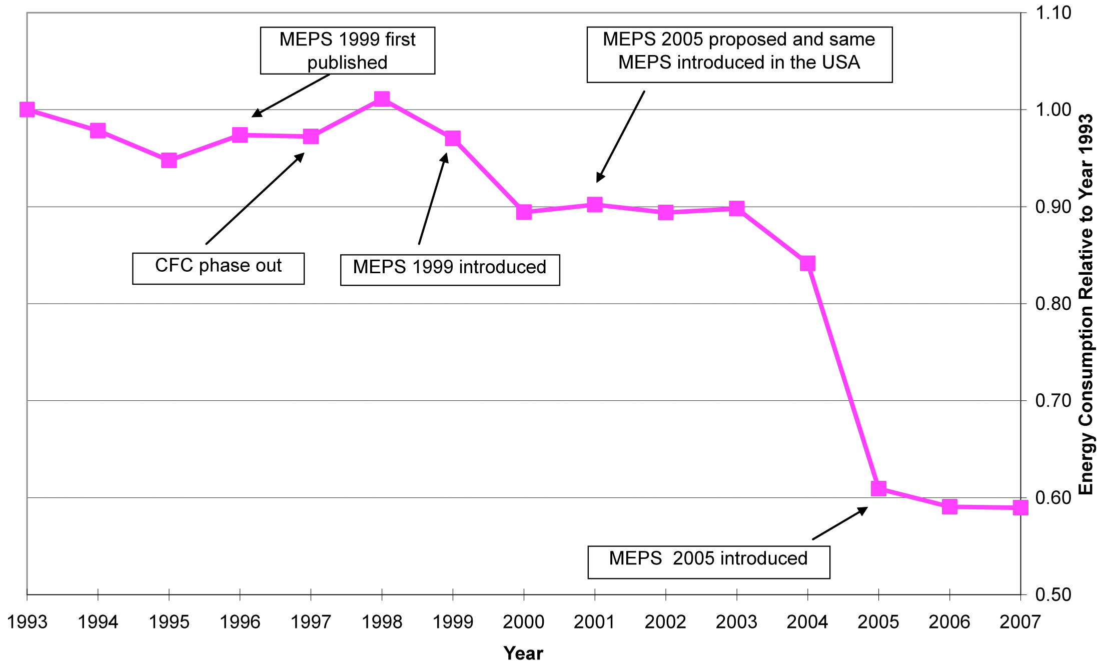

Figure 2. Energy Consumption of Freezers

Clothes Washers

Energy labelling for clothes washers was introduced in 1990 and the labelling algorithm was revised in 2000. Voluntary water efficiency labelling commenced in the 1990's and mandatory water efficiency labelling commenced in July 2006.

Market Trends: Total sales increased at 4.8% per annum over the analysis period to a total of 775,000 units in 2007. Front loading machines have been dramatically increasing their market share in recent years and constituted 38% of all machines sold in Australia in 2006 (see Figure 3). The market share of front loaders in Queensland and Western Australia are the highest at 45% and 43% respectively. Average capacity is increasing steadily for both front and top loading machines and is now 6.9kg and 6.8kg respectively for these types. Prices have decreased in real terms for top and front loaders over the analysis period. Twin tubs have increased in price in recent years but the average capacity for this type is now much larger and sales share remains at about 1%, so this only has a minor overall impact.

Energy: Energy consumption within top loading and front loading machine types has shown little change over the past 10 years. However, the overall average energy for clothes washers has been declining as a result of increased market share of front loaders. Average water consumption decreased by 3.5% per annum since 1993, which is now being driven in part by mandatory water labelling which has been in force since 2006. The average star rating under the new star rating system (2000) increased from 1.28 in 1993 to 2.85 in 2007.

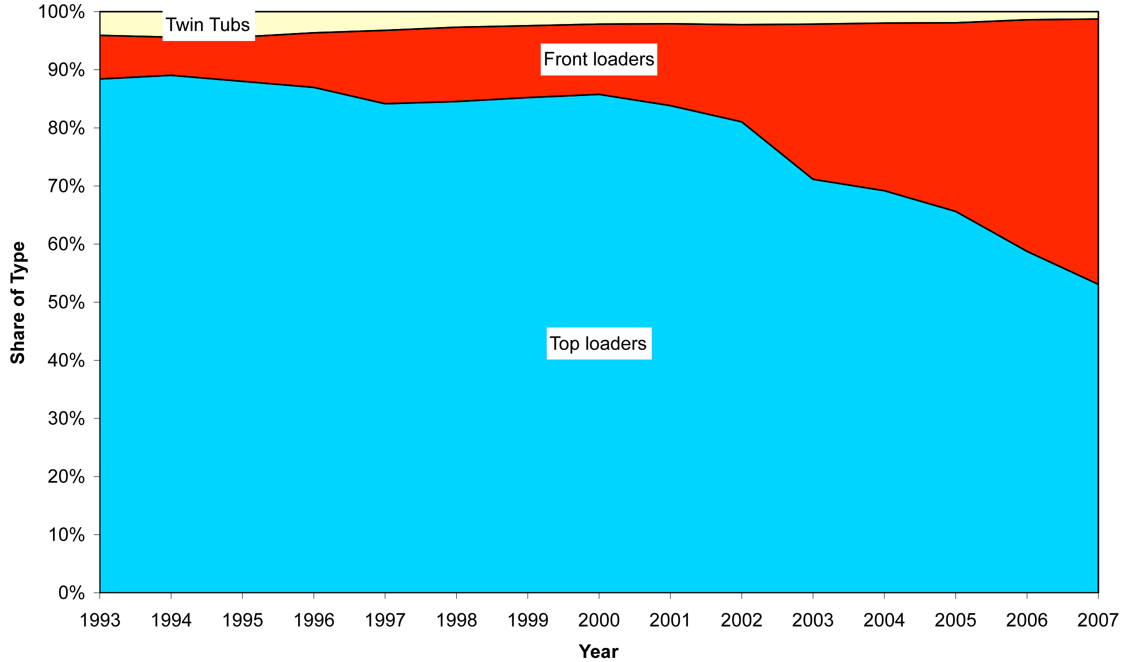

Figure 3. Share of Clothes Washer Type

Clothes Dryers

Energy labelling for clothes dryers was introduced in 1989 and the labelling algorithm was revised in 2000.

Market Trends: Total sales increased at an average of about 6.2% per annum from 1993 to 2007 to a total of 295,000 in 2007, but there has only been a small increase in sales since 1995. The market share of auto-sensing dryers has increased significantly from 10% in 1993 to 42% in 2007 (see Figure 4). Average load capacity has been static since 1993. Prices for timer dryers were generally steady in real terms over the analysis period while auto-sensing dryers have decreased in real terms over the analysis period. Condenser dryers only account for a few percent of the market. The has been a substantial increase in combination washer-dryers over the period, which now make up an additional 30,200 dryer sales in 2007 (about 10%). A local concern is the high water usage of these products during the drying function – many use more water for drying than they do for washing.

Energy: Energy consumption decreased at an average of 0.7% per annum from 1993 to 2007. All dryers appeared to decline slightly in efficiency in 2000 as a result of the new test method (lower initial moisture content). The average star rating under the new star rating system (2000) increased from 1.52 in 1993 to 1.74 in 2007. These increases are primarily due to an increase in market share of auto-sensing dryers with no real improvement in the fundamental efficiency of the products.

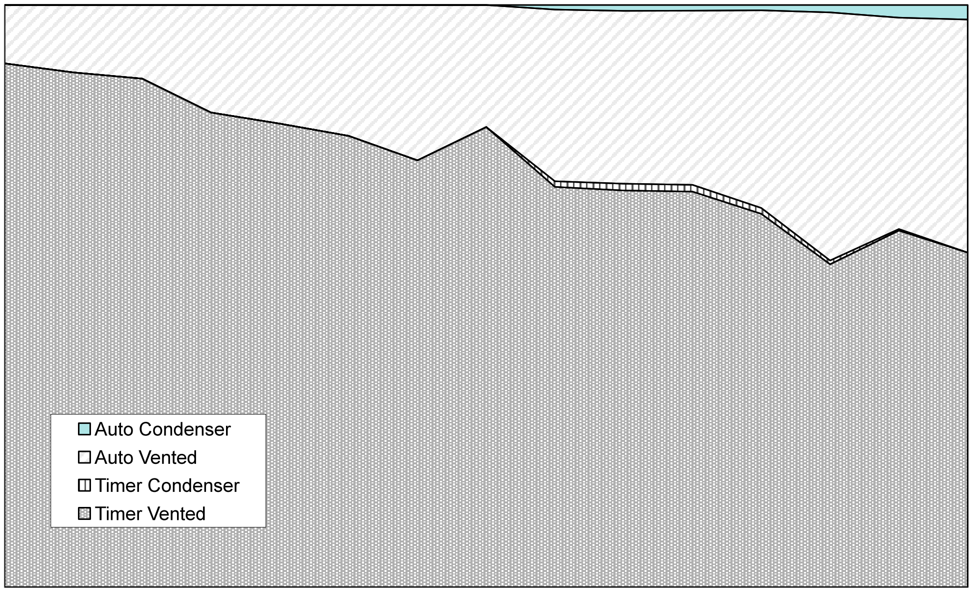

Figure 4. Share of Clothes Dryer Type

Dishwashers

Energy labelling for dishwashers was introduced in 1988 and the labelling algorithm was revised in 2000. Voluntary water efficiency labelling commenced in the 1990's and mandatory water efficiency labelling commenced in July 2006.

Market Trends: Total sales are continuing to increase with a growth of 7.5% per annum from 1993 to 2007 to a total of 310,000 units in 2007. Average capacity (place settings) has been stable since 1996 although there has been a slight decline since 2000. Prices were steady in real terms to 2003 but fell slightly through to 2007.

Energy: Energy consumption decreased at an average of 3.6% per annum from 1993 to 2007 (see Figure 5). Water consumption decreased by 4.5% per annum since 1993, which is now being driven in part by mandatory water labelling which has been in force since 2006. The average star rating under the new star rating system (2000) increased from 1.88 in 1993 to 2.7 in 2007.

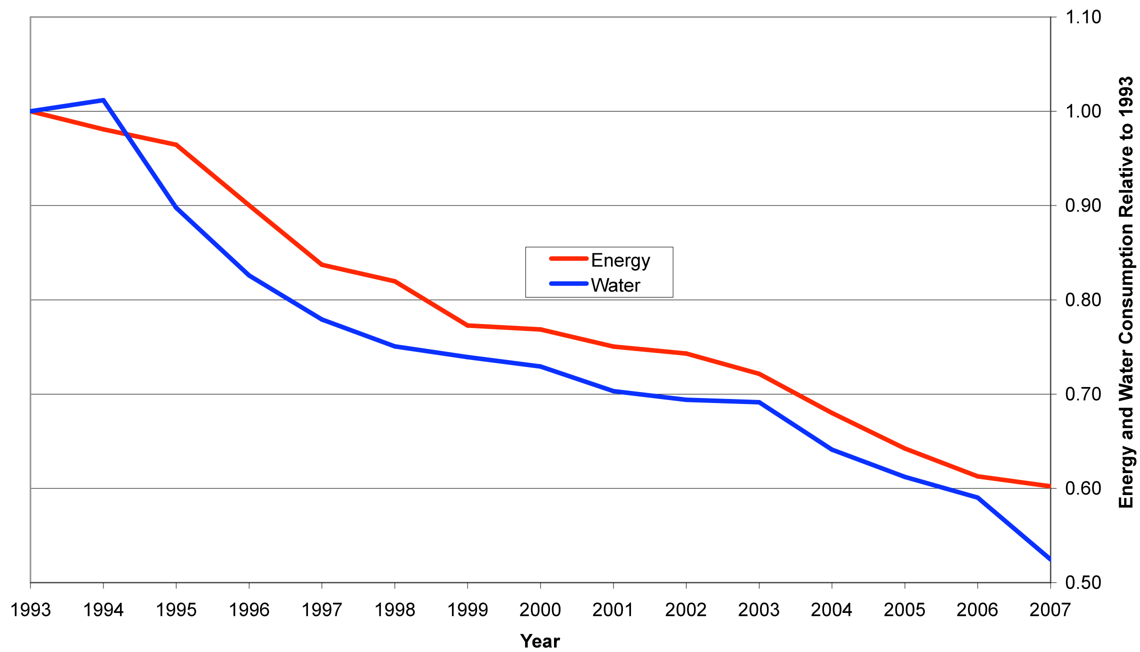

Figure 5. Energy and Water Consumption of Dishwashers

Air Conditioners

Energy labelling for air conditioners was introduced in 1987 and the labelling algorithm was revised in 2000, a further revision will be introduced in 2010. MEPS for three phase air conditioners was first introduced in 2001 and for single phase in 2004. More new stringent MEPS levels were introduced in April 2006 for most single phase products, and October 2007 for all remaining product types. Revision to MEPS levels for cooling and the introduction of MEPS levels for heating will also be introduced in 2010. More stringent MEPS levels are also being introduced in 2011 and 2012. In addition, new requirements for minimum power factor and non-operating energy consumption are being introduced.

Market Trends: Total sales in 2007 are about 1 million units per year, but about one third of these are used in the commercial sector. Average heating and cooling capacity has been stable since 2003. Prices have fallen substantially in real terms from 2003 through to 2007.

Energy: EER and COP have both increased at an average of 4.6% and 4.2% per annum respectively from 2003 to 2007 (see Figure 6). The average star rating for cooling under the new star rating system (2000) increased from 2.85 in 2003 to 4.52 in 2007, the average star rating for heating under the new star rating system (2000) increased from 2.88 in 2003 to 4.43 in 2007. The changes are being driven by MEPS levels which were introduced during this period.

Like for refrigerators and freezers, analysis has been completed to assess the impact of MEPS on the purchase prices of air conditioners, and similarly, no correlation was found to exist between the impact of MEPS and changes in purchase prices [3].

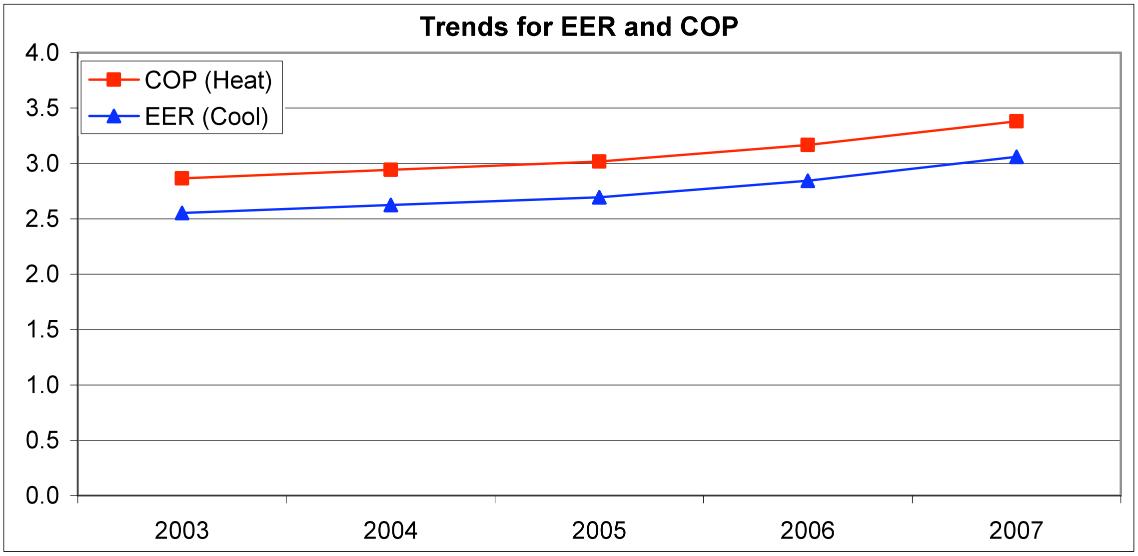

Figure 6. Trends for EER and COP for Air Conditioners

Conclusions

All white goods covered by the mandatory energy labelling scheme, apart from clothes dryers, have shown a substantial and persistent ongoing improvement in energy consumption as well as other attributes such as water consumption. This is despite, in many cases, increases in appliance capacity or size over the study period. In addition, the impact of the stringent Minimum Energy Performance Standards (MEPS) for refrigerators and freezers in early 2005 is substantial and result in an acceleration in the reduction in energy to around 12% per annum for the 2 years preceding its commencement.

The price of virtually all product types tracked for this study showed a decrease in real prices over time, despite significant increases in energy efficiency. This flies in the face of conventional wisdom that energy efficiency has a substantial purchase cost premium associated with it. Separate analysis on both the refrigerator and air conditioner markets based on the characteristics and actual price paid for hundreds of models showed that correlations between price and efficiency were at best weak and for many types, non existent [3] and [4].

Ongoing collection of detailed sales data is a valuable tool in the assessment of delivered energy savings to the market place and provides a sound basis for assessing and evaluating a range of policies options to reduce energy consumption of appliances and equipment.

The data in this paper relies on energy labelling registration data which is based on Australian and New Zealand Standards and test procedures relevant to each product group. While the values reported are useful and reflect general improvements in product performance, care is required if using this data to estimated the energy consumption of the products in the home due to factors such as climate and consumer usage patterns, which in some cases differ from the assumptions in the standard.

More details for all products covered above can be found in [2].

References

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