Tracking Appliance Energy Efficiency Trends in Australia

Lloyd Harrington, Energy Efficient Strategies, Australia

Synopsis

Appliance retail sales data has been matched with detailed performance information in Australia from 1993 to 1995 to enable an analysis of sales weighted appliance characteristics.

Abstract

Australia has had a mandatory appliance energy labelling program in place since 1986 and this now covers major household appliances such as refrigerators, freezers, dishwashers, clothes washers, clothes dryers and room air conditioners. The program has a very high profile - nearly 90% of prospective or recent appliance purchasers can recall detailed information from the labels. The label is clear, distinct and easy to understand and is regarded by many analysts as one of the better international examples. While there has been ample process evaluation of the program since its implementation over 10 years ago (GWA 1991a & GFCV 1991), until recently there has been little concrete data regarding the impact that the program has had on residential energy consumption.

Since 1993, the Federal Government in Australia has been obtaining detailed retail sales data of residential appliances, both nationally and at a state level, from a commercial monitoring service. Individual model sales and actual retail price have been obtained for a large percentage of the appliance market, typically 75% to 90% of all retail sales for each appliance group. Model sales data, combined with the detailed information on the national appliance energy labelling registers in Australia, has allowed the tracking of appliance performance and energy efficiency trends by appliance type. An overview of the energy consumption and energy service trends (and therefore energy efficiency) for each appliance group are examined over the period where data are available.

1. Energy Labelling in Australia

1.1 The Introduction of Energy Labelling in Australia

Energy labelling for major appliances in Australia was first proposed in the late 1970s, by the State governments of 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.

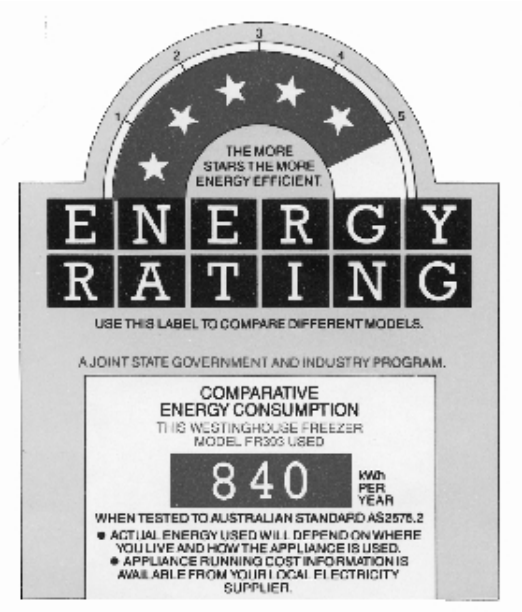
Despite three years of negotiation, government and industry could not agree on a mutually satisfactory voluntary labelling program. Finally, the NSW and Victorian state governments announced in late 1985 they would make energy labelling mandatory in those States. NSW and Victoria (which contain Australia's two largest cities - Sydney and Melbourne) 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 (and their combinations) became mandatory in late 1986. In 1987 and 1988, room air conditioners and dishwashers were included in regulations. After a change of government in NSW in 1988, Victoria pressed on 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.

Most of the remaining States and Territories now have 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. Many use labelling data in their point of sale information. However, there is still some resistance to extending the program to new appliance groups.

In Australia it is mandatory for manufacturers and importers to register energy labels for designated appliances before they can be sold by retailers in Australia. This has provided governments with a large and detailed database of appliance energy and performance information which is essential for tracking appliance efficiency trends. Collection of such data from published sources would be nearly impossible, as this often omits energy consumption data. Manual collection of detailed data for all models on the market is a difficult and time consuming exercise.

1.2 The Energy Label

Energy labelling regulations in Australia require labels to be affixed on all units offered or displayed for retail sale. Local manufacturers tend to label all units while still on the production line while importers generally label ex factory as well. An example of a freezer energy label is shown in Figure 1. The label itself has black, yellow and red components on a white background and shows two key items of information: the C*omparative Energy Consumption*(expressed as kWh/year) and the "star rating" (note that this bears no relation to the ISO[1] snowflake or star rating system for freezers). The comparative energy consumption is an estimate of the annual energy consumption of the appliance, based on the tested energy consumption (measured against the relevant standard - see Table 1.2) together with information about the typical use of the appliance in the home (see Table 1.3). The energy efficiency rating (EER[2]), which is the value given on the red background dial at the top of the label, gives a quick comparative assessment of the model's *energy efficiency*The integer value of the EER is the "star rating", which is the most obvious part of the label. EER and Star Rating are non-dimensional measures of energy service per unit of energy consumption and this is calculated using an algorithm which takes into account energy consumption and volume or capacity. Other information on the label includes program name and capacity for appliances other than refrigerators and freezers.



1.3 Consumer Recognition of the Energy Labelling

The energy label has very high visibility and recognition. Recognition of the label among randomly surveyed adults is consistently over 65% throughout Australia (based on a longitudinal survey at fortnightly intervals over 2 years). Awareness among appliance buyers is even higher: in 1991 nearly 90% of recent and intending appli-

ance purchasers said they were aware of the energy label, and 45% said they used the information on it to compare appliances prior to purchase (based on a sample of 300 recent appliance purchasers) (GFCV 1991). The labelling program is supported by take-home guides in retail outlets which list all models, so that energy-aware customers can identify the most energy-efficient models on the market and then search for them.

There is also evidence that labelling has raised the priority given to energy efficiency in purchase. A 1991 survey showed that 28.4 % of respondents around Australia considered the energy efficiency rating to be the most important factor when purchasing a new appliance (IPC 1991) which was the most frequently reported "most important" factor. Running costs was nominated as most important by a further 13.5% of respondents, so about 42% of customers reported energy efficiency or related factors as being *the most* important consideration in the purchase of an appliance. This gave energy efficiency equal importance with other key appliance characteristics such as size, brand and price.

1.4 Australian Appliance Testing Standards for Performance and Energy

The energy labelling program relies on Australian Standards to define test procedures for the measurement of energy consumption, and to set minimum performance criteria which appliances must meet before qualifying for labelling. While ISO[1] standards *do* specify minimum performance requirements for refrigerators (the temperature operation test), minimum performance requirements, which are absent from corresponding IEC[3] energy test standards for other appliances, are important consumer protection features of the Australian energy labelling program. They prevent appliances claiming a low energy consumption solely because, say, they do not wash dishes or clothes to an acceptable level of cleanliness. Setting minimum levels of performance is done on a consensus basis between government, industry and consumer groups through the standards process. A program of check tests against these standards is conducted on a regular basis by state governments, who contract accredited laboratories[4] to undertake tests. The performance requirements in the Australian Standards are summarised in Table 1.1.

Table 1.1: Mandatory Performance Requirements for Appliances in Australia

Appliance	Performance Requirement	Description
Refrigerator	Pull down	Reach specified internal temperatures in 6 hours, at 43°C ambient
	Operation	Maintain specified internal temps under wide range external temps (10°C to 43°C)
Clothes washers	Soil removal	Achieve minimum 80% swatch soil removal criteria - AS9
	Spin drying	Maximum allowable moisture on final spin (1.1 now, 0.9 proposed)
	Wash severity	Maximum allowable fray index on fray cloth of 0.5
Clothes dryers	Single setting	Achieve 6% final moisture content in a single program/setting
	Efficiency	Maximum specific energy of 1.36 kWh/kg water removed
	Scorching	Maximum allowable clothes/drum temperature of 130°C
Dishwashers	Washing	Minimum wash index of 0.7
	Drying	Minimum dry index of 0.5
Room air conditioners	Capacity	Claimed cooling/heating capacity within strict limits
	Max operation	Acceptable performance under extreme heat conditions

Australian Standards are regularly updated to keep pace with changes in international standards, changes in technology and in manufacturing practice. The standards used for appliance energy labelling in Australia, and their related international standards, are listed in Table 1.2. The main information used to calculate the comparative energy consumption is shown in Table 1.3. Specific notes regarding the testing of particular appliance types are included in the following sections.

Table 1.2: Australian Standards for Appliance Energy Labelling

Appliance	Australian Standard	Related International Standard
Refrigerators and freezers	AS1430 - Performance ## AS2575.2 Energy consumption	Broadly based on ISO7371, ISO8561, ISO8187 and ISO5155 but with local external (tropical) and internal temperature requirements **
Clothes washers	AS2040	Broadly based on IEC456 (except use of AS9 swatches, inclusion of top loading machines)
Clothes dryers	AS2442	Based on USA AHAM A197.6 - new IEC1121 is under consideration
Dishwashers	AS2007	IEC436 (but local equivalent soiling agents)
Room air conditioners	AS1861.1	ISO5151 ++

Notes:
** Test conditions for refrigerators are broadly equivalent to US DOE/AHAM.
++ ISO859 was withdrawn and replaced by ISO5151 in late 1994, there are minor differences
These standards are due to be republished as a single document in early 1997.

Table 1.3: Key Usage Assumptions Used to Calculate Label Comparative Energy Consumption

Appliance	Assumed CEC Usage	Other Information on the Label
Refrigerators and freezers	Continual operation	
Clothes washers	365 warm washes per year	Load (kg) and program used
Clothes dryers	150 loads dried per year	Load (kg) and program used
Dishwashers	365 washes per year	Load (place settings) and program used
Room air conditioners	500 hours cooling	Cooling capacity in kW
	500 hours heating (if applicable)	Heating capacity in kW (if appl.)

1.4.1 Refrigerators and Fr eezers

Refrigerators are tested to Australian Standard AS2575.2 to determine energy consumption. This test is conducted without freezer test packages (air temperatures only) in an ambient temperature of 32^{o}C without door openings and has many similarities with the US AHAM[5] test procedure HRF-1. Care should be taken when comparing Australian energy consumption figures with those that have been conducted under ISO standards for refrigerators, which tend to give lower values. Approximate conversion to equivalent ISO values is possible, but fraught with dangers (Harrington 1994 & Waide 1995). In addition to the energy consumption test, appliances must meet the performance requirements of both a temperature operation test (a test with freezer test packages similar to ISO

but with more extreme ambient conditions: +10°C to +43°C) and a pull down test (similar to the AHAM pull down test).

As of October 1999, all refrigerators and freezers manufactured or imported into Australia will be required to meet minimum energy performance standards (MEPS). These levels are slightly less stringent than those proposed for Europe in 1999. Details can be found in Harrington (1994), Harrington & Wilkenfeld (1997) or EES (1996).

1.4.2 Clothes Washers

Clothes washers are tested to Australian Standard AS2040, which is similar to IEC456 but modified to account for agitator and impeller (top loading) machines, drum machines and twin tubs, in additional to a number of local conditions such as soft water. Energy consumption is determined on a warm wash (nominal 40°C) using a "Normal" program which is suitable for a cotton load. Soil removal is determined using soiled swatches from CFT in the Netherlands (AS9). Mandatory minimum performance requirements in the standard include soil removal, spin drying performance (water extraction) and severity of washing. The label energy consumption assumes 365 washes per year on warm wash. However, market research indicates that around 50% of all washes are in fact in cold water and that the average frequency of washing is slightly less than 7 times per week (ACA 1995). The former finding is significant as some 85% of the total energy used by clothes washers is embodied in the hot water, so the current label substantially overestimates the in-use energy consumption. An additional rating for cold water washing is currently under consideration. The star rating is based on total energy consumption per kg capacity plus a factor for spin drying performance (assuming that some households will subsequently use a clothes dryer immediately after washing). Note that the spin drying performance index is based on dry mass (zero moisture content) rather than the normalised clothes mass under IEC456 (nominally 8% moisture content for cotton).

1.4.3 Clothes Dryers

The clothes dryer performance standard is based on the old AHAM test method and is conducted at an ambient temperature of 23°C. The initial moisture content of the clothes in the 1996 edition is 90% and the final moisture content is less than or equal to 6%, although all the data analysed in this paper is based on the old specification which is 100% initial moisture content. Note that the moisture content is based on dry mass (zero moisture content) rather than the normalised clothes mass under IEC1121. Clothes dryers have to be able to achieve the required final moisture content in a single setting while using less than the maximum allowable specific energy consumption of 1.36 kWh per kg moisture removed. The maximum drum or clothes temperature is also specified to prevent scorching. The energy label assumes 150 uses per year, but market research indicates that average usage is somewhat less than this (in the range 50 to 100 uses per year, depending on the region). Units without automatic moisture sensing controls (mostly timer dryers) are penalised 10% in the calculation of the comparative energy consumption and star rating. However the energy consumption of these units is determined precisely at 6% moisture content, while auto-sensing units are left to terminate automatically. Cool down periods are not included in the Australian tests.

1.4.4 Dishwashers

Dishwashers are tested to Australian Standard AS2007, which is almost identical to IEC436-1981. The wash program for energy labelling is not specified, but a minimum washing and drying performance level is specified. The energy label assumes 365 uses per year. A significant number of machines available in Australia are connected to both hot and cold water, so the standard is structured to account for energy imported from an external hot water source and for corrections in deviations in cold water temperature for those operations where the thermostat operates for internal heating.

2. Tracking Energy Efficiency Trends of Appliances

2.1 Sales Weighted Efficiency Data

At any single time in the market place, there are a number of forces at work which encourage manufacturers to pursue improvements in the energy efficiency of their products. Although it is not possible to directly attribute all of the ongoing efficiency improvement estimated in this paper to energy labelling or efficiency standards, it is clear that energy labelling is responsible for a substantial part of this improvement through the provision of information into the market place. Past analysis by energy consultants suggests that at least half of the current rate of efficiency improvement is attributable directly to energy labelling (GWA 1991b & GWA 1992).

2.1.1 Background to Sales Weighted Analysis

In Australia, a commercial monitoring service collects retails sales data of major appliances through a comprehensive survey of retailers. They claim to cover more than 99% of total retail appliance sales in Australia. It is unclear what proportion of total appliance sales occur outside the retail system (such as some large institutional buyers or other large direct wholesale purchases), but these sales are not likely to exceed 10% to 15% of total retail sales in most cases. Separate work is under way to quantify and monitor these sales. Retail appliance sales are primarily to the residential sector, but also include some sales to the commercial sector.

The commercial monitoring service estimates that about half of the sales data is from retailers with full census information (via computerised listings of every unit/model sold), while the model breakdown in the remaining 50% of sales is estimated on the basis of sampling from selected stores in each retail chain. It should be noted that the total sales figures and sales value for each appliance type will be accurate - only the market share by model is estimated by sampling.

In late 1995, the federal Department of Primary Industries and Energy purchased this appliance sales data for those appliances which are covered by the energy labelling program (except for air conditioners, as retail data is not yet available) for the years 1993, 1994 and 1995. Energy Efficient Strategies was commissioned to undertake a full analysis of this appliance sales data. This paper provides a summary of the national results for each of the labelled appliances over the three year period. It is expected that data for future years will also be purchased allowing longer term tracking. The cost of purchasing the data and the subsequent analysis is commercially confidential, but totals less than ECU 30 000 per year.

2.1.2 Source Data

The appliance sales data shows the largest selling models for each of the main appliance categories. Data shows sales at a national and state level for each of the appliance groups in the form of a “hit list” - that is, a listing of models in order of decreasing sales. The “hit list” purchased covers some 75% to 90% of all retail sales, while the balance is shown as “other” and “exclusive” models. The only data available for other and exclusive models is the number sold and total sales value.

2.2.3 Methodology

Critical performance data about individual models is not contained in the appliance sales data. To overcome this, model sales from the listings were matched with the master database of energy labelling registrations for each of the appliance groups. This labelling database has all of the essential information required to track appliance efficiency trends when combined with data on sales by model.

Once model sales in a particular year were cross matched with an energy labelling registration number, the key performance data by model was imported into the sales database. Model characteristics were then weighted by actual sales to obtain true average market data for the appliance group and type.

3. Results

The key national results for each of the appliance types covered by the appliance sales data for the years 1993 to 1995 are summarised in the following sections. The total retail value of the appliances covered by this analysis is just over AU $1 billion/year.

3.1 Refrigerators and Refrigerator/Freezers

3.1.1 Market Trends

Total retail refrigerator sales for the period 1993 to 1995 were flat at around 500 000 units per annum. The 110 models identified make up over 80% of retail sales. The most significant market trend is the move away from cyclic 2 door and manual defrost single door appliances towards 2 door frost free refrigerator/freezers. The market share of frost free refrigerators was about 47% in 1995 and the trend from 1993 indicates that this share is increasing at 2% to 3% per annum. Against this trend the share of "all refrigerators" (without a frozen food compartment) is also increasing slightly, probably as a result of the continued popularity of pigeon pairs (an all refrigerator with a separate vertical freezer of the same height).

The average fresh food compartment size for refrigerators and refrigerator/freezers in Australia is 250 litres and this appears to be almost static. In contrast, average freezer compartment sizes are about 90 litres in 1995 and increasing at just under 3% per annum. This is a reflection of the declining sales of single door refrigerators with an internal freezer compartment, which tend to be small. The price of refrigerators is increasing at around 5.1% per annum, which is substantially higher than the inflation rate, which has been around 2% to 3% over the past 4 years. This could be partly explained by the fast phase out of CFCs in Australia which was completed by August 1994.

3.1.2 Energy Efficiency Trends

The energy consumption of refrigerators is trending downwards at -0.6% per annum, although there is some noise in this trend from year to year. As the adjusted volume is still increasing, the total energy efficiency of the refrigerator market is increasing at a rate of around 2% per annum. In 1993, about 40% of refrigerator sales would have failed the MEPS levels which are coming into force in Australia in 1999. By 1995, this proportion had fallen to about 29%, which is on track to meet these requirements. The total sales of those models which fail MEPS are expected to decline 7% per year to 1999. Table 3.1 summarises the key results from 1993 to 1995.

Table 3.1: Annual Change in Refrigerator Performance Characteristics from 1993 to 1995

Characteristic	1993=>95
Fresh Food Volume	0.5%
Freezer Volume	2.8%
Adjusted Volume	1.4%
Energy	-0.6%
kWh/adjusted litre	-1.9%
EER	2.1%
Price	5.1%

3.2 Separate Freezers

3.2.1 Market Trends

Total retail freezer sales for the period 1993 to 1995 were flat at just under 90 000 units per annum. The 30 models identified make up around 85% of retail sales. The market share of chest freezers is 38% and this is falling very slightly. The balance of sales are vertical freezers with about one third of these (ie about 20% total freezer sales) being frost free units. The share of frost free units appears to be increasing slightly.

The average freezer size for all freezers in Australia is 219 litres and this appears to be almost static. However, the average size in each segment is quite different (chest freezers = 200 litres, vertical manual defrost = 180 litres, vertical frost free = 330 litres). The size of chest freezers appears to be declining slightly. The price of freezers is increasing at around 6.8% per annum, which is substantially higher than the inflation rate which has been around 2% to 3% over the past 4 years. This could be partly explained by the fast phase out of CFCs in Australia which was completed by August 1994.

3.2.2 Energy Efficiency Trends

The energy consumption of freezers is trending downwards strongly at around -3.0% per annum. As the adjusted volume is nearly static, the total energy efficiency of the freezer market is also increasing at a rate of around 3% per annum. In 1993, about 40% of freezer sales would have failed the MEPS levels which are coming into force in Australia in 1999. By 1995, this proportion had also fallen to around 29%, which is on track to meet these requirements. The total sales of those models which fail MEPS are also expected to decline 7% per year to 1999. Table 3.2 summarises the key results from 1993 to 1995.

Table 3.2: Annual Change in Freezer Performance Characteristics from 1993 to 1995

Characteristic	1993=>95
Freezer Volume	0.2%
Adjusted Volume	0.2%
Energy	-3.0%
kWh/adjusted litre	-3.2%
EER	2.8%
Price	6.8%

3.3 Clothes Washers

3.3.1 Market Trends

Total retail clothes washer sales for the period 1993 to 1995 increased at around 4.5% per annum to just under 450 000 units in 1995. The 60 models identified make up around 75% of retail sales. The market share of top loading machines (mostly vertical axis, with some impeller machines) is dominant in Australia at just under 90% of sales, while the share of front loading machines (horizontal axis) is 7.5% and twin tub machines (impeller) is 4.2%. The market share of all three clothes washer types is fairly static for the period analysed. The front loading market share has been at this level for about 20 years in Australia. There are currently no top loading horizontal axis machines on the Australian market.

The average load capacity for all clothes washers in Australia is 5.4 kg and this is increasing at about 1.7% per annum. These capacity changes are occurring mostly in the top loading segment as manufacturers appear to be trying to increase the capacity of their machines as part of a product differentiation campaign in the market place.

Water consumption of clothes washers has an upward trend of 1.1% per annum to 150 litres per wash (probably as a result of increasing capacity), while spin drying performance of clothes washers (water extraction) is fairly static at 0.84 (-0.3% per annum).

The price of clothes washers is increasing very slowly at around 0.7% per annum, which is substantially lower than the inflation rate, probably due to intense market competition between the three local manufacturers.

3.3.2 Energy Efficiency Trends

The energy consumption of clothes washers has a downward trend of around -1.0% per annum. As the capacity is also increasing, the average Energy Efficiency Rating (EER) of the clothes washer market is increasing at a rate of around 2% per annum. Note that a significant part of the EER is made up of spin drying performance (water extraction), so the EER is increasing at a rate which is slower than could be expected from capacity and energy changes alone. Table 3.3 summarises the key results from 1993 to 1995.

Table 3.3: Annual Change in Clothes Washer Performance Characteristics from 1993 to 1995

Characteristic	1993=>95
Capacity (kg)	1.7%
Water Consumption	1.1%
Water Extraction Index	-0.3%
Energy	-0.9%
EER	1.9%
Price	0.7%

3.4 Clothes Dryers

3.4.1 Market Trends

Total retail clothes dryer sales for the period 1993 to 1995 increased at around 12.5% per annum to just under 200 000 units in 1995. The annual sales of clothes dryers in Australia are somewhat dependent on weather and the economy, so this growth rate is not expected to continue for a long period. The 25 models identified make up nearly 90% of retail sales. Almost all clothes dryers sold in Australia are the vented type: condenser dryers are available but these are fairly unusual. Timer dryers currently make up about 87.5% sales. The market share of auto-sensing dryers is only about 12.5%, but they are increasing market share at over 1% per annum. Gas dryers do exist on the Australian market but they have negligible market share. The energy labelling program currently only applies to electric tumble dryers.

The average load capacity for all clothes dryers in Australia is 4.4 kg and this is nearly static. The two main capacities available are 3.5 kg (about 30% of sales) and 5 kg (about 60% of sales). Larger sizes up to 9 kg and smaller sizes of less than 3.5 kg are available, but these have only a small market share. Average program time for clothes dryers is static at around 140 minutes.

The price of clothes dryers is increasing at around 2.1% per annum, which is consistent with inflation for the analysis period.

3.4 2 Energy Efficiency Trends

The energy consumption of clothes dryers has a downward trend of around -1.2% per annum. This is partly as a result of increasing market share of auto-sensing dryers (timer dryers incur a 10% energy penalty for labelling) and partly because the raw specific energy consumption of clothes dryers (kWh per kg water removed) is falling

at -0.9% per annum. The EER for clothes dryers is increasing at 4.1% per annum due to the above factors and because the algorithm for clothes dryers is designed to accentuate small changes in the specific energy consumption. Table 3.4 summarises the key results from 1993 to 1995.

Table 3.4: Annual Change in Clothes Dryer Performance Characteristics from 1993 to 1995

Characteristic	1993=>95
Capacity	-0.3%
Program Time	-0.2%
Specific Energy	-0.9%
Energy	-1.2%
EER	4.1%
Price	2.1%

3.5 Dishwashers

3.5.1 Market Trends

Total retail dishwasher sales for the period 1993 to 1995 increased at around 10% per annum to about 100 000 units in 1995. The annual sales of dishwashers in Australia are somewhat dependent on the economy, so this growth rate is not expected to continue for a long period. The 40 models identified make up nearly 80% of retail sales. Almost all dishwashers sold in Australia are standard sized 600 mm wide European style under bench units of 12 to 14 place setting capacity. Smaller units of less than 10 place settings are available but are fairly unusual.

The average place setting capacity for all dishwashers in Australia is 13.4 and this is declining at -1.7% per annum. This decline is probably partly in response to discussions and proposals in the Australian Standard's Committee for capacity claims to be more carefully defined. Program times for dishwashers are decreasing at around -5% per annum to 62 minutes in 1995 - this is partly as a result of increased market share for hot and cold water (dual) connect machines which have faster wash times. In fact, many models on the Australian market have dual connection capability, but most of these are labelled on cold connect to obtain the minimum energy consumption possible. The water consumption of dishwashers has a downward trend of -5.3% per annum to 26 litres in 1995, mainly in response to competition from high end European models which typically achieve a water consumption of less than 20 litres.

The price of dishwashers is falling at around -0.8% per annum, mostly due to intense market competition amongst local manufacturers.

3.5.2 Energy Efficiency Trends

The energy consumption of dishwashers has a downward trend of around -1.8% per annum. The EER for dishwashers is nearly static due to the decline in place setting capacity. Table 3.5 summarises the key results from 1993 to 1995.

Table 3.5: Annual Change in Dishwasher Performance Characteristics from 1993 to 1995

Characteristic	1993=>95
Place Settings	-1.7%
Program Time	-5.3%
Water Consumption	-5.3%
Energy	-1.8%
EER	0.1%
Price	-0.8%

4. Conclusions

For all appliances covered by the energy labelling program in Australia, the sales weighted energy consumption is decreasing. For some appliances such as refrigerators, freezers and clothes washers, this energy decrease is despite increases in average capacity of appliances sold. For clothes dryers, there is still a significant increase in raw appliance efficiency over the period analysed even though the capacity is static. For dishwashers, the efficiency appears to be static, but this is because claimed capacities in the market place are being adjusted back to more realistic levels, rather than as a result of any real change in the energy service provided to consumers. For dishwashers, the key indicators of energy and water consumption continue to decrease significantly.

The analysis presented in this paper has shown that there is a general improvement in the energy related performance characteristics of appliances sold in Australia, although these changes are gradual. For attributes that are not immediately apparent to the consumer, such as energy consumption and some performance measures, the credit for much of this improvement must be attributed to the national energy labelling program, which has increased consumer awareness and demand for energy efficient products.

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Endnotes

1 ISO is the International Organization for Standardization, based in Geneva, Switzerland
2 EER in this case does NOT refer to Energy Efficiency Ratio, which is a value sometimes quoted for compressor or heat pump efficiency (generally in Btu per hour per Watt).
3 IEC is the International Electrotechnical Commission, based in Geneva, Switzerland
4 The national laboratory accreditation organisation in Australia is the National Association of Testing Authorities, Australia (NATA)
5 AHAM is the US Association of Home Appliance Manufacturers, based in Chicago, USA

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