

Evaluation of Energy Efficiency Policy Measures for Household Air Conditioners in Australia

Technical Appendix

Prepared for

*Department of Climate Change and Energy
Efficiency:
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1 Introduction to Technical Appendix

This report is a technical appendix to accompany the main report Evaluation of Energy Efficiency Policy Measures for Household Air Conditioners in Australia prepared by EnergyConsult in 2010. The report presented further details of the background, methodology and results of the study undertaken. This report should be read in conjunction with the Evaluation of Energy Efficiency Policy Measures for Household Air Conditioners in Australia report.

1.1 Review of Air Conditioner Policies

The regulations governing the labelling and efficiency of air conditioners in Australia have been steadily developing since 1987. The focus of this study was on the period 2003 to 2008, where the two major policy interventions for singly phase air conditioners were MEPS (October 2004) and MEPS 2006/07 (Apr 2006/Oct 2007). Prior to this period, the following interventions have occurred:

- 1987 – introduction of mandatory Energy Rating Labels (ERLs) in NSW and Victoria
- 1992 – expansion of ERLs through regulations in most states
- October 2000 – change of the algorithm for ERLs for labelled products
- October 2001 – introduction of MEPS for three-phase air conditioners for the first time

The MEPS proposals were notified to the suppliers during 2002 and 2003; and also prior to the proposal to bring forward the 2007 MEPS, with key dates as follow:

- May 2002 – Presentation to the AREEMA general meeting – Sydney of the proposal MEPS levels
- May 2002 - International Review of Minimum Energy Performance Standards for Air Conditioners.
- June 2002 - Air Conditioner MEPS Steering Committee Meeting, Sydney
- August 2002 - Product profile MEPS for Air Conditioners
- August 2003 - MEPS for Air Conditioners :Consultation RIS
- **October 2004 – introduction of MEPS for single phase air conditioners for the first time**
- January 2005 - International Review of Minimum Energy Performance Standards for Air Conditioners (UPDATED)
- February 2005 – Consultation RIS for Increased MEPS for Air Conditioners
- June 2005 - Proposal to increase MEPS for Room Air Conditioners and harmonise MEPS for single and three-phase units –Final Draft RIS
- September 2005 - Notice of early adoption of increased MEPS for single phase air conditioners from 1 April 2006
- **April 2006 – more stringent MEPS for most single phase products**

- May 2007 – Postponement of the Proposed 2008 MEPS
- **October 2007 – more stringent MEPS for remaining single phase products**
- October 2007 – more stringent MEPS for all three-phase products

The standards affecting the MEPS of air conditioners are contained in AS/NZS 3823 standards and consist of two parts. The second part, Part 2, details the technical requirements for MEPS and energy labelling. As reported in the 2008 RIS (EES 2008), the 2003 edition of the standards contained MEPS levels for single phase products that were introduced in 2004, and the more stringent MEPS levels for single and three-phase products that were introduced in 2007. The 2005 edition contained accelerated levels for non-ducted single phase products less than 7.5kW output) forward to April 2006.

In summary, the suppliers of air conditioners had often two years or more notice of the implementation of MEPS levels and were able to bring into the market air conditioners that meet and exceed these levels well before the announced commencement date.

2 Methodology: Modelling and Trend Development

The following sections provide more detail concerning the energy modelling and data required to implement the methodology, and the development of baseline and policy trends.

2.1 Energy Modelling and Data Requirements

The proposed approach focuses on the establishment of an energy model of the air conditioner sales that tracks the actual results of the energy efficiency interventions and compares the impacts to the baseline. In examining the trends and establishing the model parameters, attributes are tested to determine the appropriate baseline projection, including the changes in capacity, type of air conditioner, purchase price and energy prices. In this way, the approach determines the influence of possible counterfactuals and corrects accordingly.

Ideally to quantify the impact of the ERLs and MEPS program, the sales weighted annual energy consumption of air conditioners would be obtained and compared to the weighted annual energy consumption under the baseline¹ scenario. The sales weighted annual energy savings can be calculated if the average annual model efficiency, capacity and annual model sales figures for all categories of air conditioners are known under the actual market conditions (after the implementation of a policy option) and also under the baseline scenario. However, only the GfK data offered the ability to conduct sales weighted assessments from 2003. The registration database only provided the ability to conduct model/market weighted analysis, although this dataset was available from 1987. Due to data quality issues, only the registration data from 1988 was used in this analysis.

As sales data was not available prior to 2003, the option of using model weighted analysis was explored so that trends could be determined over the period 1988 to 2002. An approach was developed to assess the reliability of using model weighted analysis and to identify the most accurate model weighted analysis approach. The approach involved the GfK data being used to create a sales weighted result and this was compared to alternative model/market weighted assessments at category, brand and model levels. In this way, it was possible to conduct an analysis of data using different techniques and compare the results with the more accurate sales weighted analysis.

2.1.1 Choice of Trend Methodology

A number of methodology pathways were explored to enable the study to meet the required objectives. The reliable estimates of energy consumption under baseline and policy options required that sales weighted energy consumptions values are used. However, the only reliable sales data was available for the years between 2003 and 2008. Subsequently almost all methodology options were focused on reliably estimating the historic sales records, by

¹ The Baseline scenario or Business as Usual (BAU) scenario refers to the likely market conditions in the absence of policy option. The term Business as Usual scenario tends to be used for forecasts and Baseline for counterfactual scenarios.

categories, brands and more desirably by model. A number of options were explored and tested, which included;

- Using average percentage differences between sales and model weighted values after 2003 and applying such percentage difference to pre 2003 model weighted values to convert them into sales weighted values
- Using the sales data for the years 2003 to 2008, back trending sales data at very granular levels i.e. by category and star rating and then using such sales values to conduct sales weighted values.
- Back trending sales values at brand levels and conducting analysis at brand level.
- Apply mathematical relationship between sales and model weighted calculations and hence estimate historic sales weighted values (e.g. EER/COP, CEC or capacity) required for comparison between baseline and policy options.
- For the registration data, generate sales values for each model using random number generation so that the sales weighted values between 2003 from actual GfK data and from randomly generated sales data are almost identical.

However, all these options were tested and dropped due to their lack of reliability and rationale. Finally the following methodology was adopted;

1. The appliance registration and GfK data were considered the primary source data.
2. The GfK data for years 2003 to 2008 suggested that four categories of 1 phase air conditioners i.e. reverse and cooling only systems of split and unitary type ACs account for nearly 99% of total sales hence only these categories were included.
3. Data for 1987, the first year of maintaining the registration database, appeared to be erroneous; hence it was excluded from all analysis.
4. An average model age was considered to be three years, hence a model was repeated in the database for two more years after the registration year, as provided in the database.
5. All performance parameters (CEC, EER/COP and capacity) were converted to requirements in 2002. This included converting CEC expressed in kWh before 2002 to kW in and after 2002. Similarly different formulae for calculation of EER and COP were used.
6. The final dataset was subjected to rigorous data quality checking. This included cross checking if CEC was equal to the ratio of Capacity and EER/COP and vice versa. Similarly missing values were calculated and entered into the database using values of other known parameters.
7. The finally cleaned set of GfK and registration data were used to produce sales weighted and model weighted CEC, EER/COP and Capacity by categories (4 as provided above) and year, starting from 1988, were produced. The model weighted values were calculated for the years between 1988 and 2008, whereas sales weighted values were calculated for the years between 2003 and 2008.
8. The difference between sales and model weighted values, as percent of model weighted values, were calculated for the years 2003 to 2008.
9. The percentage differences for each category were back trended to the years before 2003, using linear trend function.

10. An assumption was applied that number of models have increased over the years, and as early as 1988 the number of models were so low that model weighted values were almost equal to sales weighted values.
11. Subsequently, the back trended percentage values were standardise by the respective values of model weighted average values.
12. The resulting annual standardised percentage differences were applied to model weighted values for the respective years to estimate corresponding sales weighted values. The standardisation allowed the estimated sales weighted average values to converge to model weighted values as years get older.
13. It was noted that the difference between sales weighted and model weighted EER and COP was much smaller than such differences for CEC and capacity. The differences between sales weighted and model weighted values for EER and CEC reduced even further when standardisation was applied.
14. The actual and estimated sales weighted values identified as above were combined to produce a continuous string of values of three performance parameters (CEC, EER/COP, and capacity) for the years 1988 to 2008 and for the 4 major categories of ACs.

Once the sales weighted values of 4 performance parameters were estimated, the baseline and policy trends were established, and subsequently the resulting energy savings were calculated as described in the following section.

2.1.2 Calculating Energy Savings: Baseline and Policy Trends

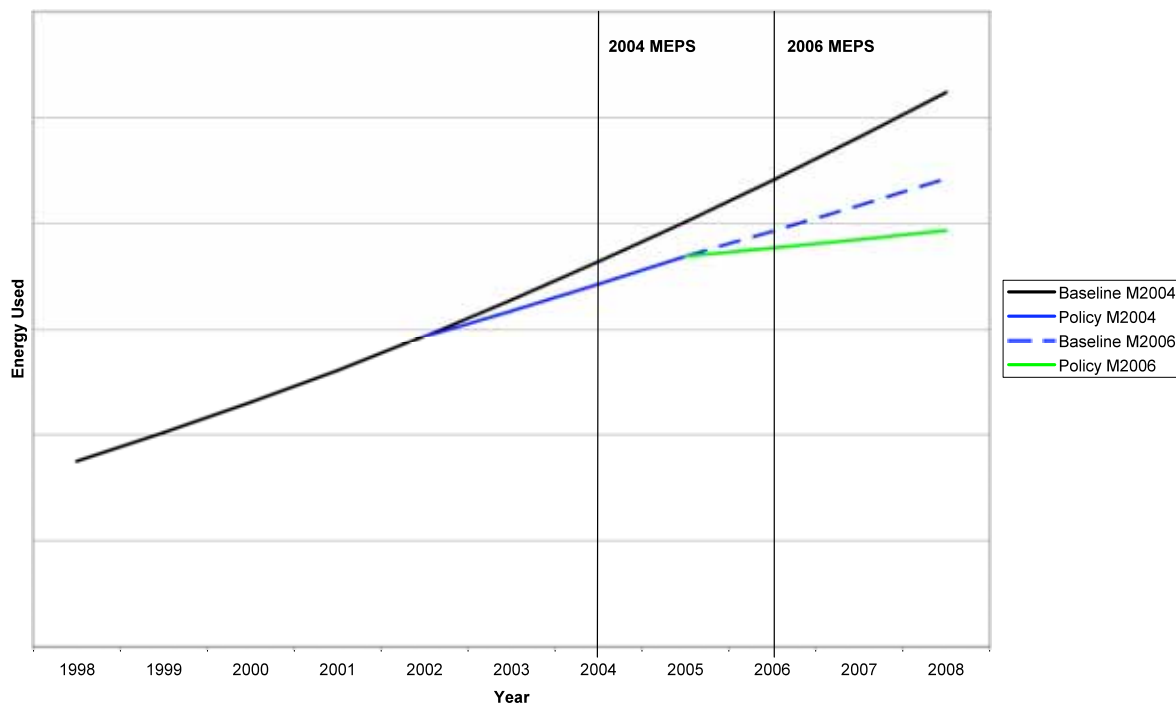
The methodology used to estimate energy savings resulting from implementation of 1st round of MEPS in 2004 and 2nd round of MEPS in 2006/07 was based on identifying divergence in trends due to the implementation of policy. Hence, the differences between estimated sales weighted average annual energy consumptions and projected trends for baseline scenarios, for each group of air conditioners, were used to estimate energy savings resulting from the implementation of different policy options. The value of energy savings for a category in a given year were calculated as product of annual sales of the group and difference between policy and baseline values in that given year.

The energy savings resulting from the two regulatory options were estimated separately due to the assumption that the policy first implemented (i.e. MEPS 2004) changes the previous baseline trend and sets a new trend. Effectively the post-policy trend becomes the new baseline trend when determining the impact of the second policy intervention (i.e. MEPS 2006/07). The baselines for the two MEPS have been labelled BaselineM2004 for MEPS 2004 and BaselineM2006 for MEPS 2006/07. 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 baseline for a given year. Hence, the savings due to MEPS 2004 between the period 2002 and 2005² can be

² Note: The impact of both MEPS is assumed to precede the actual implementation date of the MEPS, as industry plan and anticipate the change in regulations. This is supported by the previous results concerning when changes in air conditioner efficiency occurred relative to the MEPS regulation dates.

estimated simply as a function of difference between the policy and BAU1 values. However, the savings due to MEPS 2004 from 2005 to 2020 are the function of Policy – BaselineM2004 – BaselineM2006, where as the savings due to MEPS 2006/07 for the same period would be Policy – BaselineM2006.

Figure 1: Illustrative example of separation of savings resulting from two policy implementations.



It is worth noting that some regulatory policies may have specific life span when they produce benefits. The resulting benefits gradually may decline as policy becomes a market standard. For example, the efficiency of air conditioners was improved by the policy implementation; but baseline efficiency could eventually “catch up” to the policy setting, perhaps due to improvements in overseas markets increasing the overall efficiency of the appliances in the world market. This is also the case when a more stringent regulation is introduced in parallel with the existing regulation.

The baseline is a trend that is built on the basis of historic values and can never be verified, as conditions driving that trend were altered with the implementation of the policy. Also while the baseline trends are often smooth lines, the policy trends are the actual trends influenced by evolving market situations and therefore are often characterised by small and large variations. The policy trends will be affected by several factors, such as competition, new technological developments, changes in sources of overseas manufacturing and markets etc, and these factors cannot possibly have been influenced by ERLs and MEPS policy regulations.

Consequently, as can be seen from various assessments presented in previous sections, the policy trend could be higher (in other words the policy trend line may be above the baseline trend line) than the corresponding baseline trend, indicating that baseline might have been a more efficient solution than the policy option.

It is not possible to determine what the actual baseline trend would have been if the policy were not implemented. However, while not necessary true, it is very likely that if the policy trend shows an upward trend the corresponding baseline trend would have followed similar or even more adverse trend in the absence of the policy option.

Therefore, when estimating energy savings as a function of difference between policy trends and baseline trends, only those energy savings were included where the policy trend was higher than the baseline trend. The difference was set to zero (and consequently no energy savings realised) if baseline was higher than the policy value.

2.1.3 Calculating Energy Savings: Input Power

The methodology used to estimate sales weighted average annual energy consumption of various groups of air conditioners, has been explained above. The annual sales weighted average values for CEC, EER/COP and heating and cooling capacities were estimated using the methodology as above. In principle the energy savings would be a function of difference between baseline and MEPS input power (CEC) and estimated annual hours of operation. However, use of simple CEC tends to include the effects of changes in the capacity of the air conditioners. This effect was partially normalised if the EER for cooling or COP for heating was used as these variable represents the output capacity divided by the input power. Furthermore, the estimated sales weighted CEC appeared to show very large variations between the years – in line with changes in capacity – as well as offered very high values of difference between model weighted and sales weighted values. In contrast, as shown in results, the values of EER and COP offered very consistent and stable trends as well as very little deviation between model and sales weighted values.

Consequently the EER and COP were used to estimate CEC and subsequently the actual energy savings using the following approach.

1. The values of estimated annual average sales weighted capacity were assumed to be same for both baseline and policy cases. This was due to the fact that customers purchase and install air conditioners based on their cooling or heating capacities. The input energy was affected by changing EER and COP values.
2. The difference in input energies for baseline and policy case was estimated as;

$$CEC_{Sav} = \frac{Capacity}{EER_{BAU}} - \frac{Capacity}{EER_{MEPS}} \text{ ----- (1)}$$

CEC_{Sav} = Sales weighted CEC Savings per unit

$Capacity$ = Sales weighted Capacity

EER_{BAU} = Sales weighted EER (or COP) for Baseline

EER_{MEPS} = Sales weighted EER (or COP) for MEPS

When applying appropriate mathematical representation for sales weighted EER and capacity equation 1 can be shown as;

$$CEC_{Sav} = \frac{\sum_{i=1}^N Capacity_{iBAU} \times Sale_{iBAU}}{\sum_{i=1}^N EER_{iBAU} \times Sale_{iBAU}} - \frac{\sum_{i=1}^N Capacity_{iMEPS} \times Sale_{iMEPS}}{\sum_{i=1}^N EER_{iMEPS} \times Sale_{iMEPS}} \text{-----}(2)$$

3. It can be seen that the above approach introduced an error since the actual CEC savings can be shown mathematically as;

$$CEC_{Sav} = CEC_{BAU} - CEC_{MEPS}$$

$$CEC_{Sav} = \frac{\sum_{i=1}^N \frac{Capacity_{iBAU}}{EER_{iBAU}} \times Sale_{iBAU}}{\sum_{i=1}^N Sale_{iBAU}} - \frac{\sum_{i=1}^N \frac{Capacity_{iMEPS}}{EER_{iMEPS}} \times Sale_{iMEPS}}{\sum_{i=1}^N Sale_{iMEPS}} \text{-----}(3)$$

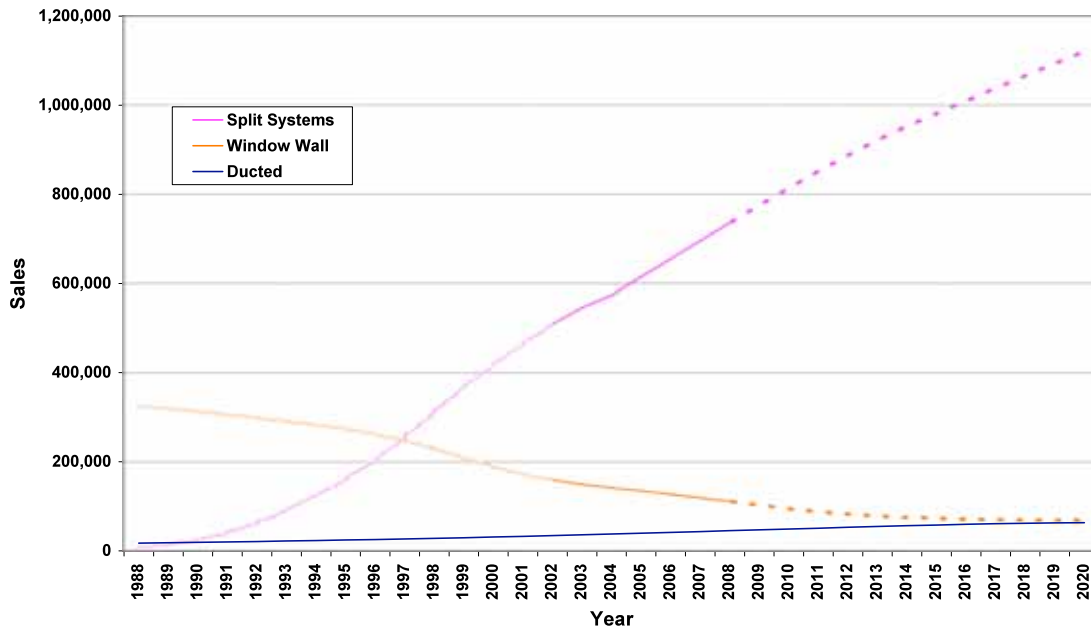
4. It can be seen that equation 2 and 3 differ in mathematical representation, and hence warrant an inherent error in calculated value of energy savings. However, we estimated the CEC savings through both methods above using the known data (2003 to 2008) and found that the level of error was within 10%.
5. Given the constraints of data and low error level, the above approach to estimate CEC savings per unit was applied to estimate total energy savings.
6. Once CEC energy savings were estimated for two Baselines, they were applied to the annual sales of units affected by two sets of MEPS and consequently annual energy savings were estimated.
7. The final estimate of annual energy savings was a function of energy savings per unit for a given year by category, number of units sold in that year, number of units sold in previous years but affected by the energy savings in current year, and average number of hours of operation for the given year.
8. The annual energy savings were estimated for each of the 4 major categories and for each year between 2003 and 2008.
9. Finally all values were also forecast from 2009 to 2020

2.1.4 Estimated Annual Sales by Category

The annual sales for the selected categories of air conditioners were estimated for the periods 1988 and 2002. GfK data provides actual sales values compiled through market research surveys of selected retail outlets since 2003. The sample of selected retail outlets was estimated to have accounted for between 60% and 75% of total national sales for the period between 2003 and 2008. The values in this study were therefore scaled up to account for the total national sales. It was estimated that the GfK sample provides a reliable estimate of sales for single phase split systems and window wall units, but not ducted systems. Industry estimated values are used to derive ducted air conditioner sales. Figure 2 illustrates the sales trends for single phase air conditioners for the period between 1988 and 2008, and a forecast from 2009 to 2020. The figure shows that the sales of air conditioners have increased consistently since 1988, with a large increase in the share of split systems compared to the decrease in sales of

window wall units. Also, the estimated sales of ducted systems have increased over the same period (GfK does not provide good coverage of ducted systems, as these are not generally sold via retail outlets).

Figure 2: Estimated Annual sales of Air conditioners (1988 – 2020).



3 Results: Additional Details

The results presented in the following sections provide additional details concerning the findings of the study, but the principle results have already been reported in the main report.

3.1 Average Efficiency Trends

The efficiency of an air conditioner was measured in terms of its EER value for its efficiency in cooling and its COP value in terms of its efficiency for heating. The trends in these attributes provide the measure of the change in the efficiency of air conditioners.

3.1.1 Average Efficiency Trends after the Introduction of MEPS

The trends of average efficiency for different groups of air conditioners were assessed using a combination of results from GfK and registration database. Sales weighted results have been provided in the main report, but the model weighted results are provided here. These results are largely consistent with the previously reported sales weighted results.

3.1.1.1 Model Weighted Results

The registration database was used to produce trends of *model weighted* average efficiency of various groups of air conditioners. Note that the model weighted values for a year refer to simple averages of annual energy consumptions of all models for a group in that year. The model weighted values do not provide as accurate trend compared to sales weighted values, but rather an indicative situation analysis. Therefore, it was important that the analysis based on model weighted values is treated with caution. Figure 3 and Figure 4 illustrate trends of changes in *model weighted* average efficiencies of various groups of air conditioners after introduction of ERLs in 1987.

Figure 3: Model weighted average EER by air conditioner category.

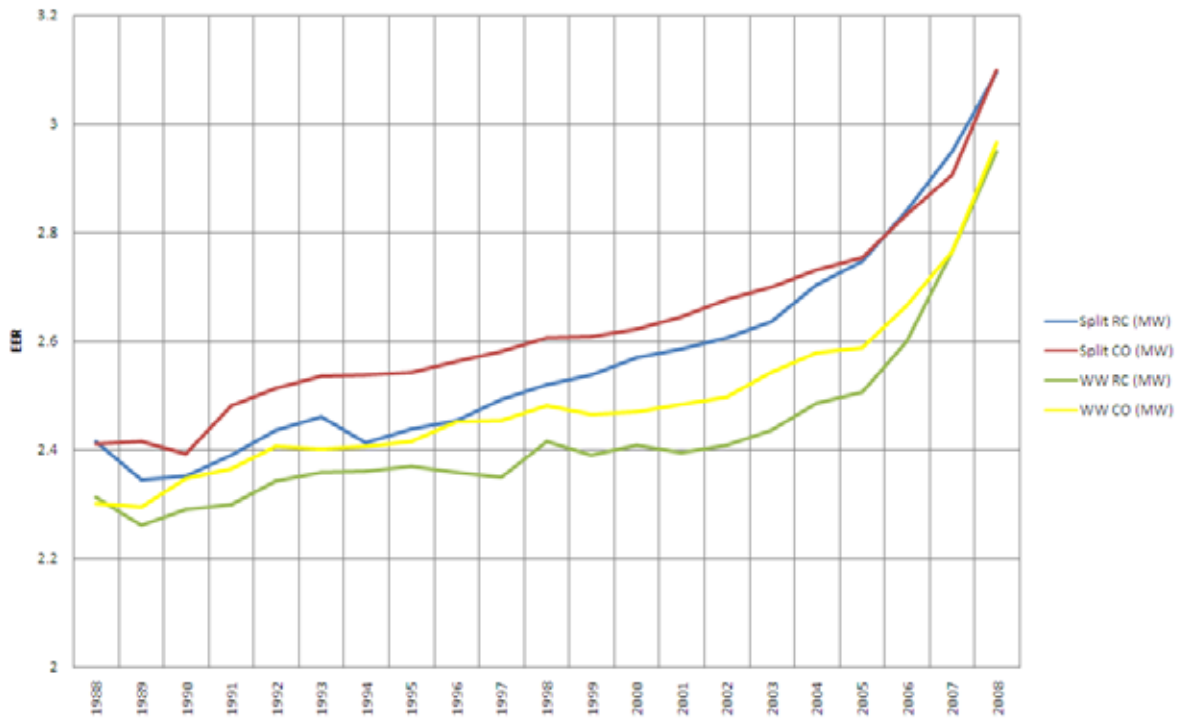


Figure 4: Model weighted average COP by air conditioner category.

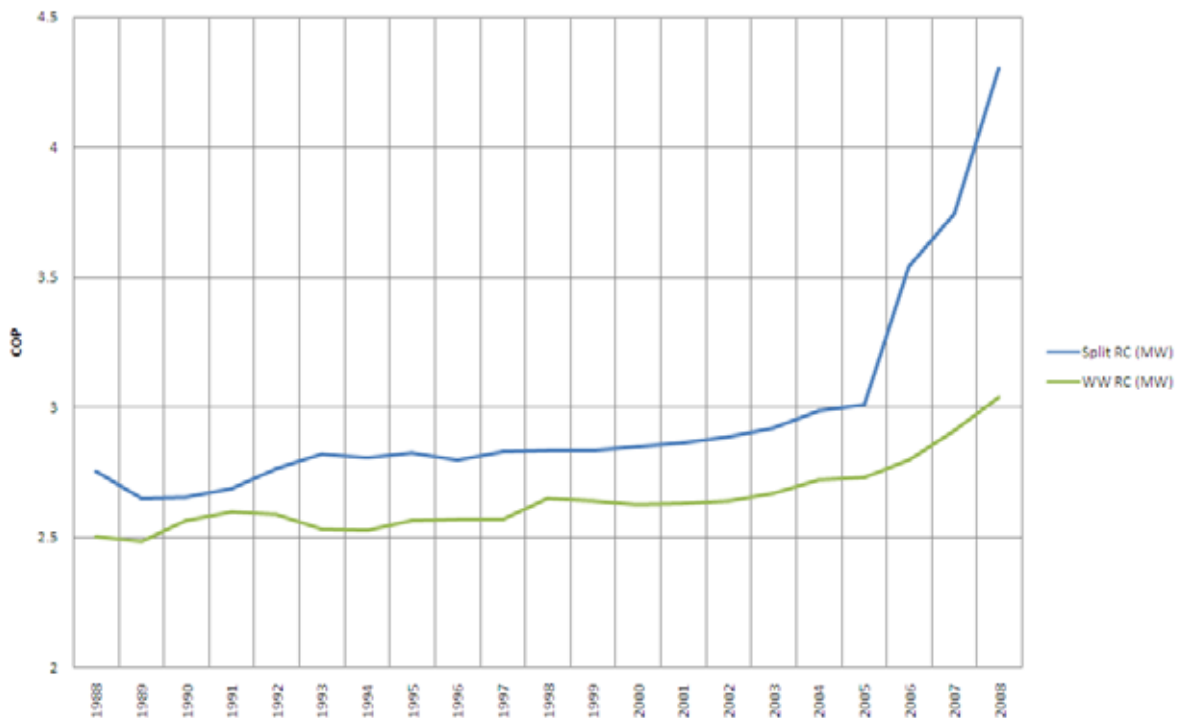


Figure 3 and Figure 4 show that changes in the energy efficiency of all types of air conditioners were responsive to two rounds of MEPS. Though there was a steady baseline improvement trend in air conditioner efficiency prior to the MEPS being announced, the rate of improvement started to accelerate from 2002 in some air conditioner types and clearly increased for all type from 2004.

3.1.1.2 Summary

Both the sales weighted and model weighted EER and COP trends clearly show an acceleration in the improvement of the efficiency of the air conditioners since the introduction of the air conditioner MEPS, or slightly before they were regulated. In the absence of any other factors leading to this improvement, it is reasonable to conclude that the introduction of MEPS has led to an above baseline improvement in the efficiency of air conditioners in Australia.

3.2 Average Input Power Trends

Currently, as a requirement of MEPS, all air conditioners must be tested according to AS/NZS 3823 to determine their average annual energy consumption under controlled conditions, as described in the standard. AS/NZS 3823 was first published in 1998 and first introduced in 1987 at the time of the introduction of energy labelling in the state regulations. In 2000 the standard and labelling algorithm was revised. It was therefore important in the analysis of the results to ensure they are normalised to the current labelling algorithm.

3.2.1 Average Input Power Trends after the Introduction of Labelling

The trends of average annual input power for different groups of air conditioners could be assessed by using a combination of results from GfK and registration database.

3.2.1.1 Model Weighted Results

The registration database was used to produce trends of *model weighted* average input power of various categories of air conditioners. Note that the model weighted values for a year refer to simple averages of input power of all models for a category in that year. The model weighted values do not provide as accurate trend compared to sales weighted values, but rather an indicative situation analysis. Therefore, analysis based on model weighted values needs to be treated with caution. Figure 5 and Figure 6 illustrate trends of changes in *model weighted* input power of various categories of air conditioners after introduction of ERLs in 1987.

Figure 5: Model weighted average input power for cooling - air conditioners.

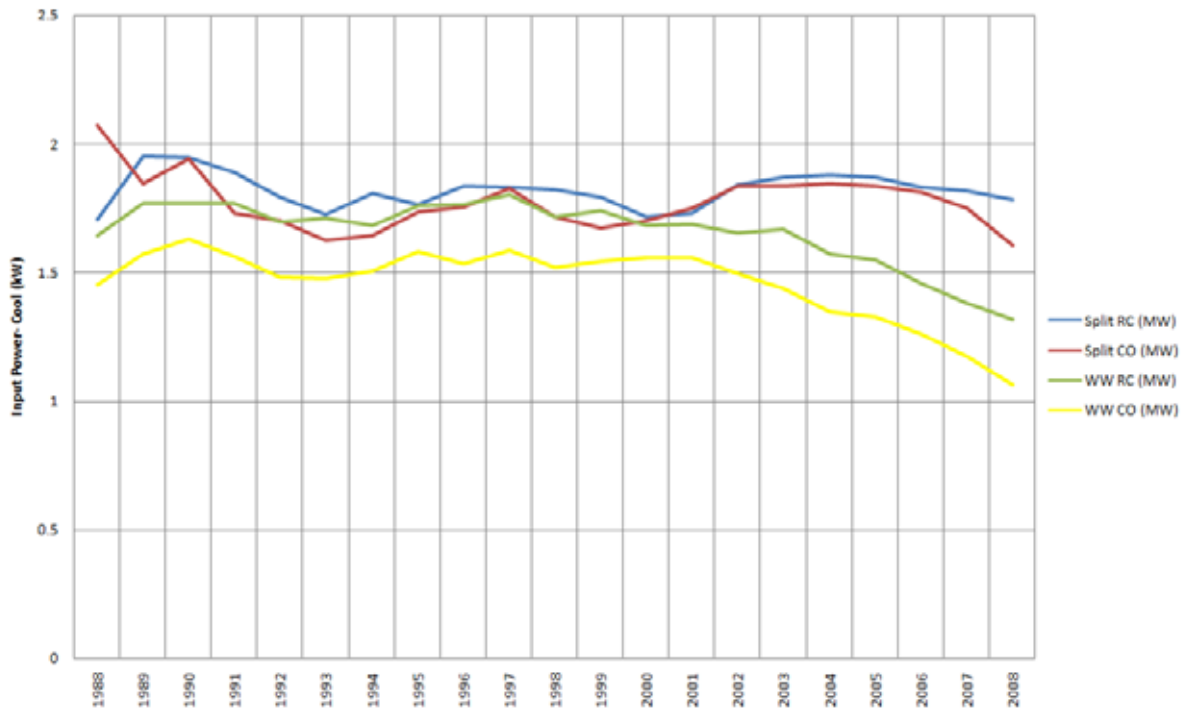
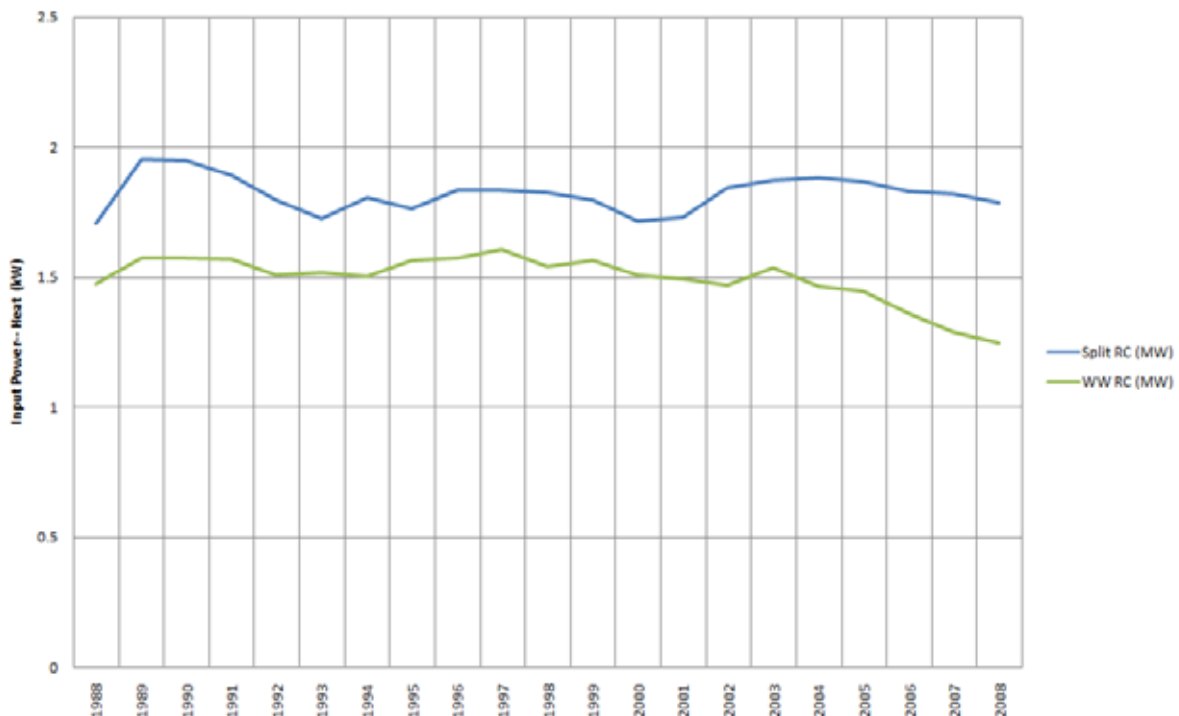


Figure 6: Model weighted average input power for heating - air conditioners.



It can be seen from Figure 5 and Figure 6 above that there has been a consistently declining trend for average input power for window -wall air conditioners since the early 2000's. The two figures strongly suggest that the introduction of MEPS 2004 and MEPS 2007 produce

significant impacts. This was evident from reasonably sharp decline in the trend lines in the years after suppliers are believed to have acted in anticipation of meeting the MEPS requirements i.e. 2003 to meet requirements of MEPS 2004.

The trend for split air conditioners is not as pronounced but is still present, with a gradual decline in input power occurring since 2004. This in part may be because of changes in the size of air conditioners sold over the period 2003, with an increase in capacity evident in 2003/04.

3.2.1.2 Sales Weighted Results

The GfK data was used to produce *sales weighted* trends of average input power of different categories of air conditioners. Sales weighted average input power figures provide a better indication of the average input power of new appliances in any given year. Figure 7 and Figure 8 illustrate trends of changes in *sales weighted* average input power of various groups of air conditioners. Because of the limitations of GfK data the trends start only after 2003. The analysis of sales weighted average input power shows continuously declining trends for all air conditioner categories.

Figure 7: Sales weighted average input power for cooling - air conditioners.

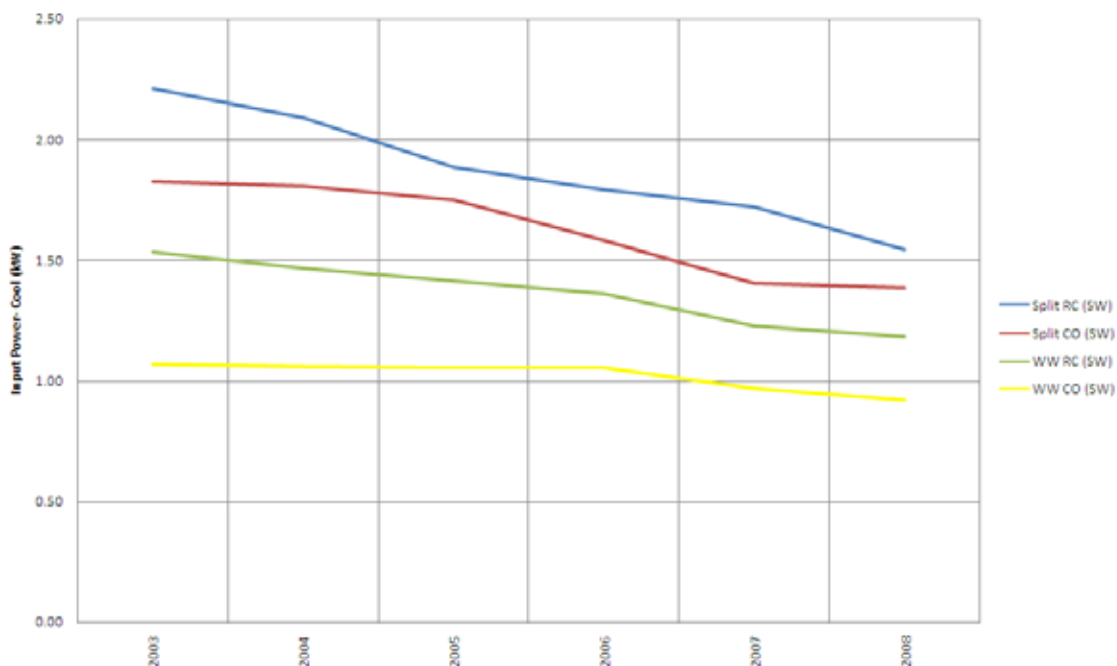
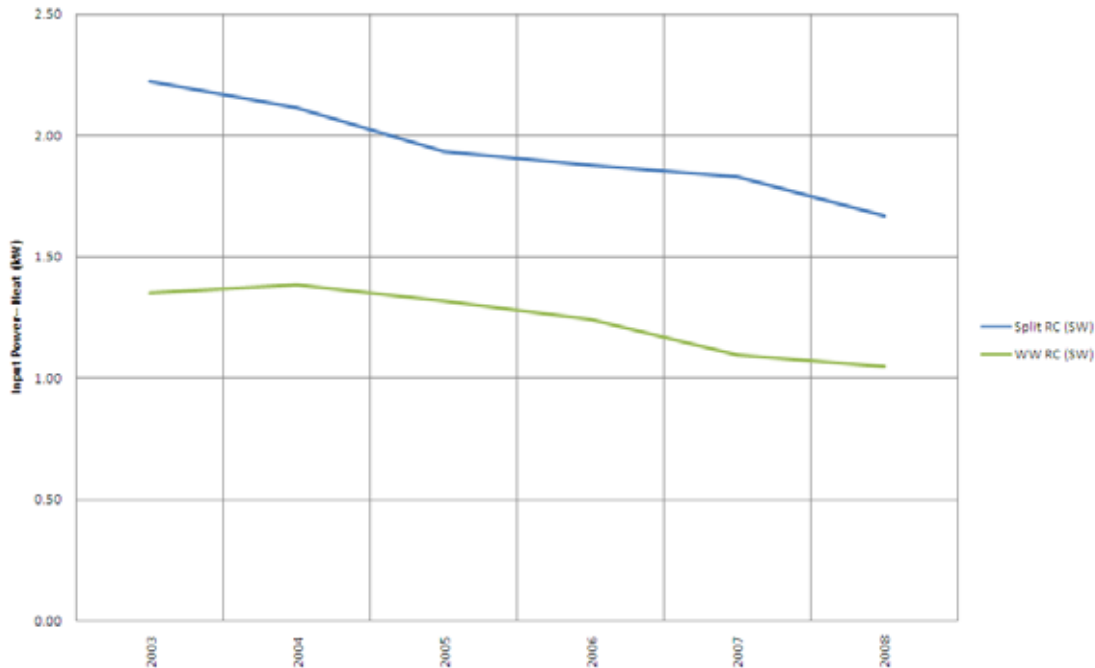


Figure 8: Sales weighted average input power for heating - air conditioners.



The model weighted and sales weighted trends are displayed together in Figure 9 to enable comparison of the two forms of trends.

Figure 9: Model- and sales-weighted average input power for cooling - air conditioners.

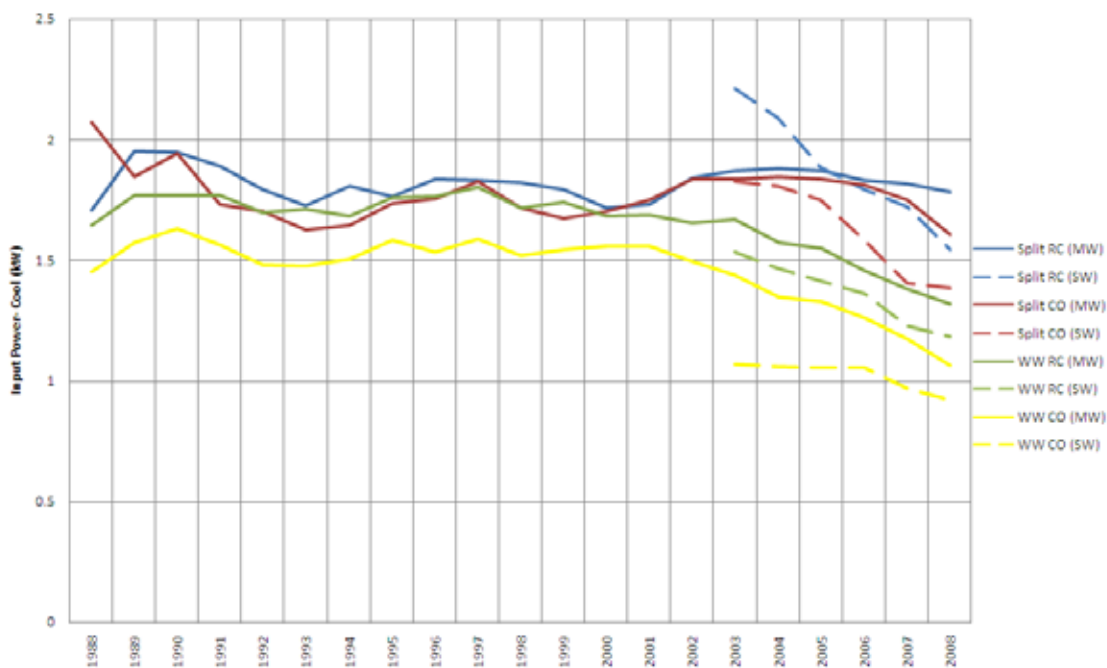
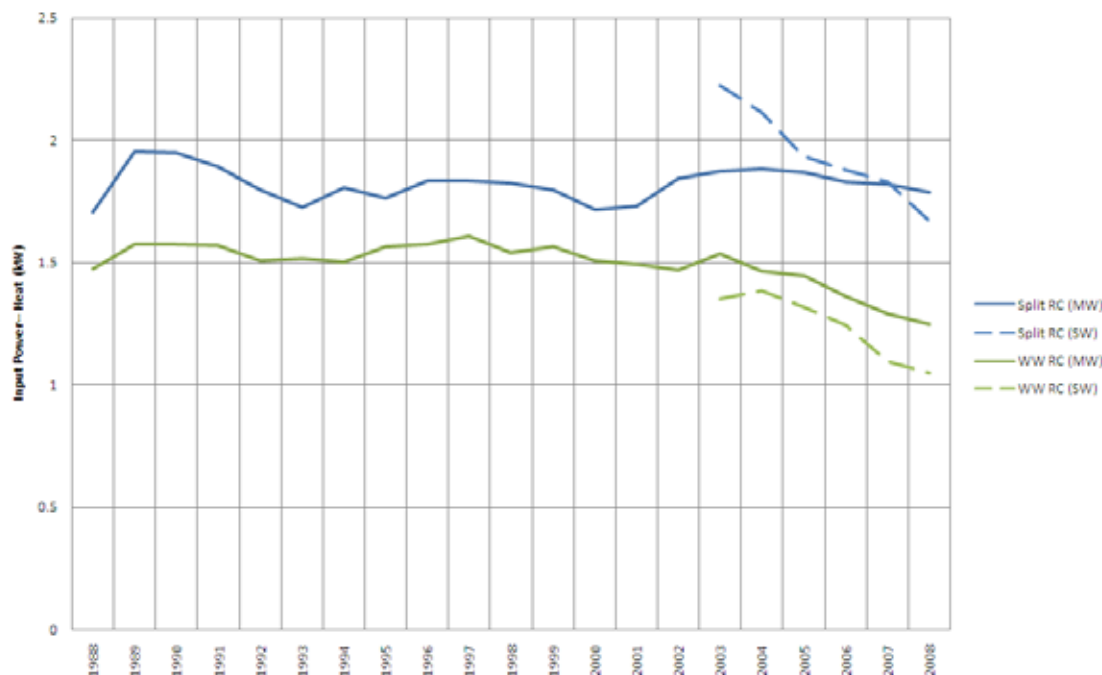


Figure 10: Model and Sales weighted average input power for heating - air conditioners.



These charts show the sales weighted trends like the model weighted trends show declined in input power but there appears to be differences in model weighted and sales weighted trends, especially for split systems. Generally the sales weighted trends show a more significant decline than the model weighted trends. The declining trends mainly appear to start before 2004, when the MEPS were introduced, and this was consistent with suppliers adjusting their model availability in response to the anticipated introduction of the MEPS.

A number of factors could be responsible for the differences between the model and sales weighted results. The time lag between the introduction and implementation of a new regulation may have allowed suppliers to engage in the development of new products that would be compliant with anticipated new regulation. Consequently they tend to register new products that would be compliant with upcoming new regulation in advance. However, the new product only starts to impact on the sales weighted results as the sales of the model increase in volume and the previous model is cleared from the market.

Another factor may have been that the lower efficiency models had greater sales volumes than the high efficiency models, and the elimination of these low efficiency models by the MEPS therefore led to a greater impact on the sales weighted input power, as it produced a proportionally bigger shift towards the sales of higher efficiency models.

3.3 Average Capacity Trends

The trends in air conditioner capacity are examined in this section. If MEPS are producing improvements in efficiency, some decrease in capacity installed below the baseline trend would be expected to occur when MEPS are introduced.

3.3.1.1 Model Weighted Results

The registration database was used to produce trends of *model weighted* average capacity of various groups of air conditioners. Figure 11 and Figure 12 illustrate trends of changes in *model weighted* average capacity of various groups of air conditioners after introduction of ERLs in 1987.

It can be seen from Figure 11 and Figure 12 that there has been some slight decline in cooling and heating capacity for window-wall air conditioners post 2003, except for a slight increase in cooling capacity for 2007 and 2008. In contrast, the capacity of split systems has increased or remained stable since 2003. Once again this aspect was cross checked with *sales weighted* analysis.

Figure 11: Model weighted average cooling capacity of air conditioners.

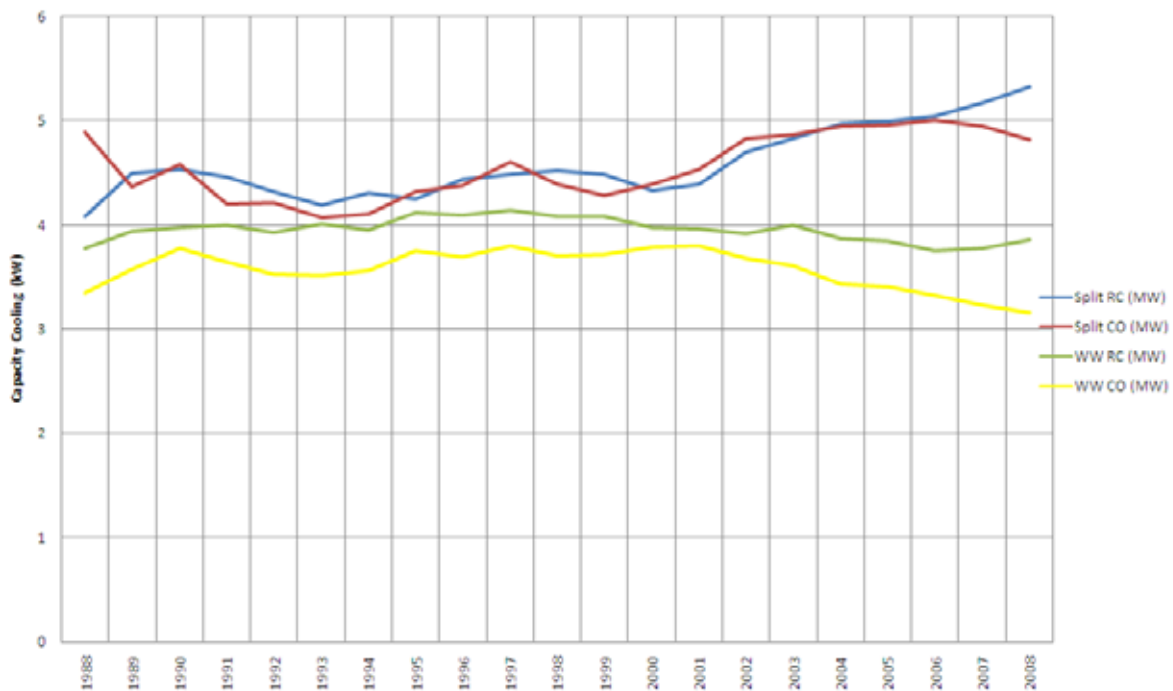
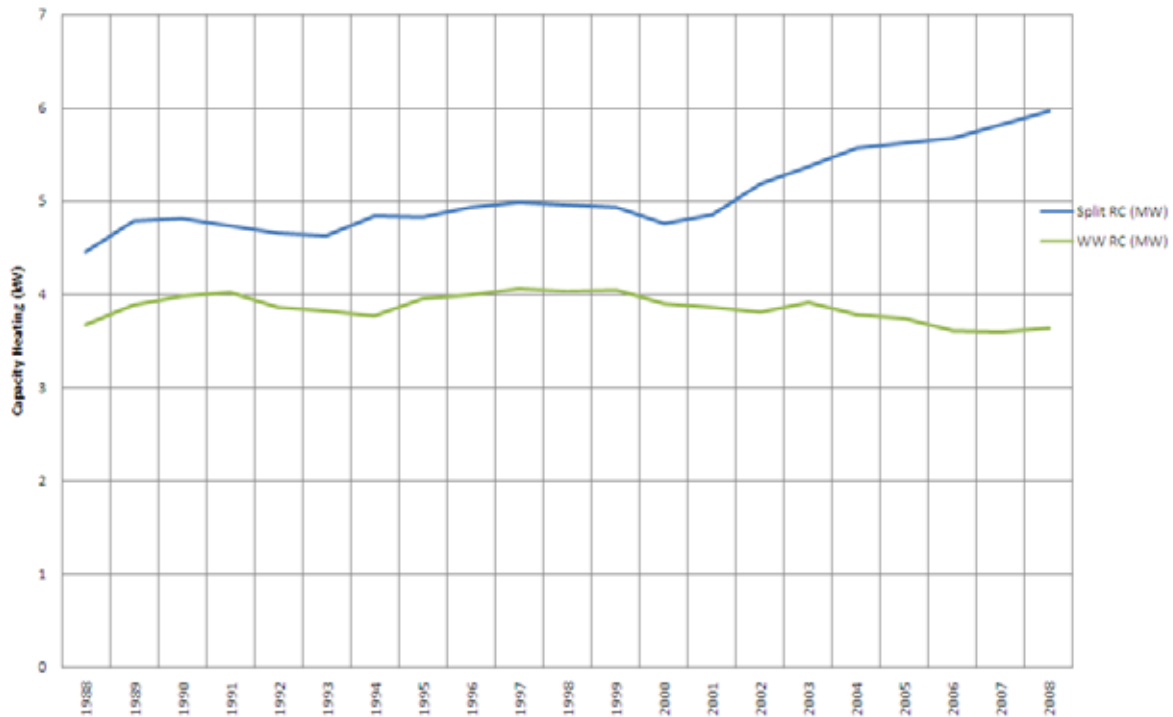


Figure 12: Model weighted average heating capacity of air conditioners.



3.3.1.2 Sales Weighted Results

The GfK data was used to produce *sales weighted* trends of average capacity of different groups of air conditioners. Figure 13 and Figure 14 illustrate trends in *sales weighted* average capacity of air conditioners by category. Because of the limitations of GfK data, the trends start only after 2003.

Figure 13: Sales weighted average capacity of air conditioners – cooling.

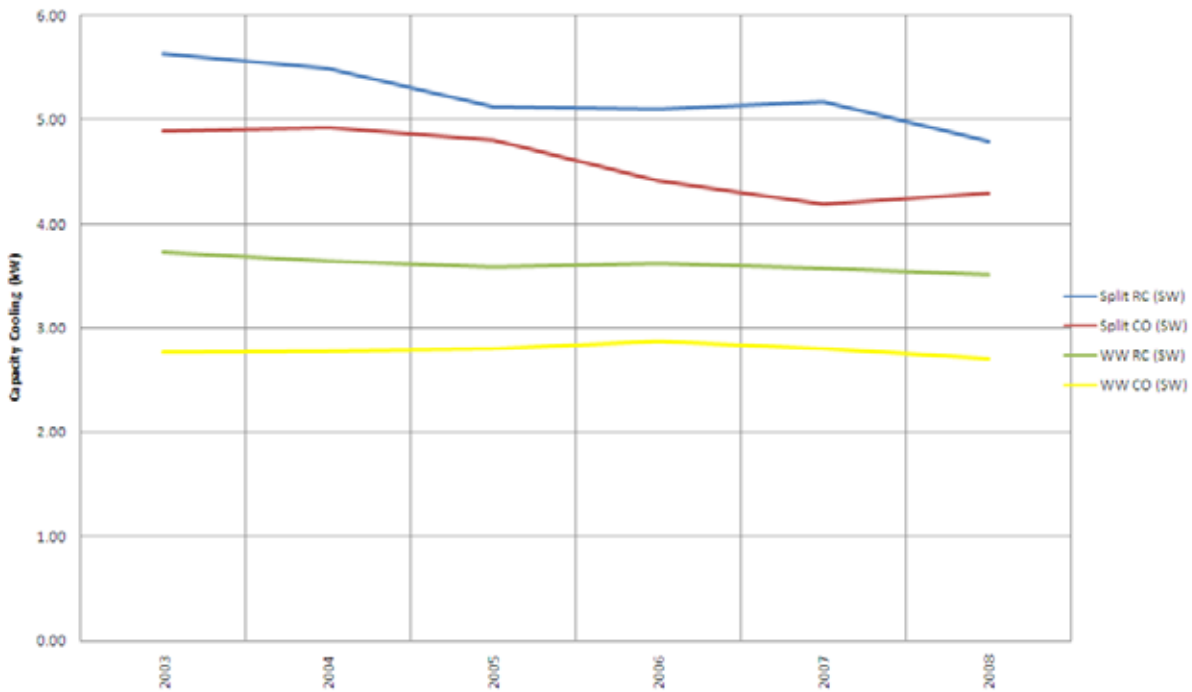
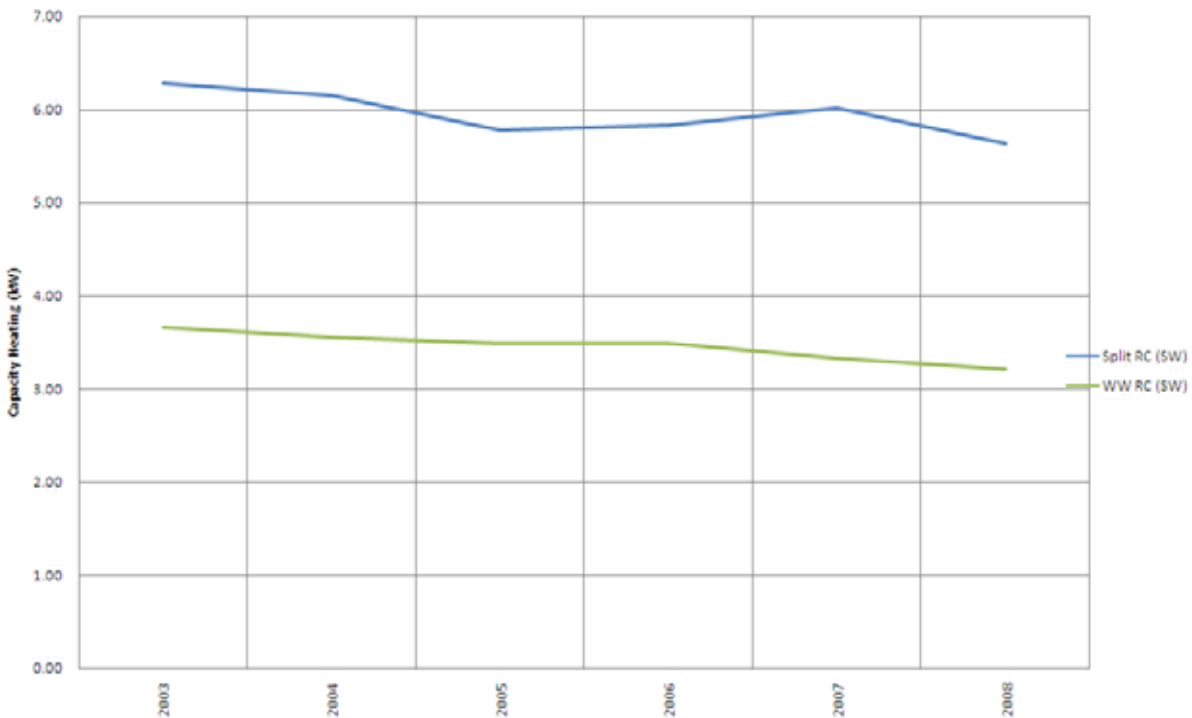


Figure 14: Sales weighted average capacity of air conditioners – heating.



The charts show that sales weighted capacity has declined for all air conditioners since the introduction of MEPS.

The model weighted and sales weighted trends are displayed together in the charts below to enable comparison of the two forms of trends.

Figure 15: Model and Sales weighted average capacity for cooling of air conditioners.

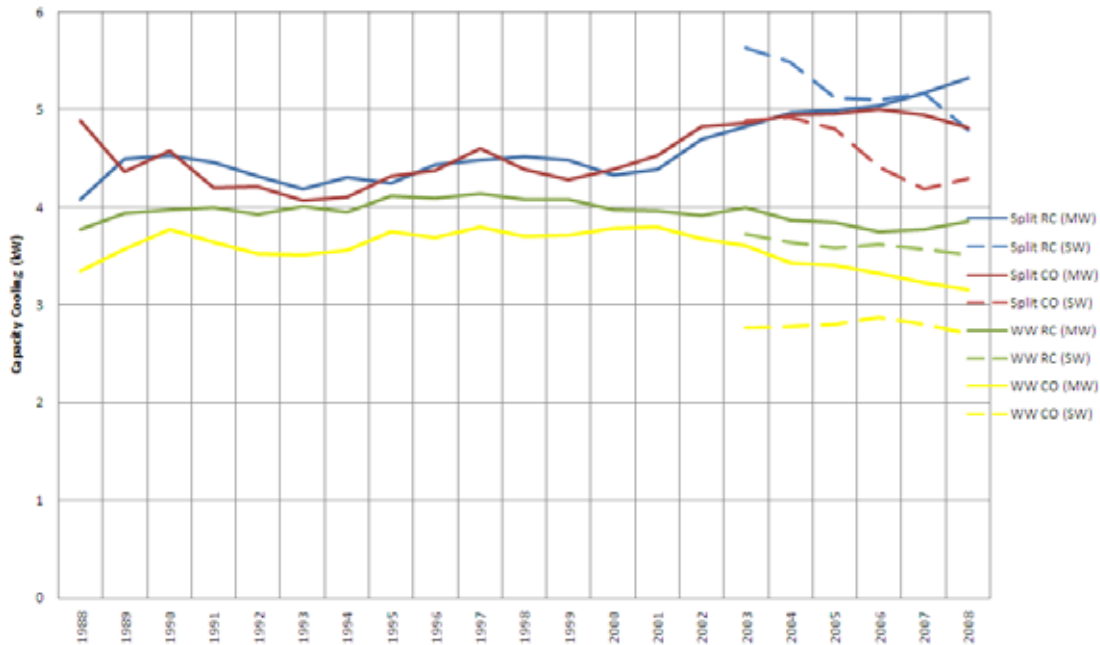
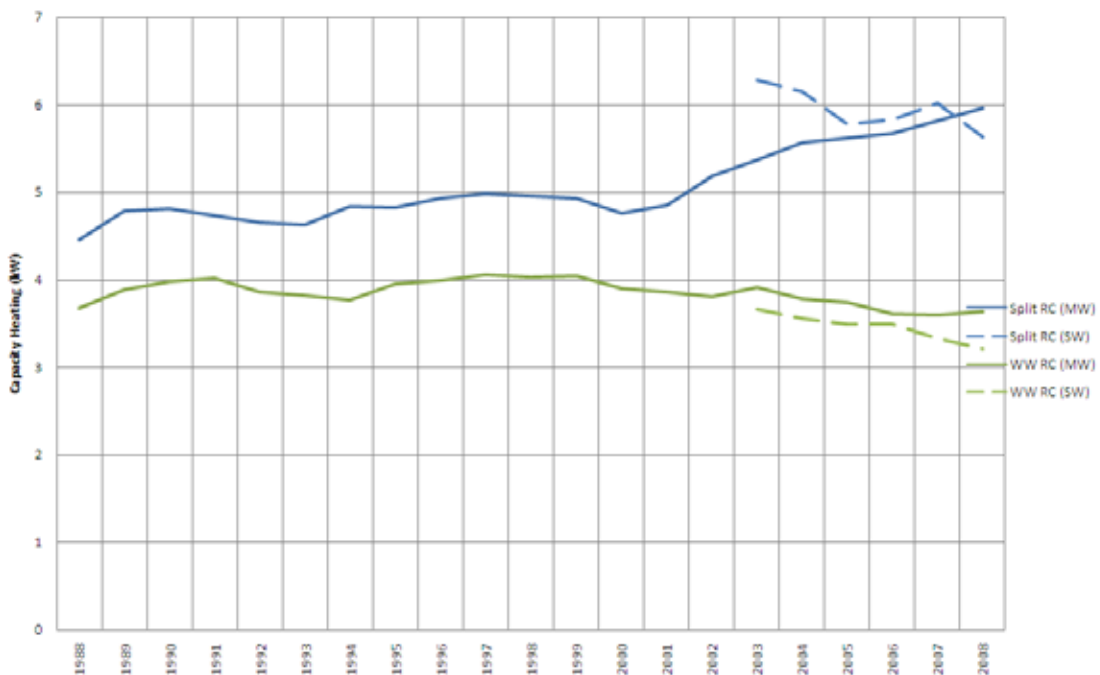


Figure 16: Model and Sales weighted average capacity for heating of air conditioners.



The analysis of *sales weighted* average capacity show reasonably similar results for both air conditioners, compared to the *model weighted* analysis. With the exception of reverse cycle split

systems, model weighted and sales weighted trends all indicate declining capacity. The sales weighted trends for reverse cycle split systems also show a downward trend in capacity, but the model weighted trend was for an increase in capacity. It is possible that this is the result of supplier's predictions of demand, as reflected in model registrations, not being accurate and the market continuing to prefer lower capacity models.

3.3.1.3 Summary

The sales weighted analysis suggests that there has been an overall decrease in air conditioner capacity since 2003, when MEPS were announced.

3.4 Estimated Energy Savings

The main results of the analysis concerning the estimated energy savings from the MEPS have been reported in the main report. This section provides further details of the analysis used, results for product categories and the execution of the methodology.

3.4.1 Estimated Sales Weighted Average Annual Energy Consumption Trends

The sales weighted average EER/COP and capacity were used to produce annual energy consumption trend lines, using 5 year moving averages. (The methods used to estimate sales weighted average annual energy consumption of various groups of air conditioners, have previously been explained.) The following trends were produced:

- **Policy:** Actual sales weighted average annual energy consumption for each group of air conditioners as estimated using methodology previously explained.
- **Baseline M2004:** Trend as determined by conditions before the introduction of MEPS in 2004.
- **Baseline M2006/07:** Trend as determined by conditions before the introduction of more stringent MEPS 2006/07.

The differences between the Policy and baseline annual energy consumption was then calculated for each year and for the different baselines. The differences represent the annual energy savings from introducing the MEPS policies.

3.4.1.1 Saving from MEPS 2004

The difference between the energy expected to be used under the Baseline M2004 scenario versus what occurred under the MEPS 2004 actual policy are shown in Figure 17 and Figure 18 as energy savings.

Figure 17 shows that the 2004 MEPS immediately produced energy savings from air conditioners when cooling, with saving starting in 2003, the annual saving peaked in 2013 and then declined. Energy savings from the changes to the split reverse cycle systems were the main component of this savings.

Figure 18 shows that the 2004 MEPS produced energy savings from air conditioners when heating but the saving started later in 2005. Again the annual saving peaked in 2013 and then declined. Energy savings from the changes to the split reverse cycle systems were again the main component of this savings.

Figure 17: Annual Energy Savings (cooling) from only 2004 MEPS.

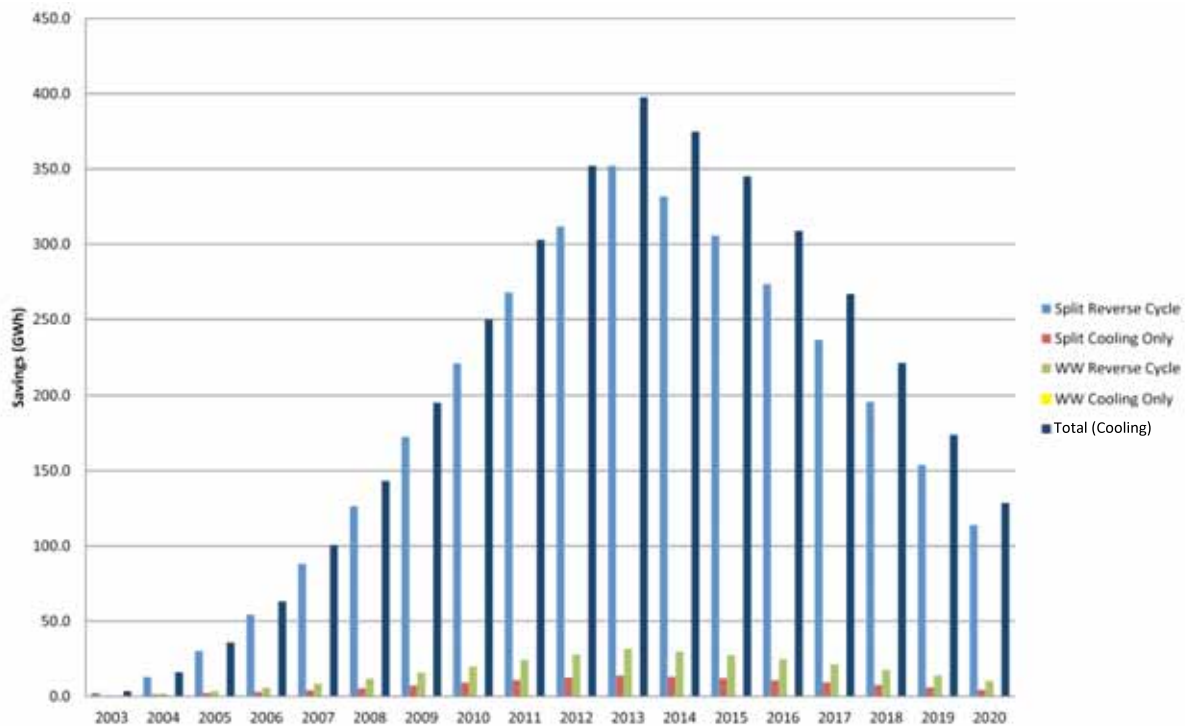
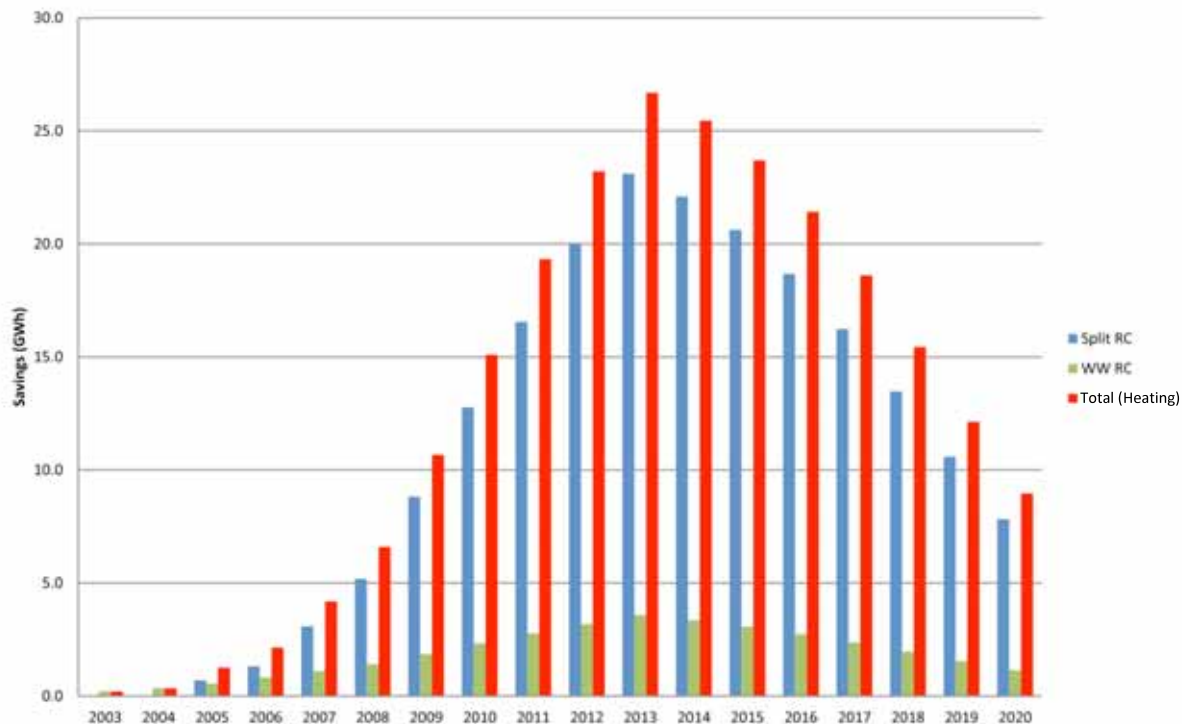


Figure 18: Annual Energy Savings (heating) from 2004 MEPS only.



3.4.1.2 Saving from MEPS 2006/07

The difference between the energy expected to be used under the Baseline M2006/07 scenario versus what occurred under the MEPS 2006/07 actual policy are shown in Figure 19 and Figure 20 as energy savings. This scenario assumes the MEPS 2004 policy was introduced.

Figure 19 shows that the 2006/07 MEP immediately produced energy savings from air conditioners when cooling, with saving starting in 2007, the annual saving peaked in 2015 and then declined. Energy savings from the changes to the split reverse cycle systems were the main component of this savings. Figure 20 shows the energy savings impact was produced by the 2006/07 MEP from air conditioners when heating also started in 2007 and peaked in 2015. Energy savings from the changes to the split reverse cycle systems were again the main component of this savings.

Figure 19: Annual Energy Savings (cooling) from 2006/07 MEPS.

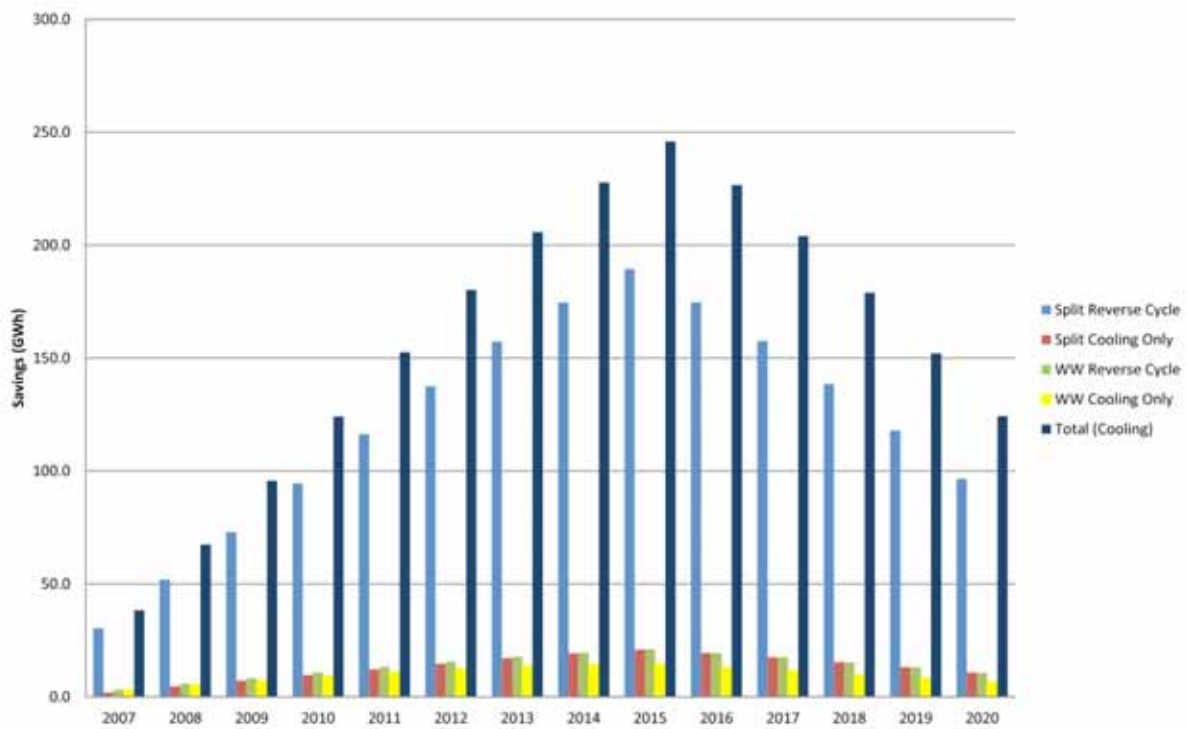
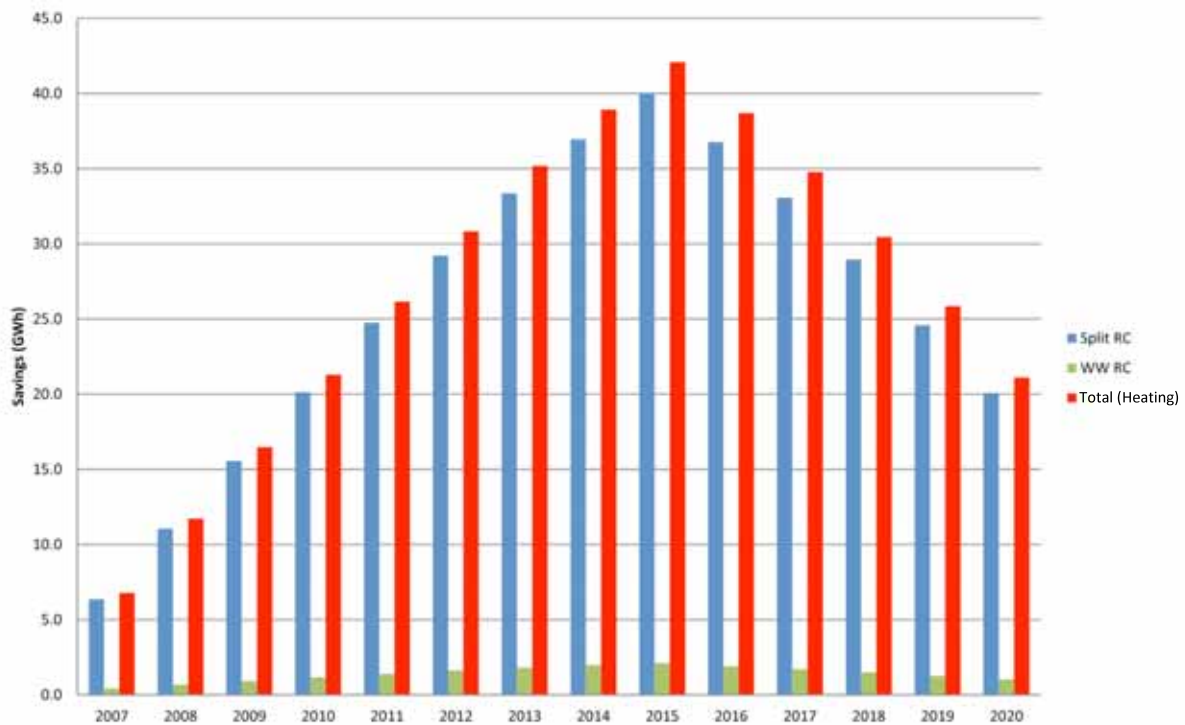


Figure 20: Annual Energy Savings (heating) from 2006/07 MEPS.



3.4.1.3 Saving from MEPS 2004 and 2006/07

The difference between the energy expected to be used under the baseline scenario versus what occurred under both MEPS 2004 and MEPS 2006/07 actual policy are shown in Figure 21, Figure 22 as energy savings. Effectively the savings was the combined savings as calculated from the Baseline 1 and Baseline 2 scenarios.

Figure 21 shows the energy saving from air conditioners in cooling mode with the effect of both MEPS starting in 2007, with the annual saving peaked in 2013 and then declining. Figure 22 shows the energy savings from air conditioners in heating mode impact started slightly later in 2005 but that it again peaked in 2015.

Figure 21: Annual Energy Savings (cooling) from both MEPS.

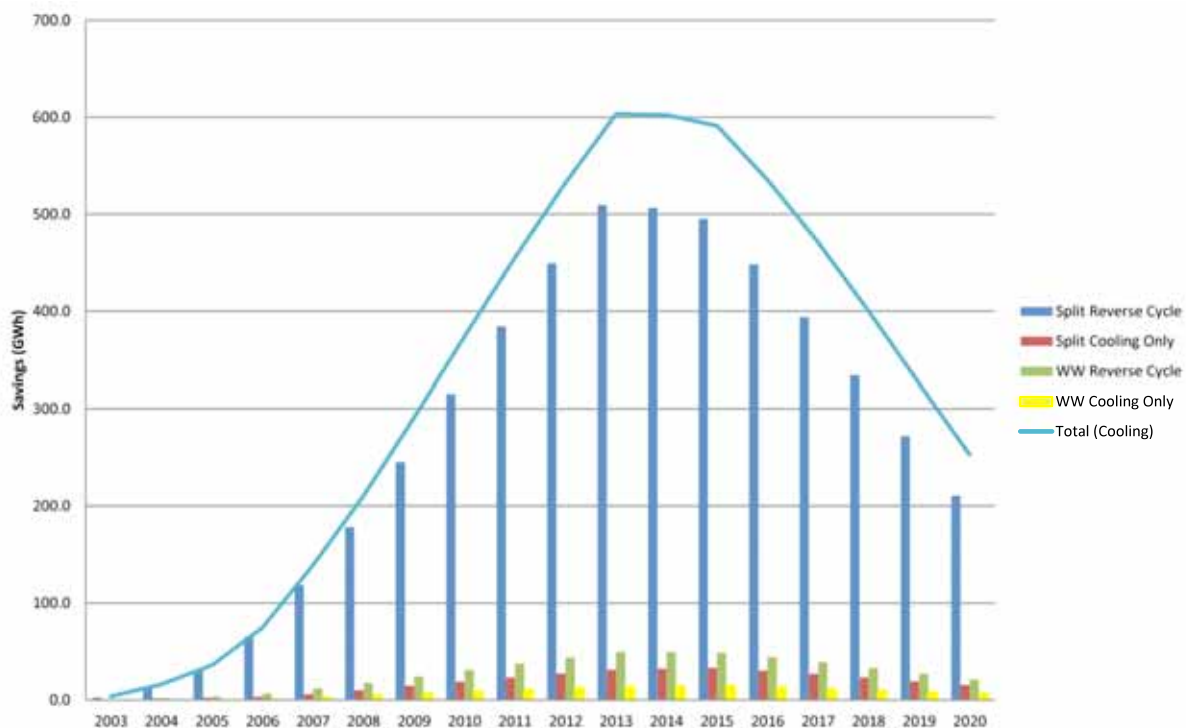


Figure 22: Annual Energy Savings (heating) from both MEPS.

