Ministry for the Environment

Economic Impact Analysis of Mandatory Energy Performance Standards for Specific Product Classes

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EXECUTIVE SUMMARY

PA Consulting Group (PA) has been retained by the Ministry for the Environment (on behalf of the Ministry, The Treasury, The Ministry for Economic Development and the Energy Efficiency and Conservation Authority) to conduct an investigation of the economic impact on end users of mandatory Minimum Energy Performance Standards for selected product classes.

The three product classes covered along with the relevant Standards are:

- Domestic refrigeration appliances, as defined in AS/NZS 4474.1 (test method) and AS/NZS 4474.2 (requirements);
- Three phase cage electric motors as defined in AS/NZS 1359.102.3 (test method) and AS/NZS 1359.5 (requirements); and
- Packaged air conditioners as defined in AS/NZS 3823.1.1 (test method) and AS/NZS 3823.1.2 (requirements).

This study is the most recent of a series of investigations and streams of policy advice stretching back to the development of the Long Term Integrated Strategy for Energy Efficiency announced by the Government in July of 1994.

The objective of the investigation is to identify those individuals (or groups of individuals) who may be made better or (in particular) worse off by the introduction of MEPS, along with the extent of that advantage or disadvantage. Special consideration is given to the possible adverse impact of MEPS on low-income purchasers and to situations where affected product may only be used intermittently.

In accordance with the brief, this study does not purport to represent the costs and benefits of MEPS to society as a whole. For example, it does not address questions such as whether the variable rate of electricity represents the value to society of electricity saved. It is but one of the necessary inputs into the policy decision of whether or not to proceed with MEPS.

Although the timeframe provided for this assignment was tight – allowing just 3 weeks between its commencement and completion of a draft report – it has been possible to gather a considerable amount of both quantitative and qualitative information from the industry and other sources about the products affected. Consequently, we have a considerable degree of confidence about the robustness of the overall conclusions presented.

Methodology and Information Sources

At the core of the study is a discounted cash flow (DCF) analysis conducted from the perspective of the end user. The key parameters used are the electricity price, the discount rate, the capital cost premium (if any) and energy savings for MEPS compliant product vis-à-vis their non-complying equivalents. The values for all of these parameters are those that would be faced by the end-user.

The focus on the end-user means that the value of these parameters varies from one market segment to another. For example the (variable) price of electricity faced by a commercial consumer is not generally the same as that faced by a domestic consumer. Similarly, the discount rate relevant to a firm is not relevant to a low-income consumer.

In order to capture these differences, the DCF analysis was run with respect to a variety of different values for each of the product classes under consideration. In addition, we have calculated the impact of an increase in the price of carbon on the cost of fossil fuels and geothermal energy sources and modelled the impact that this would have on the price of electricity. The impact of this increase has been included in the sensitivity analysis.

In terms of the information sources referred to, we have relied on a combination of published material (including previous reports, relevant websites and product literature) the analysis of industry data obtained from Statistics New Zealand and interviews with key industry players – including importers, manufacturers and retailers. Given the timeframe provided for this study, it has not been possible to independently verify published material on such things as energy consumption for particular appliances. Unless we had good reason to think otherwise this material was assumed to be correct.

Domestic Refrigeration Appliances

The New Zealand market for domestic refrigeration appliances is characterised by the existence of two major players (Fisher & Paykel and Email) along with a number of small importers. Although imports from Korea are increasing, the market share of Korean appliances (LG and Samsung) is still small compared to that of the main players.

The New Zealand market appears to be strongly influenced by the pending introduction into Australia of MEPS for domestic refrigeration appliances. The closeness of the two markets means that the transition of the Australian market to MEPS compliant product has provided the impetus for the New Zealand market to change as well. We have not been able to identify any product currently available within New Zealand that would not meet the joint New Zealand Australian Standard.

With respect to low income earners, four new models appear to be popular – particularly two of the LG product range. These appliances are all MEPS compliant. Our analysis of the second hand market for domestic refrigeration appliances shows that the market is competitive with prices typically well below new price levels.

As a result of the above, we conclude that it is most likely that the introduction of MEPS at the level considered will have no impact at all on the end-user. Notwithstanding this conclusion, it is possible that MEPS could make the end user worse off – if the market was about to revert to non-compliant product and the product was put on the market at a price well below compliant product. It is also possible that MEPS could make the end-user better off – if the market was about to revert to less efficient product and the capital cost was similar to MEPS compliant product.

In order to demonstrate the relationship between efficiency levels and the capital cost of the appliance, we calculated how much cheaper a non-compliant fridge would need to be for a low income purchaser to be made worse off by MEPS, under varying assumptions relating to discount rate, cost of carbon and efficiency differential. The results suggest that product which is slightly less efficient than the proposed MEPS standard could plausibly be brought to the New Zealand market at a discount sufficient to make the end-user worse off under MEPS. This might occur if there is a sudden over-supply of non-compliant product.

However, we do not believe that this alternative scenario is particularly likely. For one thing, markets world-wide are progressively moving to more (not less) efficient product to meet increasingly demanding efficiency standards. In addition, our discussions with the manufacturers and experience in Australia suggest that the cost penalty associated with making MEPS compliant product is very low to the point of being insignificant.

Nevertheless the possibility of this alternative scenario is a matter relevant to the wider MEPS policy question.

Three Phase Cage Electric Motors

The New Zealand market for three-phase cage induction motors is supplied principally by five major importers. WEG is the market leader followed by Brook Crompton, TECO, ABB and Motor Technologies. No player has more than 30% of the market. Together these suppliers provide 95% of all motors sold within New Zealand. There are no domestic motor manufacturers.

As with domestic refrigeration appliances, there are strong links between the Australian and New Zealand markets. The industry tends to view these markets as one. Some New Zealand suppliers combine orders with their sister companies in Australia in order to increase the volume of the order and achieve more competitive pricing.

Published data on efficiency levels is, arguably, less reliable than that available for domestic refrigeration appliances. For example many of the lower cost motors imported from China do not include within their product literature the Standards underpinning the efficiency data supplied.

Importers of this product acknowledge that improved efficiencies may be required if mandatory Standards backed up by regulations and enforcement are introduced. However they felt that, in the event that this did impose additional cost, it would most likely be absorbed by the manufacturers – due to the competitive nature of the market.

Aside from the uncertainty with respect to efficiency levels discussed above, it appears that only one manufacturer currently imports non-compliant product in one (large) sub-segment of the market (motors less than 7.5kW). Typically these motors are sold to Original Equipment Manufacturers (OEMs) for inclusion in products such as extractor fans or other building service applications.

We estimate that the present value of the energy savings accruing to the end user as a result of bringing a 7.5 kW motor up to the MEPS standard would range between around $100 and over $5000, depending on their use pattern. In the time available, we have not been able to obtain from the manufacturer information on the associated price premium (if any) of the MEPS compliant equivalent motor. However, a comparison of the energy savings with the cost of the motor (around $800) strongly suggests that it is highly unlikely that any consumer of these motors would be made worse off by the introduction of MEPS.

In summary, we think it is most likely that, for most of the product range, MEPS at the level considered will have very little impact on the end-user. Most of the market appears to have already anticipated the introduction of MEPS. The pending introduction of MEPS into Australia coupled with the strong links between the two markets provides good reason to suspect that the transition to compliant product will be complete within the near future. Where existing motors are non-compliant, the proposed MEPS are most likely to make all end users better off.

As with domestic refrigeration appliances, we have conducted sensitivity analysis to determine the impact of the proposed MEPS under the assumption that the market would revert back to non-compliant product in the absence of the introduction of MEPS into New Zealand.

The sensitivity analysis shows that it is highly unlikely that MEPS would make the end-user worse off under this scenario. Even if the market was about to revert to non-compliant product, the high running cost to capital cost ratio means that for most applications, the energy cost savings resulting from the introduction of MEPS would overwhelm any plausible capital cost differential.

Packaged Air Conditioners

The New Zealand market for packaged air conditioners is supplied by two main manufacturers; Temperzone and Carrier. Temperzone has around 70% of the market with Carrier around 20% of the market. The rest of the market is made up of product from York, Trane, Alcair, Lennox and a number of other more minor manufacturers.

Temperzone is an Auckland based manufacturer. It not only supplies the domestic market but is also a significant exporter. Around 70 per cent of its production goes offshore. Most is destined for Australia (around 60% of export volumes) with the remaining units going into Asia. Carrier supplies New Zealand from its Perth factory.

There is no second hand market for packaged air conditioning units. The cost of installing a packaged air-conditioning unit on top of a building is such that the overriding consideration is to obtain a reliable unit. A second hand unit not only needs to be removed from an existing building, but will also typically lack the reliability of a new unit.

As with motors, there is a degree of doubt surrounding the published energy efficiency data. In particular, it is unclear how the published efficiency data might compare with testing done to the draft Australian/New Zealand Standard. On this note, manufacturers have indicated to us that they are reluctant to invest in the required testing while the Standard is still in draft form and thus subject to change.

Notwithstanding reservations about the data, current indications are that all existing product would comply with the draft Standard. This coupled with the fact that Australia is about to introduce MEPS for packaged air conditioners and the fact that the Australian and New Zealand markets are strongly intertwined means that we consider it most likely that the introduction of MEPS at the level considered will have no impact on the end-user.

However, as with both domestic refrigeration appliances and three phase cage motors we can not rule out the possibility that the market may move away from its current high level of compliance to non-compliant product in the absence of MEPS.

In the (unlikely) event that this was to occur, sensitivity analysis suggests that, like motors, the additional energy costs would not be sufficiently compensated for by a reduction in capital cost. This, under this scenario, it is most likely that MEPS would make the end user better off.

Summary of Conclusions

All of the product classes considered are notable for the current high level of compliance with the MEPS standards. It appears that the product being supplied to New Zealand is strongly influenced by international trends towards more efficient product. In particular, the forthcoming introduction of MEPS in Australia and the very close relationship between the New Zealand and Australian markets mean that the market in New Zealand has largely already been transformed.

Notwithstanding this general conclusion, there are a few areas of uncertainty. Specifically, the testing procedures used to generate efficiency data with respect to some motors and air conditioners is not always disclosed and/or the relationship with the proposed Australian/New Zealand testing standard is sometimes unclear.

However, where this uncertainty exists, our discussions with manufacturers and importers suggest that in the event that non-compliance was discovered this could be remedied without a corresponding penalty in terms of purchase price flowing through to the end-user.

The only market where it is clear that there is product which would not comply with the Standards is with respect to small motors (less than 7.5kW) imported for the purpose of inclusion by Original Equipment Manufacturers in appliances such as extractor fans. But, even in this market, only one importer is affected.

An examination of a number of scenarios with respect to the end-use of these motors suggests that it is highly unlikely that the end-user would be made worse off – even if bringing them up to MEPS levels resulted in a price increase.

Overall, we believe that it is highly unlikely that the introduction of MEPS at the levels considered in this study will have an adverse impact on any end-user for any of the product classes under consideration.

1. INTRODUCTION

PA Consulting Group (PA) has been retained by the Ministry for the Environment (on behalf of the Ministry, The Treasury, The Ministry for Economic Development and the Energy Efficiency and Conservation Authority) to conduct an investigation of the economic impact on end users of mandatory Minimum Energy Performance Standards for selected product classes.

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This report is the third of three provided to the Ministry during the course of the assignment. The report is structured as follows:

- Section 2 discusses the background to the assignment, including the context of the report, the scope of this study, the impact of the timeframe and issues of data availability;
- Section 3 provides an overview of the methodology employed in conducting the analysis along with the information sources referred to. It begins with an overview of the core parameters relevant to all cost benefit analyses and then discusses in turn the approach being used with respect to each of the three product classes;
- Section 4 provides an indication of the key input assumptions used in the analysis. The need to make assumptions has been driven either by the unavailability of the data or because the limited time made available for this assignment did not permit its collection or because the inputs required involve uncertain projections of the future course of events;
- Sections 5-7 present the results of our investigations and analysis for the three product classes under consideration, namely domestic refrigeration appliances, three phase cage electric motors, and packaged air-conditioning units; and
- Section 8 provides our conclusions.

As with all cost benefit analyses, in many cases it has been necessary to interpret the insights we have formed about the markets under consideration in the form of projections about what we believe will occur in the future. Wherever we have done this, a rationale has been provided for the particular values assumed. In addition, sensitivity analysis has been undertaken where the parameters are critical to the overall conclusions.

2. BACKGROUND

2.1 CONTEXT OF THE REPORT

2.1.1 The Development of MEPS Proposals

The development of proposals for mandatory Minimum Energy Performance Standards has its genesis in New Zealand in the development of the Long Term Integrated Strategy (LTIS) for Energy Efficiency approved by the Government in July of 1994.

The development of the LTIS was driven in part by economic imperatives (coming relatively quickly after the hydro shortage of the early 90s) and in part by a desire to curb emissions of greenhouse gases (carbon dioxide in particular).

Although the majority of the initiatives contained within the LTIS were based around the provision of information or relied on education or voluntary commitment, it also contained a proposal to investigate MEPS for a variety of product classes. Product classes considered included fluorescent lamps and ballasts, domestic electric storage water heaters, electric motors and domestic refrigerators. For trade reasons, the levels considered were those contemplated for Australia.

The mandatory nature of MEPS made their introduction particularly problematic from a policy perspective. Consequently, the refinement of policy in this area during the intervening years has been both slow and controversial[1]. (The attendant methodological issues are touched on in more detail below in Section 2.1.2 below).

More recently, interest in MEPS has been heightened by the continuing evolution of climate change policy and in particular by the obligations placed on New Zealand pursuant to the Kyoto Protocol of December 1997 as well as the passing of the Energy Efficiency Act earlier this year[2].

The Kyoto protocol, if ratified, obliges New Zealand to manage its emissions to 1990 levels on average in the period 2008 to 2012. Although New Zealand has yet to ratify the Protocol, the Government is currently developing and refining its policy response with a view to making a determination on ratification in the near future.

The policy response is likely to consist of an economic instrument (such as tradable emission permits) and/or a suite of non-price “complementary measures” aimed at either facilitating the operation of the instrument or addressing particular market failures. MEPS comes into consideration with respect to the latter.

Concurrent with the policy drivers embodied in the Kyoto Protocol and the passing of the Energy Efficiency Act are a number of other important policy considerations relevant to the consideration of MEPS. These include, notably:

- A goal of reducing the (compliance) costs imposed on businesses within New Zealand through regulation;

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[1] Three of these product classes (lamps and ballasts and water heaters) have recently been approved by Cabinet. Other product classes are still being assessed.

[2] The Energy Efficiency Act 2000 provides the legislative vehicle necessary for the introduction of MEPS. Kyoto Protocol obligations are contingent on New Zealand ratification.

- A goal of assuring the well-being of those less well-off within New Zealand society; and
- A goal of liberalising trade and facilitating closer economic relations with our key trading partners[3].

Thus, the possible introduction of MEPS within New Zealand is being considered within the context of economic, environmental, social and trade policy imperatives.

2.1.2 Nature of the Policy Debate

As indicated above, MEPS have been problematic as a policy initiative because of their mandatory nature. In particular, they remove the capacity for consumers to make judgements for themselves as to the value of the appliance they are buying and the trade-offs involved. In addition, as a blanket policy instrument, they do not distinguish between the different circumstances faced by consumers (e.g. high product utilisation vis-à-vis low product utilisation).

Whenever the ability of the consumer to make choices is removed or restricted, there is a risk that some consumers will be made worse-off by the policy measure. In addition, to the extent that removal of consumer choice mutes the signals from the consumer to the manufacturers, the policy measure can have long term detrimental dynamic efficiency effects.

All of the above mean that proposals such as MEPS must be evaluated extremely carefully and at the very least be predicated on a plausible hypothesis of why the market may fail to maximise societal welfare generally.

In the case of MEPS, hypotheses for market failure are usually based around some or all of the following:

- *Principal agent issues* – for example where the purchase of the unit and the liability for the on-going running costs are separated;
- *Asymmetric information issues* – particularly where the seller of the more efficient product is unable to effectively signal the advantage or credibility of lower on-going running costs;
- *Path dependency* – where future purchase decisions are strongly controlled by past purchase decisions;
- *Bounded rationality* – for example where matters such as the capital cost/running cost trade-offs do not enter into the purchasers deliberations, being swamped by other considerations; and

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[3] Most significant in this respect is the Trans Tasman Mutual Recognition Arrangement (TTMRA) which liberalises the transboundary movement of goods and services between Australian jurisdictions and New Zealand. At present a temporary exemption from the Arrangement is in place with respect to goods subject to various Australian energy efficiency requirements. Officials from both sides of the Tasman are currently working through the issues with a view to either removing the exemption or implementing a permanent exemption. As foreshadowed earlier, the TTMRA is also relevant when it comes to the question of determining the level at which MEPS should be struck. There is a strong imperative to have New Zealand and Australian levels aligned.

- *External effects* – for example where the price of the electricity consumed does not reflect the external (social) cost associated with carbon dioxide emissions resulting from electricity generation.

In practice, it is impossible to determine *ex ante* whether the market failure issues are of sufficient stature to outweigh the effects associated with the loss of consumer sovereignty. The question is essentially an empirical one and must be resolved with respect to particular markets and particular product classes.

Further, the empirical nature of the question means that it is quite plausible that MEPS will be found to be beneficial with respect to some product classes but not for others. The empirical nature of the question is the reason why the debate over MEPS can only be advanced to a limited extent at the theoretical level and, in the end, cost benefit analysis must be brought to bear on the problem.

2.1.3 Cost-Benefit Analysis and the Determination of Distributional Impacts

Cost benefit analysis informs the policy debate by considering the stream of benefits and costs flowing from a policy proposal and relating them to one another so that one can form a view about whether the proposal will lead to an overall improvement. Typically, cost benefit analyses are conducted with respect to society as a whole. That is, they add the total benefits to society to the total costs to society and determine the net balance.

However, while cost benefit analysis can provide some insight as to whether the total benefits of the proposal are likely to exceed the total costs, this may not be sufficient grounds for concluding that the proposal is desirable. In particular, it is possible that a net societal benefit could mask significant distributional impacts.

For example, with proposals for MEPS, we are unlikely to end up with a situation where the proposed standards will give rise to an unambiguous (Pareto) improvement. Rather, we are more likely to find a situation where, whatever the outcome is with respect to total costs and benefits, at least some may be made worse off from the proposal (in particular, those who use more expensive energy efficient products very infrequently).

Whenever this situation arises, the decision becomes one of trading off the overall economic gain against the acceptability of making some worse off. While this is essentially a normative question, the decision-making can be improved by analytical work aimed at skilfully segmenting customer groupings thereby exposing the nature of the distributional impacts.

2.2 SCOPE OF THE STUDY

This study is not intended to be a societal cost benefit analysis *per se*. That is it does not attempt to answer the question of whether the benefits to society of MEPS exceed the costs (let alone the question of whether the New Zealand Government should introduce MEPS).

Rather its scope is limited to that of assessing the impact of the introduction of MEPS on the end-user and in particular identifying those who might be made worse off by MEPS. As such, it is more about providing insight into the distributional impact of MEPS than it is about forming a view on whether MEPS is beneficial to society as a whole.

The Terms of Reference for this study also stipulate that the study assumes that end-users that would have purchased a new non-compliant appliance will now purchase a new compliant appliance that has the same service capacity. A more comprehensive analysis would also examine the effects of substitution between new appliances and second-hand appliances, and the effects of substitution to lower capacity compliant appliances. While such analyses were not required as part of the terms of reference of this study, we also doubt that sufficient data is available to perform such analyses to any reasonable degree of accuracy.

2.3 TIMEFRAME AND DATA AVAILABILITY

The timeframe set for this study was tight. The study commenced on 28 November 2000, with a first draft required by 19 December and a final report by 19 January. This constrained the opportunities for data collection.

Notwithstanding this constraint, however, we have managed to obtain a considerable amount of information directly from manufacturers and, where relevant, retailers and wholesalers.

The information included “hard” data such as actual sales figures, but equally importantly “softer” qualitative data on the likely impact of MEPS on product ranges and the purchasing habits of low income consumers.

Notwithstanding the tight timeframes and the impact this has had on data collection, we are confident that the combination of quantitative and qualitative data are sufficient to support the conclusions developed at the end of this report.

3. METHODOLOGY AND INFORMATION SOURCES

In this section we outline how we approached the study in terms of the methodology employed and the information sources referred to. The section begins with a description of the core discounted cash flow methodology used for all of the product classes and then looks at product-specific methodology issues with respect to each of the three product classes.

3.1 CORE METHODOLOGY

The core of the analysis is the preparation of a discounted cash flow from the perspective of the end user. The methodology is the same with respect to each of the product classes.

3.1.1 Discounted Cash Flow

A discounted cash flow (DCF) is calculated with the cash flows being:

- an initial outflow equal to the additional cost to the end-user (if any) of purchasing the product with MEPS in place; and
- ongoing inflows equal to the value to the end-user of on-going energy savings (if any) from using a MEPS compliant product.

As foreshadowed earlier, the results of the DCF analysis indicate whether, from the perspective of the end-user, there is an economic benefit from introducing MEPS. The results do not indicate whether there is an economic benefit to the country of introducing MEPS. In particular, part of the indicated benefits to the end-user may simply be transfers from other parties in society.

The discount rate used for the DCF analysis is based on the opportunity cost of capital faced by the particular market segment being analysed. The opportunity cost of capital allows for either:

- Capital to be borrowed, in which case the opportunity cost is the post-tax cost of borrowing; or for
- Capital to be surplus and available for investment, in which case the opportunity cost is the post-tax returns from the best alternative investment.

3.1.2 Key Data Requirements

The key data requirements for the discount cash flow analysis are:

- The change in the initial cost of the products purchased;
- The change in the value of electricity used by the products purchased; and
- The discount rate.

3.1.3 Market Segmentation

For each of the product classes under examination, consideration has been given to the segmentation of the markets into sub-components. The need for segmentation and the basis upon which it is done reflects an *ex ante* assessment of likely differences in the benefit/cost ratio within the market as a whole. Consequently, the segmentation is different with respect to each product class. Segmentation issues are discussed further below.

3.1.4 Post-Tax Nominal Calculations

Discount cash flow analysis can either be carried out on a real basis or on a nominal basis. If conducted on a real basis, all the inputs to the analysis must net out the effects of inflation and the discount rate used must reflect the opportunity cost of capital after adjusting for the effects of inflation. If conducted on a nominal basis, all the inputs into the analysis (including the cost of capital) reflect the expected values in dollars of the day.

While the methods are more or less equivalent, conducting the analysis on a real basis becomes much more problematic when depreciation and taxation elements are brought into the analysis. This is particularly the case when the project being appraised includes a mixture of short and long lived assets (ie varying depreciation rates) and/or the expected inflation rate is variable. Accurately calculating the "real" value of these impacts on the tax liability component of the benefit stream, for example, often becomes unwieldy.

For these reasons, it is most common for major investment decisions to be analysed on a post-tax nominal basis. That is the:

- effect of inflation is accommodated by inflating revenues and expenditure by the expected annual increments;
- revenues are those accruing to the project after tax; and
- discount rate reflects the nominal opportunity cost of capital.

In line with convention in this area, the analysis conducted in this study has been carried out on a post-tax nominal basis.

3.2 DOMESTIC REFRIGERATION APPLIANCES

With respect to domestic refrigeration appliances, the net benefit calculation amounts to a consideration of the size of any price premium for a MEPS compliant appliance and the stream of any on-going energy cost savings. To the extent that MEPS results in an increase in the price of refrigerators, this will be manifest in year zero as an additional cash outflow for the consumer. Benefits then accrue from reduced expenditure on electricity in each year of the appliance's life.

3.2.1 Market Segmentation

Of particular interest is the possible impact of MEPS for refrigeration appliances on low-income households. This means that it is necessary to segregate the market for domestic refrigerators on the basis of household income. (Note that, as the data on low-income purchases is relatively sparse and mainly anecdotal, the segmentation will inevitably be less than precise.)

3.2.2 Required Information

The following information is required to analyse the impact of MEPS on domestic refrigerators:

- Market size / share for each make and model. The analysis will focus on the models that are not MEPS compliant;

- Impact of MEPS on purchase price of refrigerators;
- Estimates of numbers of non-compliant refrigeration units, for both the total market and for low income purchasers;
- The annual energy consumption for appliances that:
  - do not meet the requirements of MEPS; and
  - will substitute for a non-compliant appliance once MEPS are introduced.

3.3 MOTORS

3.3.1 General Issues

The impact of MEPS for three phase motors on the end user in New Zealand has historically been difficult to assess. Past reports are inconclusive with respect to the impact of MEPS on motor purchase price. In addition, the recent Standard that defines the MEPS for motors was not available at the time the previous economic analysis of MEPS was undertaken[4].

Furthermore, the motor market is particularly complex. Motors vary in size and synchronous speed as well as load and efficiency. The end use varies in terms of applications and hours of use. End user pricing of motors is also difficult to determine with discounting on list price of up to 50% not being uncommon.

3.3.2 Motors Excluded from this Study

The following categories of motors are excluded from the analysis, as they are not covered by the proposed Standard:

1. Submersible (sealed) motors specifically designed to operate wholly immersed in a liquid;
2. Motors that are integral with and not separable from, a driven unit;
3. Multi-speed motors;
4. Motors that have been granted exemption by the relevant regulatory authority[5]; and
5. Motors for use only for short-time duty cycle applications (eg those used for hoist, roller doors and cranes) which have a duty type rating of S2 under the IEC 60034-12.

3.3.3 Focus on Common Models

Interviews with four of the five main suppliers of motors to New Zealand suggest that 2 & 4 Pole motors represent 80% - 90% of the market. In order to make the study

[4] See for example *A Review of EECA's Energetics Energetics/Wilkenfeld report on MEPS* – NZIER March 1996

[5] At present there are no motors within this category.

manageable, we have focussed our analysis on these two main classes of motor, i.e. 2 & 4 pole.

There is also a consensus among the main suppliers that WEG, Brook Crompton, TECO, ABB and Motor Technologies supply over 95% of the 3-phase induction motor market. Thus, we have also focussed our analysis on motors supplied by these manufacturers.

3.3.4 Market Segmentation

Preliminary investigations indicated that most motors are already MEPS-compliant. The major exception is for motors that are less than 7.5kW. Typically these are supplied for incorporation into other manufactured equipment destined either for export or for the New Zealand domestic market. Accordingly, the focus of our quantitative analysis is on this segment of the market.

3.3.5 Required Information

The following information is required to analyse the impact of MEPS on the market for motors:

- Market size for each motor model (i.e. 2 pole, 4 pole, 6 pole, 8 pole);
- Impact on motor purchase price of MEPS;
- Estimate of quantities provided to equipment manufacturers;
- Estimates of numbers of non-MEPS compliant motors in low use applications where a significant increase in purchase price has been identified;
- Estimates of the number of non-MEPS compliant motors in continuous or near continuous centrifugal pump and fan applications; and
- Estimates of energy use differentials between non-compliant product and its likely replacement.

3.4 PACKAGED AIR-CONDITIONING UNITS

3.4.1 General Issues

As with motors, analysis of packaged air conditioning units is constrained by a lack of good data. For example, there are no pre-existing reports detailing the size of the market for PAC units.

This has meant that a considerable effort has been devoted in this part of the analysis to obtaining good market information, including the identification of the most common makes and models along with their efficiency levels.

In the main, we have gone to equipment suppliers for the necessary data. However, this has been cross-checked with information from consulting engineers and mechanical maintenance contractors, wherever possible.

Market share information, in combination with product literature from the major equipment suppliers has enabled us to develop a good feel for the market share of each supplier together with an indication of the most popular models and their associated efficiency.

As with the other product classes, the objective of this part of the study is to identify models that do not meet the MEPS standards, determine their market share and efficiency and postulate what they would be replaced with under MEPS.

3.4.2 Focus on Common Models

There are many types and sizes of PAC units. Wherever possible we have simplified the analysis by focusing on the most common models.

3.4.3 Market Segmentation

The market was segmented geographically. Our analysis was focused in the first instance on Auckland because it has the majority of commercial office space and, for climatic reasons, the requirement for cooling is more pronounced.

Analysis of data relating to Wellington and the South Island was made contingent on the identification of a significant capital cost increase with the implementation of MEPS.

3.4.4 Required Information

To analyse the impact of MEPS it was necessary to collect the following information from equipment suppliers:

- Market size for each make and model focusing on main manufacturers and common models;
- Impact on purchase price of the MEPS requirements;
- Estimates of numbers of non-MEPS compliant PAC units in low use applications where a significant increase in purchase price has been identified; and
- The efficiency differentials of all units which do not meet the requirements of MEPS.

4. KEY INPUTS INTO THE ANALYSIS

Any forward looking cost benefit analysis has at its core assumptions about what is likely to happen in the future. As such the assumptions driving the analysis will always be debatable to a greater or lesser extent. For this reason it is particularly important that key inputs into the analysis be selected with some care and clearly articulated. This chapter describes the key inputs into the analysis along with the rationale underpinning their selection. It covers:

- Future product prices;
- Product trends in the absence of MEPS (the counterfactual);
- The cost of capital used in the DCF analysis;
- Future electricity prices; and
- A range of more product-specific assumptions relevant to each of the product classes.

4.1 FUTURE PRODUCT PRICES

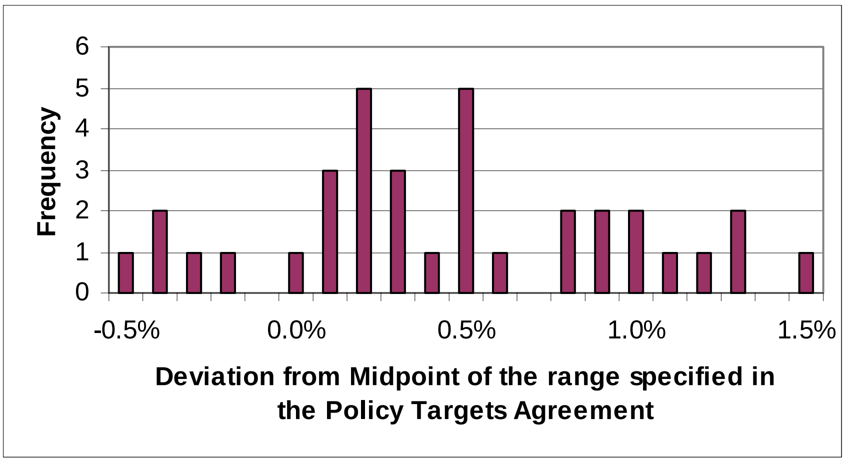
Our base assumption is that future product prices would rise at the rate of CPI inflation, unless there is evidence that they change at a different rate. Thus, we require a forecast of CPI inflation plus any adjustments for specific product classes.

4.1.1 Inflation

Annualising the quarterly CPI rates contained in the Reserve Bank's December 2000 Monetary Policy Statement provides an annual CPI inflation of 3.2% for the year ended 31 December 2001, and 1.6% for the years ended 31 December 2002 and 2003.

Figure 1 below shows the distribution of the deviation of the RBNZ's target inflation measure from the midpoint of the applicable range, for the quarters ended March 1992 – September 2000. It is clear from Figure 1 that the target inflation measure is more often above the midpoint of the range than below the midpoint. The mean of the deviation is 0.45% above the midpoint of the target measure.

Figure 1: Distribution of Deviation of RBNZ Target Inflation Measure from the Midpoint, Mar 1992 - Sep 2000



The current Policy Targets Agreement specifies an inflation band of 0%-3%. Thus, based on the above analysis, we assume an inflation rate of 2.0% for the inflation rate for the year ended December 2005 and each subsequent year. For the year ended December 2004, with have assumed an inflation rate of 1.8%, which is midway between the 1.6% rate for 2003 and the 2.0% rate for 2005[6].

4.1.2 Product-Specific Price Changes

Wilkenfeld (1999) determines that the average annual rate of increase in refrigerator and freezer prices in Australia between 1993 and 1997 was 1.0% more than the CPI.[7] In the absence of any information regarding the general rate of price changes for motors or packaged air-conditioning units, we have assumed that prices will increase at the rate of inflation.

Thus, we have the following price inflation forecasts for the products included in this analysis:

Table 1: Assumed Product Price Inflation

Product	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Fridge	4.2%	2.6%	2.6%	2.8%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Motor	3.2%	1.6%	1.6%	1.8%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
PAC	3.2%	1.6%	1.6%	1.8%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%

4.1.3 Exchange Rates

Product prices may also change significantly with exchange rate variations, particularly those products that are imported from countries whose currency does not move in line with the New Zealand dollar. However, this will only be a significant issue if product from one country is going to be replaced by product from another country once MEPS are introduced and the value of currencies of these two countries diverge. At the present moment, we consider that this effect is unlikely to be significant.

4.2 THE COUNTERFACTUAL

4.2.1 Issues in Defining the Counterfactual

One of the most critical tasks in conducting any cost benefit analysis is the definition of the counterfactual, i.e. the determination of what would happen in the absence of MEPS. It is against this baseline that the impact of MEPS must be measured.

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[6] Inflation projections are unlikely to have a significant impact on the results of this analysis, as the most crucial issue is the price differential between MEPS compliant and non-compliant products. Initial tests indicate that changing the assumption of 2.0% inflation to a constant annual rate of 5.0% has an impact of less than 0.3% on the final net present value from the discount cash flow analysis.

[7] George Wilkenfeld and Associates, *Regulatory Impact Statement: Energy Labelling and Minimum Energy Performance Standards for Household Electrical Appliances in Australia*, prepared for the NSW Department of Energy and the Australian Greenhouse Office, George Wilkenfeld and Associates Pty Ltd with Energy Efficient Strategies Pty Ltd, February 1999, p.53.

While it is tempting from a simplicity point of view to adopt the status quo as the counterfactual, there are a number of reasons why this is likely to be inappropriate. First, the efficiency of technical appliances tends to increase over time; i.e. later generations of products tend to be more efficient than the ones they replace. The value of MEPS is thus not that they induce efficiency levels that would not otherwise be attained, but, rather, that they *accelerate* the introduction and uptake of more efficient products.

Second, other energy efficiency initiatives are already working towards the more efficient use of energy – including, for example, the corporate commitment and motors programmes already being run by the Energy Efficiency and Conservation Authority.

Third, there can be spillover effects on energy efficiency arising from initiatives in other countries. The most obvious example is with respect to the Australasian market for domestic refrigerators where the main suppliers (Fisher and Paykel and Email) tend to supply the same product to both New Zealand and Australia. Consequently, the Australian requirements with respect to labelling and MEPS for fridges are already having an impact on the product supplied to New Zealand. Note, however, this effect can also work in the opposite direction, with the implementation of energy efficiency standards in other countries causing non-compliant product to be redirected to New Zealand. The issue is examined in more detail in 4.2.2 below.

Determination of the counterfactual is not a trivial task, nor is it an exact science. Invariably, there is a range of possible influences on the future direction of the market. In the end, the task of determining the counterfactual boils down to a judgement about which of the various influences is likely to be the most significant. Our analysis of the general counterfactual is presented below.

4.2.2 Counterfactual Scenarios (and the Impact of Regulation in Other Jurisdictions)

Arguably one of the most significant influences on the future direction of the New Zealand market is the extent of the introduction of MEPS in other jurisdictions. We are aware that in many jurisdictions around the world, including the APEC region and Europe, MEPS for the products under consideration are either in place already (albeit at different levels or measured to different standards) or are being contemplated for introduction in the foreseeable future.

In thinking about the impact this may have on the New Zealand market it is useful to distinguish what might happen in the long term from short-term effects. In the long term, it is reasonable to expect that as world markets shift to more efficient product, New Zealand will inevitably ride on the coat tails of initiatives elsewhere; in other words, the more efficient product will end up in New Zealand as well. Further, in the long run, we could expect the price of the more efficient product to reflect the underlying long run cost of production. The price differential will, other things being equal, reflect the cost differential between the MEPS compliant and the MEPS non-compliant product.

In the short term, however, prices and product availability may be more strongly influenced by other factors. For example, one can imagine that the introduction of standards in some markets may result in the re-direction of remaining non-compliant product to markets in which standards are not in force.

There is some evidence of this type of effect occurring elsewhere. For example, during the early 1990s, at the time of the introduction of a number of energy efficiency information measures in Germany (voluntary labels plus disclosure of energy efficiency information) there was some re-direction of less efficient refrigerators to the United Kingdom.

(Interestingly enough, however, the re-directed German product still tended to be amongst the most efficient of appliances available on the UK market). Similarly when Switzerland recently introduced tougher stand-by standards for television sets, all the most efficient televisions were re-directed to Switzerland with the remainder going to consumers in surrounding EU countries.[8]

Whether or not these types of effects will occur in practice is likely to be a function of a number of influences including; the lead time for the standards to come in, the relationship of lead times to the re-tooling cycle of the manufacturing plant and the extent to which all countries move in unison.

With respect to the short-term prices for any re-directed product, one can mount arguments for them either staying the same or falling. For example, if energy efficiency is not a key consideration in the purchase decision (as it tends not to be in the products under consideration), and there is not an over-supply of non-compliant product on the market vis-à-vis the markets in which it can be sold, then one could expect little change in price. On the other hand if the world wide supply of product is having to adjust quickly to MEPS constraints in key markets, it is possible that we could see an oversupply of non-compliant product and the price in markets where MEPS are not in place drop accordingly.

The above examples suggest that, notwithstanding the long-term general trend to more efficient appliances, the possibility of some reversion to less efficient appliances – at least as a short term phenomena – can not be dismissed out of hand. Consequently, we have analysed various scenarios of this type in the sensitivity analysis.

4.3 COST OF CAPITAL

The cost of capital is an important input into the discount cash flow calculation. Although the Terms of Reference for this study specify three values to be used in the discount cash flow calculations, it is helpful to examine the relevance of those rates to the various analyses in this study.

4.3.1 Assumed Rates

The assumed rates for the cost of capital specified in the Terms of Reference are 5%, 10%, and 20%. However, these rates are real rather than nominal values. To conduct our analysis on nominal terms, it is first necessary to convert the assumed rates into nominal values. The conversion is not precise, as we are not assuming a constant rate of inflation.

We have converted the real rates to nominal rates as follows:

- We have first assumed a constant real stream of $1 per annum for 10 years, and calculated the DCF using the appropriate real discount rate (ie either 5,10 or 20 percent);
- We then inflate the real stream by the assumed CPI inflators (as specified in Section 4.1) to derive a nominal stream; and

[8] Benoit Lebot, International Energy Agency, pers. Comm.; Tina Fawcett, Environmental Change Unit, University of Oxford, UK pers. Comm.; Frank Pool, Chair APEC Expert Group on Energy Efficiency and Conservation, APEC, pers. comm.; Energy Policy 1994 22(9) 779-787 *Is Britain a third world country? The case of German refrigerators*.

- The nominal discount rate is then calculated which will yield the same NPV from the nominal stream as was obtained by discounting the real stream with the real discount rate.

Adopting the procedure described above provides the nominal discount rates shown in Table 2.

Table 2: Nominal Discount Rates

Scenario	Real Rate	Nominal Rate
Low	5%	7.19%
Medium	10%	12.31%
High	20%	22.57%

4.3.2 Cost of Capital for Households

The cost of capital used as the discount rate for the discount cash flow analysis will depend on the particular market segment (i.e. household income level). There are two primary reasons for this:

- Different market segments will have access to different sources of capital, each with differing costs; and
- Personal tax rates can have a significant effect on the cost of capital faced by consumers.

Low-income segments can be expected to have access to credit card, hire purchase, and overdrafts as sources of capital. The fact that the purchase of the refrigerator may be financed by hire purchase is irrelevant to this analysis, as the hire purchase payments are equivalent in discount cash flow terms to a lump sum at the purchase date. The low-income consumer's typical opportunity cost of capital is, therefore, provided by sources such as credit cards and overdrafts. The Reserve Bank reports that for October 2000, the average first-mortgage housing rate was 8.50%. Assuming that very few low income households have mortgages, and that overdraft interest is charged at a margin of 2% above the first mortgage housing rate provides an opportunity cost of 10.5%. The Reserve Bank also reports that the weighted average interest rate on credit card debt was 19.2% for the same period. Thus, on the basis of these figures, the medium discount rate specified in the Terms of Reference provides a low-end estimate of the cost of capital for low-income earners, and the high discount rate provides a high-end estimate.

High-income consumers can be expected to have a surplus of cash, so that they are able to purchase from their cash reserves. In this instance the consumer has the opportunity of holding cash, investing in term deposits, or investing in other higher-return investments. We assume that the high-income consumer has access to high-return investments that provide a margin of at least 5% over the standard six-month deposit rate. With a six-month deposit rate of 6.5%, this means that the high income consumer can earn 11.5% pre-tax, or 7.015% post-tax (personal tax at 39%)[9]. Alternatively, the high-income consumer may have a revolving credit arrangement with a bank, in which case the opportunity cost of capital is the cost of credit. We assume that high-income consumers have access to mortgage finance at the standard first-mortgage housing rates. Typically this will be at a margin of about 2% above the six-month deposit rate. Hence, with a six-month deposit rate of 6.5%, and with no tax deductions for interest payments, the high-income earner faces a borrowing cost of 8.5%. These figures indicate that the opportunity cost for high-income earners lies between the low and medium rates specified in the Terms of Reference, with a weighting towards the low rate.

4.3.3 Cost of Capital for Firms

The cost of capital used as the discount rate in the discount cash flow analysis can vary significantly depending on the size of the firm. In particular, the cost of capital for a small firm may be relatively high, whereas the cost of capital for a large firm may be only a relatively small margin above the risk free rate of return.

The appropriate discount rate for a firm is the firm's weighted average cost of capital (WACC), which depends on the cost of debt and equity that the firm has access to, and the relative weighting of debt and equity. Calculations of the WACC for differing size firms are presented below. More detail of the calculations is provided in Appendix A.

Large Firms

We assume that large firms can access debt at a margin of 0.5% above the risk-free rate. Thus, with secondary market yields on 10-year Government Stock currently at approximately 6.7%, as the risk-free rate, the cost of debt is 7.2%. Assuming that large firms have the same average risk as the market as a whole suggests a post-tax WACC of 9.2%- 11.3% for a range of reasonable debt:equity ratios. On the basis of these figures, the cost of capital for large firms lies between the low and medium rates specified in the Terms of Reference.

Small and Medium Size Firms

We assume that the cost of debt finance for small and medium size firms lies between the retail banks' base lending rate and the average interest rate on credit card debt. This provides a range of 10.56% - 19.2%.

For medium size firms, we assume that the cost of debt is 10.6%, and that medium size firms have the same average risk as the market as a whole. Given these assumptions, the post-tax WACC for medium size firms is in the range 10.5%-12.3% for a range of reasonable debt:equity ratios. On the basis of these figures, the medium discount rate

[9] Note: personal taxation rates become a consideration with high-income earners as we are assuming that the opportunity cost of capital is equivalent to income foregone in an investment of equivalent risk. In contrast, the cost of capital for low-income earners is the cost of borrowing; as this does not involve income, personal tax rates do not become a consideration.

specified in the Terms of Reference provides the appropriate cost of capital for assessing the impact of MEPS on medium-size firms, although it may slightly understate the effect of future benefits from reduced energy consumption for some firms.

For small firms, we assume that the cost of debt is 14.9%, the mid-point of the assumed range for the cost of debt. We also assume that small firms have twice the risk of the market average. Given these assumptions, the post-tax WACC for small firms is in the range 15.9%- 21.8% for a range of reasonable debt:equity ratios. On the basis of these figures, the cost of capital for small firms lies between the medium and high rates specified in the Terms of Reference, with a weighting towards the high rate.

4.4 FUTURE ELECTRICITY PRICES

4.4.1 Base Forecast

The electricity prices used for this analysis are the prices faced by the end-user. Our forecasts are shown in Figure 2 and Figure 3 (page 4-9). These prices are the wholesale electricity price plus mark-ups for transmission and distribution. The base price paths are based on the predicted path from the current market price to the new entry price. They have been determined by predicted strategic bidding as the market supply and demand tightens using PA's internal market simulation models. We expect that new generation will be brought into the market in around 2007-2008, and that the real wholesale price will rise from its current levels of 3.5-4 c/kWh to the new entry cost of 4.5-5 c/kWh[10].

4.4.2 Cost of Carbon

A crucial determinant in future wholesale electricity prices is any future cost of carbon. This will raise the cost of generation from fossil fuel fired stations, resulting in increased wholesale electricity prices and increased electricity prices for end-users.

As a variant to the base forecast we assume (hypothetically) that government policy results in the cost of carbon being included in electricity prices. For the purposes of this scenario, we assume that the cost of CO_2 in 2010 is in the range NZ$13 to NZ$30 per tonne.[11] Further, we assume that a value for carbon would become evident in 2003 (either in the form of emission permits or derivatives based on emission permits at) 50% of the final value. The "value of carbon" would then increase linearly to attain its full value in 2010. The low and high cost of carbon scenarios are as shown in Table 3 below.

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[10] Note these real prices have been inflated using the CPI inflators in Section 4.1 for inclusion in the DCF analysis.

[11] These figures were arrived at after discussions with officials at the Ministry for the Environment. The period 2008 to 2013 is the first commitment period in which countries will be legally bound to curb their emissions. Thus the 2010 figure is the estimate of the market price for CO_2 reduction assuming that reduction obligations will be tradable.

Table 3 : Cost of Carbon Scenarios

Scenario	Year							
	2003	2004	2005	2006	2007	2008	2009	2010
Low	6.50	7.43	8.36	9.29	10.21	11.14	12.07	13.00
High	15.00	17.14	19.29	21.43	23.57	25.71	27.86	30.00

Thus, taking the low end of the range, the cost of carbon would initially be $6.50 per tonne of CO_2 in 2003, increasing up to $13 per tonne of CO_2 in 2010. We assume that it will remain constant from 2010.

In order to determine the impact of the cost of carbon on the price of electricity, we have incorporated the cost of carbon increments into the fuel costs for the various generating plants in the New Zealand electricity market, and modelled the impact on average wholesale electricity prices. The assumed levels of CO_2 for each fuel type are shown in Table 4 below. The resulting electricity price paths are shown as the “low cost of carbon” and “high cost of carbon” estimates in Figure 2 and Figure 3 overleaf.

Table 4: CO_2 Emissions by Fuel Type (MFE Estimates)

Fuel Type	CO_2 Emissions
All NZ Coal Production	90.4 tCO_2/TJ
Maui Gas Sales	52.8 tCO_2/TJ
Diesel Fuels	68.7 tCO_2/TJ
Wairakei & Ohaaki Geothermal	34 tCO_2/hour

Figure 2: Residential Electricity Price Forecasts (Real Prices, 2000 Base)

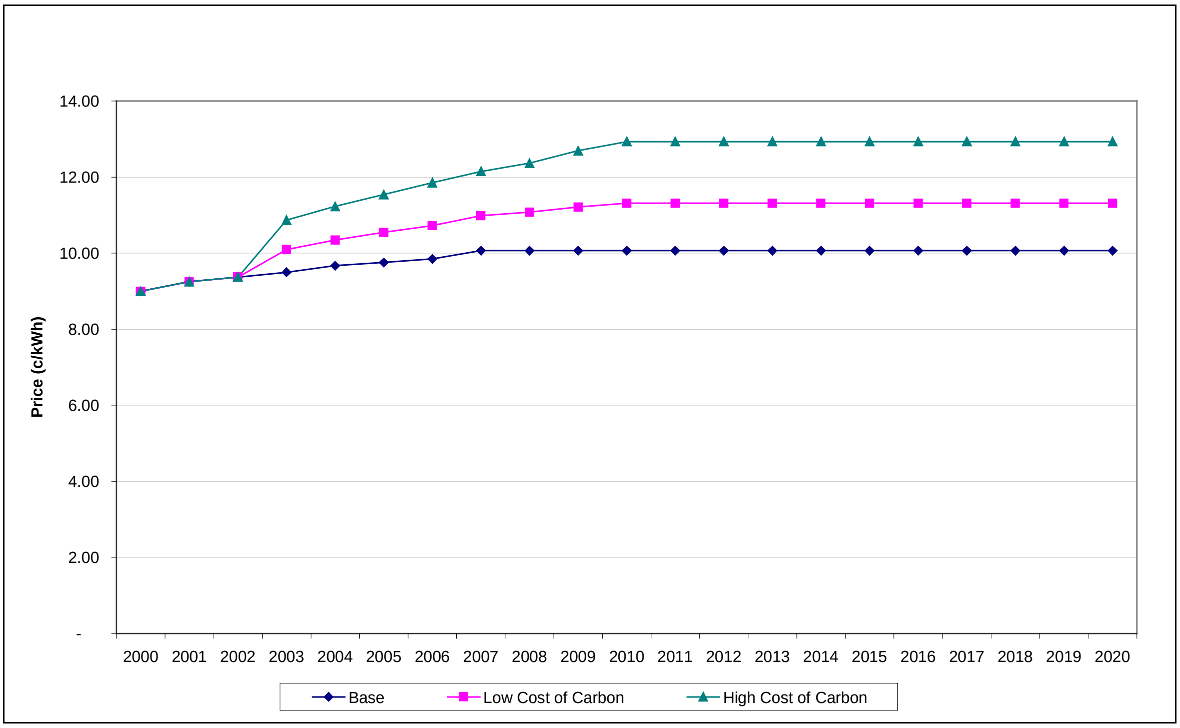
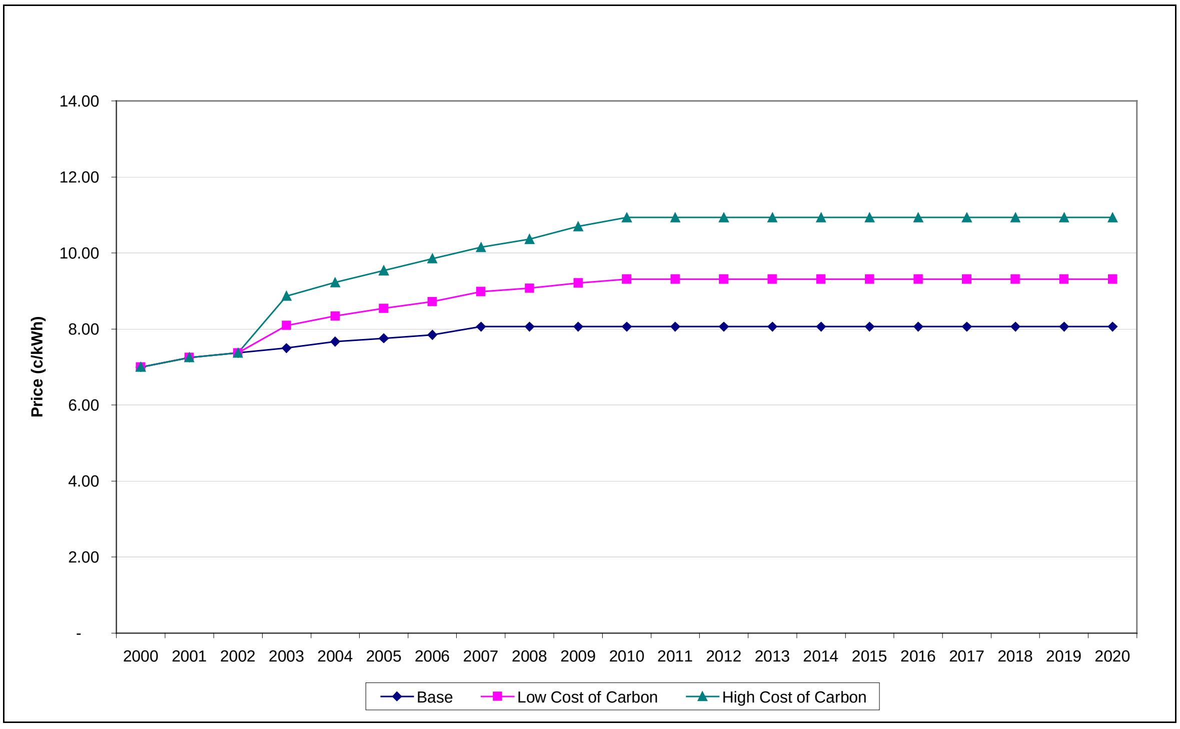


Figure 3: Industrial Electricity Price Forecasts (Real Prices, 2000 Base)



4.5 PRODUCT-SPECIFIC ASSUMPTIONS

During the course of the analysis, it has been necessary to make a number of miscellaneous assumptions about data accuracy, product characteristics, market composition etc. These are recorded below.

4.5.1 All products

Data Accuracy

With respect to all of the product classes being investigated, a number of items of data, including sales volumes and impacts on manufacturing cost, were sourced from manufacturers, importers or retailers. Wherever possible we have cross-referenced information from different sources. However, where independent verification has not been possible and, unless we have good reason to suspect otherwise, we have taken the information supplied on face value. That is we have assumed it to be accurate.

4.5.2 Domestic Refrigeration Appliances

Market Composition

As required by the Terms of Reference for this study, we have assumed that the impact of MEPS will not have any effect on the selection of appliance. That is the same size of fridge would be purchased before and after the introduction of MEPS. We also assume no difference in appliance functionality. That is the same services (butter warmer etc.) would be available post MEPS as are available pre-MEPS.

Second Hand Market

Similar to the assumption above, we are assuming that the introduction of MEPS will not influence the choice of whether to buy second hand or new. (The possible price effects on the second hand market of an increase in the cost of a new refrigeration appliance are however explicitly considered.)

4.5.3 Three Phase Cage Electric Motors

Market Composition

We assume that the market for motors over the period of the analysis remains the same ie the total market and the distribution of motors by size and type do not change. (Thus the analysis ignores effects on market composition that might result from the introduction of MEPS, as well as other factors such as the decreasing cost of variable speed drives.)

Second Hand Market

The second hand market for motors is assumed to be insignificant. Consequently, no analysis of the second hand market has been undertaken.

It is also assumed that the introduction of MEPS will have no effect on the proportion of motors that are rewound. The motor manufacturer typically performs rewinds for the original purchaser of the motor. The price of the rewind is typically set at cost plus a margin. We see no reason why the cost of rewinding a motor should change as a result of introducing MEPS.

4.5.4 Packaged Air-Conditioning Units

Market Composition

We assume that the market for PAC units over the period of the analysis will remain the same. That is, the total market will remain the same and the distribution of PAC units by size and type within the market will not change.

Second Hand Market

We have assumed the second hand market for air conditioners to be negligible. Typically, the cost of installation means that it is not cost-effective to install second hand units.

5. DOMESTIC REFRIGERATION APPLIANCES

5.1 THE NEW ZEALAND MARKET

5.1.1 Characteristics of the Current New Zealand Market

Market Share

The New Zealand market for domestic refrigeration appliances is characterised by the existence of two major players along with a number of small importers. Although details of market share are not known precisely, the following is an estimate based on discussions with leading retailers[12]:

1. Fisher & Paykel has the largest market share at approximately 55-65%.
2. Email Appliances (NZ) Ltd., which includes the Westinghouse and Simpson brands is the next largest supplier with around 30-40% of the market.
3. The remainder consists of other imported brands such as LG, Samsung, Sharp, Maytag and Whirlpool. Individually, each of these brands has a minimal proportion of the overall market. Niche market imported brands - Gaggenau, Liebherr and Sub Zero - make up about 0.5% of the market.

The major brands and product types are listed in the table below.

Table 5: Major Brands and Models of Domestic Refrigeration Appliances on the New Zealand Market

Brand	Name	Model	Total Capacity	Price	Energy Consumption (kWh/year)
Fisher and Paykel	Active Smart	E372B	373	1,700	620
Fisher and Paykel	Frost Free	N249T	248	886	691
Simpson	Opal	NB400F	400	1,450	930
Simpson	Opal	NB380F	380	1,250	920
Simpson	Opal	N245C	245	800	570
Westinghouse		BJ424S	420	1,650	730
Westinghouse		BJ385Q	380	1,400	910
Westinghouse		RJ390M	390	1,150	710
Westinghouse		RJ340M	340	1,100	680-710
Westinghouse		RJ300M	300	1,000	680
LG		GR242	215	849	550
LG		GR282	245	949	570

[12] Information obtained from Pacific Retail Ltd. (Bond & Bond and Noel Leemings).

Korean Brands

Our analysis of import data obtained from Statistics New Zealand shows that imports of domestic refrigeration appliances, particularly from Korea have been increasing in recent years (see Appendix C).

It also appears that the market for refrigerator/freezers is shifting towards Top Mount freezers from the Bottom Mount ones that were very popular a few years ago. This apparent recent change in preference may be associated with the influx of cheaper Korean models (such as Samsung and LG, formerly Goldstar) which have been coming into New Zealand over the past few years.

LG is imported by L.M. Rankine Trading Co. Ltd, They estimate LG's market share in New Zealand to be between 5 and 6 percent. They bring about 3500 refrigerators into New Zealand annually. All LG refrigerators are claimed to be MEPS compliant.

A list of all LG refrigerators available in New Zealand, along with their annual energy consumption, is shown in Table 6 below[13].

Table 6: LG Models sold in New Zealand[14]

Model Number	Type	Capacity (L)	Annual Energy Consumption (kWh)	Rating
GR051S	Fridge	48	330	2
GR131S	Fridge	95	310	2
GF161S	Freezer (Vertical)	120	323	4
GF161S	Freezer (Vertical)	120	490	2*
GR242S	F/F,Top Mount	215	550	2.5
GR282S	F/F,Top Mount	245	570	2.5

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[13] Energy consumption figures obtained from the Australian Greenhouse Office (AGO) website and L.M. Rankine Trading Co. Ltd.

[14] An asterisk indicates a star rating on the old scale. The Vertical Freezer GF161S appears twice on the old AGO ratings list. Although the dimensions and capacity of both are identical they have different annual energy consumption and star ratings. On the new list the GF161S freezer with the lower star rating does not appear. Nor does the GR372S F/F, which did appear on the older list. Items in bold were found in the initiation report for the inquiry into dumping of Korean refrigerators and refrigerator/freezers into New Zealand. (Trade Remedies Group, Ministry of Economic Development, *Dumping and Countervailing Duties Act Dumping Application Non-Confidential Initiation Report Refrigerators-Freezers and Refrigerators from Korea* December 2000.)

Model Number	Type	Capacity (L)	Annual Energy Consumption (kWh)	Rating
GR372S	F/F,Top Mount	339	660	2.5*
GR267EHF	F/F,Side by side	816	1176	
GR349SQF	F/F,Bottom Mount	305	660	2.5
GR432S	**F/F,Bottom Mount**	**392**	**728**	
GR151S	**Fridge**	**129**	**421**	

Samsung is imported by Radiola Corporation Ltd. in Porirua. They are the exclusive distributors of Samsung products in New Zealand. They bring in about 5000 refrigerators into New Zealand annually. They have an estimated market share of 5 to 7 percent. All the Samsung refrigerators sold in New Zealand are CFC free and are also sold in Australia. A list of the Samsung refrigerators available in New Zealand is shown in Table 7.

Table 7: Samsung Models Sold in New Zealand

Model Number	Type	Capacity (L)
SRG059	Fridge	57
SRG119	Fridge	96
SR30RMC	FF	285
SR37RMC	FF	334
SR44RMB	FF	401
SRG628	FF	560
SRS73DTA	FF (Double door)	680
SRGV43	**FF (Bottom Mount)**	**390**
SRGV33	**FF (Bottom Mount)**	**290**
SRGV39	**FF (Bottom Mount)**	**365**
SRGV29	**FF (Bottom Mount)**	**260**

The items in bold were found in the initiation report for the inquiry into dumping of Korean refrigerators and refrigerator/freezers into New Zealand. We are advised that these are end-of-line products no longer sold in New Zealand.[15]

[15] Robin McNabb, Radiola Corporation.

Sales of New Refrigeration Appliances to Low Income Earners

It has been possible to gain some insights into the purchase habits of low-income earners from our discussions with appliance retailers. In particular, the fact that Income Support assistance is available to beneficiaries to assist with the purchase of refrigerators means that retailers are aware in general terms of the types of refrigerators typically purchased by low income beneficiaries.

Specifically, Work and Income New Zealand (WINZ) will pay up to $400 of the cost of the refrigerator with the rest being covered by the buyer. To claim such a benefit, the beneficiary must first obtain a quotation from a retailer on the model that they want to purchase. If the model is within the approved price range, WINZ will then pay the $400. The existence of this mechanism means that retailers are aware of both the brands and the models most often purchased by beneficiaries.

Waldegrave et al report that the primary source of household income for 67% of low-income households was income support from the government.[16] On the basis of this finding, we assume that the refrigerators purchased with the aid of Income Support provide a good indication of the appliances purchased by low-income households.

The four refrigerators that are particularly popular among low-income earners are:[17]

1. Simpson, model NB380;
2. Westinghouse, model BJ385;
3. LG, model GR242; and
4. LG, model GR282.

The latter two are the most common.

Compliance of the Current Market with MEPS

All indications are that the product range currently available on the New Zealand market is MEPS compliant. The evidence comes from a number of sources. In particular, the existence of mandatory MEPS requirements in Australia, means that all manufacturers who sell in Australia are already required to meet the MEPS levels proposed for New Zealand. The vast majority of these manufacturers sell the same brands and models into the New Zealand market.

In addition, a comparison of models available on the New Zealand market with efficiency information contained on the Australian Greenhouse Office website demonstrated that virtually without exception product currently available on the New Zealand market is MEPS compliant[18]. This was supported by the published information available from the

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[16] Charles Waldegrave, Peter King, and Shane Stuart, *The Monetary Constraints and Consumer Behaviour in New Zealand Low Income Households*, 21 September 1999, p. 16.

[17] Range derived from estimates from manufacturers and retailers.

[18] There are some products that are not on the website. These include some of the LG and Samsung product range and the Cascade fridges sold by the Warehouse. The LG and Samsung products are discussed later in this section. The Cascade range of fridges are 3 way (gas, mains, 12v) and thus do not fall within the scope of the proposed Standard.

major suppliers (Fisher & Paykel and Email) as well as the niche imported brands (Gaggenau, Liebherr and Sub Zero).

Of particular note is that all models currently popular with low-income earners feature on the AGO website, implying that they are all compliant with the proposed standard.[19]

The most popular low-end brand is LG (Lucky Goldstar). Although LG (along with Samsung) do sell some models in NZ that aren't sold in Australia, the product of both manufacturers is thought to be MEPS compliant. We reached this conclusion on the basis of our discussions with the suppliers and by comparing the energy consumption of their product ranges with that of MEPS compliant models of similar capacities from manufacturers such as Fisher and Paykel and Westinghouse.

5.1.2 The Impact of MEPS on Prices

Notwithstanding the current levels of compliance with MEPS standards, we have endeavoured to form a view about the cost (and price) differentials that might exist between compliant and non-compliant product.

Our conversations with manufacturers have indicated that many of the improvements required by MEPS make good business sense and would be (have been) implemented in the absence of MEPS. This is supported by the Australian experience where most manufacturers implemented the new technology well in advance of the MEPS deadline.[20] For any residual improvements that need to be made, Wilkenfeld & Associates' February 1999 report assumed that each 1% improvement in energy efficiency would increased the production price by 0.2%. This translates to an increase of $2 for a $1,000 appliance, and an increase of $3 for a $1,500 appliance.

5.1.3 The Counterfactual

As discussed in section 4.2, the impact of MEPS must be considered with respect to a "counterfactual" of what we expect to occur in the absence of MEPS. In particular, we need to consider whether the current high level of compliance with the proposed standard would continue in the absence of MEPS or whether the market would revert to non-compliant product.

As foreshadowed above, we consider it most likely that the efficiency levels of domestic refrigeration appliances will continue to improve and that, barring the influence of short term adjustment pressures, we are unlikely to see the market revert. Certainly, the track record to date is of each generation of appliance becoming more efficient than its predecessor. This is true not only of established Trans Tasman suppliers (Fisher and Paykel and Email) as they gear up to meet new MEPS requirements in Australia, but also with respect to so-called low cost suppliers from Southeast Asia. Certainly, the latest offerings from both Samsung and LG are markedly more efficient than the models they replace *even though there are currently no MEPS requirements in place*.

In addition, discussions with retailers suggest that New Zealand consumers are highly brand conscious and generally seek to purchase a known and reputable brand. This

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[19] Note that the Simpson NB380 is sold by Email under the Kelvinator brand in Australia and appears in that market as the Kelvinator NB380.

[20] Conversation with the Australian Greenhouse Office (AGO).

suggests that it would be difficult for a new player with non-compliant product to make significant headway in the New Zealand market. We note that any discounts currently offered by minority manufacturers have been insufficient to significantly alter buyer behaviour.

However, notwithstanding this conclusion, the possibility of short-term pressures resulting in surplus stock of non-compliant product on the world market is not something that can be dismissed altogether. If, for example, MEPS requirements were introduced in a significant proportion of the world's major markets over timeframes that did not allow manufacturers to adjust their product mix, a temporary oversupply could result. This in turn might depress prices and/or result in non-compliant product being re-directed to markets where no MEPS requirements exist. This scenario is picked up further in the sensitivity analysis (Section 5.2.2).

5.1.4 Second Hand Market

The second hand market for domestic refrigerators is the most complex of the second-hand product markets in this study. The second-hand market is active, with reasonably significant volumes of appliances sold on a refurbished basis through appliance retailers. There is also a large, more informal section of the market that operates by way of private advertisements in media such as local newspapers and the "Trade & Exchange" publication and internet site.

Due to the ready availability of information on prices, and the relatively large number of individual sellers, the second-hand market for domestic refrigerators is highly competitive. A potential buyer is aware of prices for similar appliances, and must make a trade-off between a cheaper second-hand appliance and a more expensive, but potentially more reliable, new appliance. This suggests that purchasers will require a potentially significant discount from the price of a new refrigerator. In addition, the seller generally desires to sell the appliance quite quickly, as the average house has only limited space for additional refrigerators. As a consequence, there is little relationship between price movements in new and second-hand refrigerators, with sellers generally setting their price based on observations of prices set by other sellers (often in the previous week's media); discounting is common.

Given the above dynamics, we expect that the second hand market for domestic refrigeration appliances will be relatively immune to the impact of MEPS.

5.2 ECONOMIC IMPACT OF MEPS

5.2.1 Base Case

In our "base case", there are no price changes or energy savings resulting from the introduction of MEPS. The market is assumed to continue to offer MEPS compliant product in the absence of MEPS. Thus the introduction of MEPS has no economic impact on any consumers, whether high income or low income.

5.2.2 Sensitivity Analysis

As discussed above, it is possible that, in the absence of MEPS, non-compliant product could be re-directed to New Zealand – particularly if overseas manufacturers were facing adjustment pressures as a result of the rapid introduction of MEPS requirements in other markets.

Under this scenario, the consumer may be made either worse off or better off depending on the relationship between the additional running costs and the capital cost saving (if any). A useful sensitivity analysis in this circumstance is to determine how much cheaper a non-compliant brand would need to be in order to make low income consumers better off in the absence of MEPS (worse off with MEPS).

As we are particularly concerned with impacts on low-income consumers, we focus our analysis on the models that are most popular with low-income consumers.

As required by the Terms of Reference for this study, we assume that consumers who would have purchased a new non-compliant appliance will now purchase a new compliant appliance that has the same capacity. We also assume that such consumers will purchase the cheapest compliant appliance that matches the capacity, etc of the non-compliant appliance that they otherwise would have purchased.

We conducted the analysis with respect to the following parameters:

- Efficiency reductions of 5 and 50 percent;
- Real discount rates of 5, 10 and 20 percent;
- Domestic electricity prices:
  - In the absence of a cost of carbon;
  - Under the low cost of carbon scenario; and
  - Under the high cost of carbon scenario.

The results of our analysis for a 5% reduction in the efficiency of refrigeration appliances are shown in Table 8, Table 9, and Table 10 and a 50% reduction in Tables 11, 12 and 13.

Each of the tables are organised into 5 blocks of 6 columns. The first block *“NPV of Energy Consumption (Standard Models)*” describes the model being considered (Columns 1 and 2), the price of the current models (column 3) and the present value of the energy consumption of the models over the life time of the appliance under low, medium and high discount rate scenarios (columns 4, 5 and 6).

The second block “*NPV of Energy Consumption (Redirected Models)*” recalculates the present value of the energy consumption for the appliances under the assumption that they are less efficient (5% less efficient for Tables 8,9 and 10 and 50% less efficient for Tables 11, 12 and 13.

The third block *“Change in NPV of Energy Consumption”* simply shows the difference between the present value energy consumption figures of the first two blocks.

The fourth block “*Required Maximum Price (Redirected Model)”* subtracts the change in NPV figures from Block 3 from the Price of the Standard Models (Block 1, Column 3). The resultant price figures represent the break even point for the consumer (ie the point at which the reduction in purchase price exactly offsets the present value of the increased running costs of the less efficient appliance.

The final block of figures *“Minimum Price Reduction (Redirected Models)”* relates in percentage terms the price of the appliance calculated in Block 4 with the price of the Standard Models in Block 1 Column 3. The figures show how much (in percentage terms) an inefficient appliance would need to be reduced in price for the break even point to be reached.

Thus in aggregate the tables portray; the present value of the running costs of the present compliant models, the running costs of appliances 5 (or 50) per cent less efficient and relates these figures to the capital cost of the appliance, both in absolute and percentage terms.

For example, Table 8 shows, that under the high discount rate scenario, if a model such as the Simpson NB380 was made so that it was 5 per cent less efficient and brought to market at a discount of greater than $19.16 (1.5%) of the current price, the consumer would be worse off with MEPS at the proposed levels. Conversely, if the price differential was less than $19.16 (1.5%), the consumer would be made better off under MEPS.

More generally, the tables show that, as the cost of running a refrigerator is relatively small compared to the capital cost, the reduction in the purchase price of the appliance required to balance the increase in running costs is relatively small for small changes in efficiency.

However, once the efficiency differential is increased to 50%, the reduction in the price of the appliance required to compensate the consumer for the increased running costs increases considerably – up to around 35% in one scenario.

Table 8: Refrigeration Appliances: Required Reduction in Retail Price for 5% Less Efficient Refrigeration Appliances Assuming No Cost of Carbon

		Discount Scenario	Low	Medium	High
Brand	**Model**	**Price**	**7.19%**	**12.31%**	**22.57%**
NPV of Energy Consumption (Standard Models)					
Simpson	NB380	$1,250.00	$744.72	$579.81	$383.13
Westinghouse	BJ385	$1,400.00	$736.62	$573.51	$378.96
LG	GR242	$849.00	$445.21	$346.63	$229.04
LG	GR282	$949.00	$461.40	$359.23	$237.37
NPV of Energy Consumption (Redirected Models)					
Simpson	NB380		$781.95	$608.80	$402.28
Westinghouse	BJ385		$773.45	$602.18	$397.91
LG	GR242		$467.47	$363.96	$240.50
LG	GR282		$484.47	$377.19	$249.24
Change in NPV of Energy Consumption					
Simpson	NB380		$37.24	$28.99	$19.16
Westinghouse	BJ385		$36.83	$28.68	$18.95
LG	GR242		$22.26	$17.33	$11.45
LG	GR282		$23.07	$17.96	$11.87
Required Maximum Price (Redirected Models)					
Simpson	NB380		$1,212.76	$1,221.01	$1,230.84
Westinghouse	BJ385		$1,363.17	$1,371.32	$1,381.05
LG	GR242		$826.74	$831.67	$837.55
LG	GR282		$925.93	$931.04	$937.13
Minimum Price Reduction (Redirected Models)					
Simpson	NB380		3.0%	2.3%	1.5%
Westinghouse	BJ385		2.6%	2.0%	1.4%
LG	GR242		2.6%	2.0%	1.3%
LG	GR282		2.4%	1.9%	1.3%

Table 9: Refrigeration Appliances: Required Reduction in Retail Price for 5% Less Efficient Refrigeration Appliances Assuming Low Cost of Carbon

		Discount Scenario	Low	Medium	High
Brand	**Model**	**Price**	**7.19%**	**12.31%**	**22.57%**
NPV of Energy Consumption (Standard Models)					
Simpson	NB380	$1,250.00	$798.87	$618.61	$404.70
Westinghouse	BJ385	$1,400.00	$790.19	$611.89	$400.30
LG	GR242	$849.00	$477.59	$369.82	$241.94
LG	GR282	$949.00	$494.95	$383.27	$250.74
NPV of Energy Consumption (Redirected Models)					
Simpson	NB380		$838.81	$649.54	$424.94
Westinghouse	BJ385		$829.70	$642.48	$420.32
LG	GR242		$501.47	$388.31	$254.04
LG	GR282		$519.70	$402.43	$263.28
Change in NPV of Energy Consumption					
Simpson	NB380		$39.94	$30.93	$20.24
Westinghouse	BJ385		$39.51	$30.59	$20.02
LG	GR242		$23.88	$18.49	$12.10
LG	GR282		$24.75	$19.16	$12.54
Required Maximum Price (Redirected Models)					
Simpson	NB380		$1,210.06	$1,219.07	$1,229.76
Westinghouse	BJ385		$1,360.49	$1,369.41	$1,379.98
LG	GR242		$825.12	$830.51	$836.90
LG	GR282		$924.25	$929.84	$936.46
Minimum Price Reduction (Redirected Models)					
Simpson	NB380		3.2%	2.5%	1.6%
Westinghouse	BJ385		2.8%	2.2%	1.4%
LG	GR242		2.8%	2.2%	1.4%
LG	GR282		2.6%	2.0%	1.3%

Table 10: Refrigeration Appliances: Required Reduction in Retail Price for 5% Less Efficient Refrigeration Appliances Assuming High Cost of Carbon Calculation

		Discount Scenario	Low	Medium	High
Brand	**Model**	**Price**	**7.19%**	**12.31%**	**22.57%**
NPV of Energy Consumption (Standard Models)					
Simpson	NB380	$1,250.00	$868.62	$668.58	$432.49
Westinghouse	BJ385	$1,400.00	$859.18	$661.31	$427.79
LG	GR242	$849.00	$519.28	$399.69	$258.56
LG	GR282	$949.00	$538.17	$414.23	$267.96
NPV of Energy Consumption (Redirected Models)					
Simpson	NB380		$912.05	$702.01	$454.12
Westinghouse	BJ385		$902.13	$694.38	$449.18
LG	GR242		$545.25	$419.68	$271.48
LG	GR282		$565.07	$434.94	$281.36
Change in NPV of Energy Consumption					
Simpson	NB380		$43.43	$33.43	$21.62
Westinghouse	BJ385		$42.96	$33.07	$21.39
LG	GR242		$25.96	$19.98	$12.93
LG	GR282		$26.91	$20.71	$13.40
Required Maximum Price (Redirected Models)					
Simpson	NB380		$1,206.57	$1,216.57	$1,228.38
Westinghouse	BJ385		$1,357.04	$1,366.93	$1,378.61
LG	GR242		$823.04	$829.02	$836.07
LG	GR282		$922.09	$928.29	$935.60
Minimum Price Reduction (Redirected Models)					
Simpson	NB380		3.5%	2.7%	1.7%
Westinghouse	BJ385		3.1%	2.4%	1.5%
LG	GR242		3.1%	2.4%	1.5%
LG	GR282		2.8%	2.2%	1.4%

Table 11: Refrigeration Appliances: Required Reduction in Retail Price for 50% Less Efficient Refrigeration Appliances Assuming No Cost of Carbon

		Discount Scenario	Low	Medium	High
Brand	**Model**	**Price**	**7.19%**	**12.31%**	**22.57%**
NPV of Energy Consumption (Standard Models)					
Simpson	NB380	$1,250.00	$744.72	$579.81	$383.13
Westinghouse	BJ385	$1,400.00	$736.62	$573.51	$378.96
LG	GR242	$849.00	$445.21	$346.63	$229.04
LG	GR282	$949.00	$461.40	$359.23	$237.37
NPV of Energy Consumption (Redirected Models)					
Simpson	NB380		$1,117.07	$869.71	$574.69
Westinghouse	BJ385		$1,104.93	$860.26	$568.44
LG	GR242		$667.82	$519.94	$343.56
LG	GR282		$692.10	$538.84	$356.06
Change in NPV of Energy Consumption					
Simpson	NB380		$372.36	$289.90	$191.56
Westinghouse	BJ385		$368.31	$286.75	$189.48
LG	GR242		$222.61	$173.31	$114.52
LG	GR282		$230.70	$179.61	$118.69
Required Maximum Price (Redirected Models)					
Simpson	NB380		$877.64	$960.10	$1,058.44
Westinghouse	BJ385		$1,031.69	$1,113.25	$1,210.52
LG	GR242		$626.39	$675.69	$734.48
LG	GR282		$718.30	$769.39	$830.31
Minimum Price Reduction (Redirected Models)					
Simpson	NB380		29.8%	23.2%	15.3%
Westinghouse	BJ385		26.3%	20.5%	13.5%
LG	GR242		26.2%	20.4%	13.5%
LG	GR282		24.3%	18.9%	12.5%

Table 12: Refrigeration Appliances: Required Reduction in Retail Price for 50% Less Efficient Refrigeration Appliances Assuming Low Cost of Carbon

		Discount Scenario	Low	Medium	High
Brand	**Model**	**Price**	**7.19%**	**12.31%**	**22.57%**
NPV of Energy Consumption (Standard Models)					
Simpson	NB380	$1,250.00	$798.87	$618.61	$404.70
Westinghouse	BJ385	$1,400.00	$790.19	$611.89	$400.30
LG	GR242	$849.00	$477.59	$369.82	$241.94
LG	GR282	$949.00	$494.95	$383.27	$250.74
NPV of Energy Consumption (Redirected Models)					
Simpson	NB380		$1,198.31	$927.92	$607.05
Westinghouse	BJ385		$1,185.28	$917.83	$600.46
LG	GR242		$716.38	$554.73	$362.91
LG	GR282		$742.43	$574.90	$376.11
Change in NPV of Energy Consumption					
Simpson	NB380		$399.44	$309.31	$202.35
Westinghouse	BJ385		$395.09	$305.94	$200.15
LG	GR242		$238.79	$184.91	$120.97
LG	GR282		$247.48	$191.63	$125.37
Required Maximum Price (Redirected Models)					
Simpson	NB380		$850.56	$940.69	$1,047.65
Westinghouse	BJ385		$1,004.91	$1,094.06	$1,199.85
LG	GR242		$610.21	$664.09	$728.03
LG	GR282		$701.52	$757.37	$823.63
Minimum Price Reduction (Redirected Models)					
Simpson	NB380		32.0%	24.7%	16.2%
Westinghouse	BJ385		28.2%	21.9%	14.3%
LG	GR242		28.1%	21.8%	14.2%
LG	GR282		26.1%	20.2%	13.2%

Table 13: Refrigeration Appliances: Required Reduction in Retail Price for 50% Less Efficient Refrigeration Appliances Assuming High Cost of Carbon

		Discount Scenario	Low	Medium	High
Brand	**Model**	**Price**	**7.19%**	**12.31%**	**22.57%**
NPV of Energy Consumption (Standard Models)					
Simpson	NB380	$1,250.00	$868.62	$668.58	$432.49
Westinghouse	BJ385	$1,400.00	$859.18	$661.31	$427.79
LG	GR242	$849.00	$519.28	$399.69	$258.56
LG	GR282	$949.00	$538.17	$414.23	$267.96
NPV of Energy Consumption (Redirected Models)					
Simpson	NB380		$1,302.93	$1,002.87	$648.74
Westinghouse	BJ385		$1,288.76	$991.97	$641.69
LG	GR242		$778.92	$599.54	$387.83
LG	GR282		$807.25	$621.34	$401.94
Change in NPV of Energy Consumption					
Simpson	NB380		$434.31	$334.29	$216.25
Westinghouse	BJ385		$429.59	$330.66	$213.90
LG	GR242		$259.64	$199.85	$129.28
LG	GR282		$269.08	$207.11	$133.98
Required Maximum Price (Redirected Models)					
Simpson	NB380		$815.69	$915.71	$1,033.75
Westinghouse	BJ385		$970.41	$1,069.34	$1,186.10
LG	GR242		$589.36	$649.15	$719.72
LG	GR282		$679.92	$741.89	$815.02
Minimum Price Reduction (Redirected Models)					
Simpson	NB380		34.7%	26.7%	17.3%
Westinghouse	BJ385		30.7%	23.6%	15.3%
LG	GR242		30.6%	23.5%	15.2%
LG	GR282		28.4%	21.8%	14.1%

6. MOTORS

6.1 SCOPE

The analysis in this section focuses on three-phase cage induction motors with ratings from 0.73 kW up to but not including 185 kW. It covers motors of rated voltages up to 1100 V AC. Three-phase electricity supply is usually only available to industrial and commercial premises, so residential applications of motors are not considered in this analysis.

The analysis also excludes the following motors (excluded from the Standard):

1. Submersible (sealed) motors specifically designed to operate wholly immersed in a liquid;
2. Motors that are integral with and not separable from, a driven unit;
3. Multi-speed motors;
4. Motors that have been granted exemption by the relevant regulatory authority[21]; and
5. Motors for use only for short-time duty cycle applications (eg those used for hoist, roller doors and cranes) which have a duty type rating of S2 under the IEC 60034-12.

All suppliers agree that 2 and 4 pole motors represent 80%–90 % of the market. 4 pole motors represent approximately 60% of the total market, while 2 pole motors represent around 20-30% of the total market. The remainder (6 and 8 pole motors) have been ignored for the purposes of this analysis.

6.2 THE NEW ZEALAND MARKET

6.2.1 The Current New Zealand Market

The market is Highly Competitive

New Zealand is part of a highly competitive international market for motors. All equipment suppliers agree that price is a very important factor with significant discounting from list price common place. Market suppliers suggest that any price increases would result in significant loss of market share.

Market Share

There are five major suppliers in the New Zealand motor market. These suppliers sell 95% of all motors sold in New Zealand. WEG and Brook Crompton have the highest market share, followed by the other three main suppliers: TECO, ABB and Motor Technologies. No player has more than 30% of the market.

Market Composition by Motor Size and Energy Consumption

Previous studies have shown that motors rated between 7.5 –75 kW represent 26% of the total motor population, and consume 53% of the total energy consumed by electric

[21] In practice, as no exemptions have been made, this category can not be separated out.

motors. Motors below 7.5 kW represent 70% of the total motor population but consume only 14% of the total energy consumption of electric motors.[22]

In the commercial end use sector 4,417 GWh per year of energy is consumed, 17.5% of this is used in motive power, 14% of the total use is in small motors (less than 7.5 kW). In the industrial sector 10,038 GWh of energy is consumed, 60% of this is used in motive power, 14% of the total use is in small motors (less than 7.5 kW)[23].

Efficiency of Existing Motors

Figure 4 and Figure 5 show the efficiency ratings of 2 and 4 pole motors, respectively. These figures indicate that generally existing manufacturers supply models that exceed or are very close to the proposed MEPS levels. This is certainly the case for motors rated above 7.5 kW. It would appear, generally, that the impact of MEPS is already starting to occur as suppliers ready themselves for its likely introduction into Australia.

The one exception to the above is with respect to motors below 7.5 kW. With this class of motors, the published data suggests that the product offered by one supplier in particularly tends to be below the proposed MEPS levels. The sub-7.5 kW range is discussed in more detail below.

Note also that there exists some doubt about the reliability of (some of the) published data. For example, some of the low cost motors of Chinese origin do not reference published efficiency data to any measurement standard. It was acknowledged by some suppliers that there may have to be some improvement in motor efficiencies if enforceable mandatory standards are to be introduced. Notwithstanding these uncertainties however, suppliers considered that if there was any extra cost this was likely to be absorbed by the manufacturer due to the competitive nature of the motor market.

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[22] New Zealand Energy Research and Development Committee Report #145, June 1987. This report uses data collected in 1986. In a more recent report "Motors and Drives – A Study of Potential Savings (EECA Sept 1995), the NZERDC data was acknowledged as still being the best available.

[23] Energy consumption figures are 1986 figures (refer footnote above) and are used for illustrative purposes only.

Figure 4: Efficiency Ratings of 2 Pole Motors

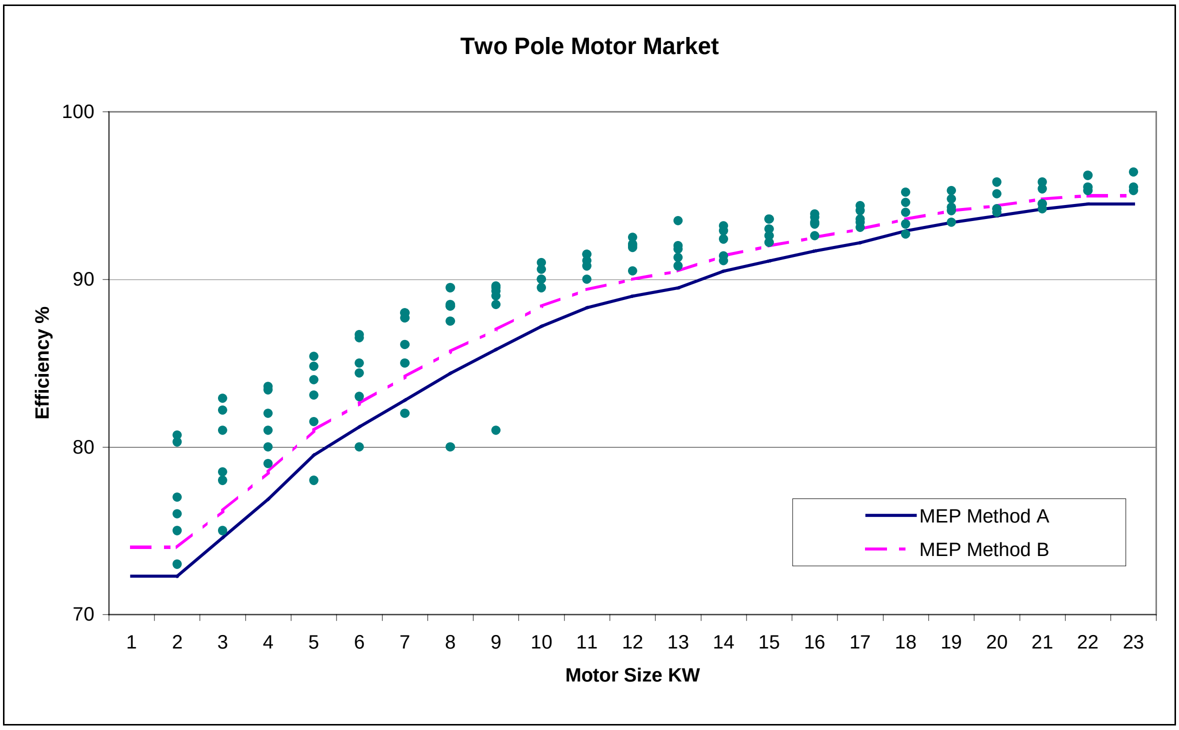
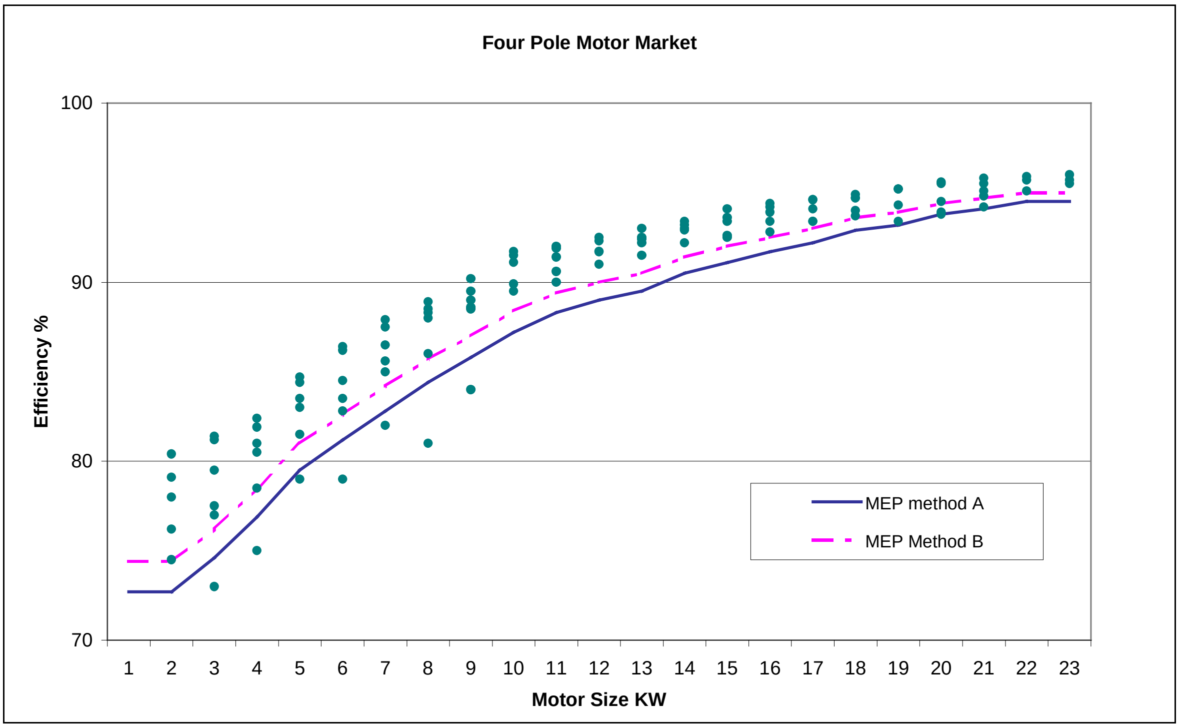


Figure 5: Efficiency Ratings of 4 Pole Motors



One Australia-New Zealand Market

There are strong links between the Australian and New Zealand markets. The industry views these markets as one. Some New Zealand suppliers combine orders with their sister companies in Australia in order to increase the volume of the order and achieve more competitive pricing. There are no motor manufacturers in New Zealand. Some motor manufacture does occur in Australia.

6.2.2 Impact of MEPS

Price

Our discussions with motor suppliers suggest that at the levels the present Standard specify, the price difference at the margin between non-compliant and compliant product would be zero or very small to the point of being insignificant. The MEPS levels only affect a few of the existing products on the market; thus they do not imply the widespread adoption of new (more expensive) technology. Furthermore, the competitive nature of the market suggests that, generally, any cost penalty associated with the meeting of the proposed Standard would more than likely be swamped by the discounting already common in this market.

The only possible exception to the above is with respect to models below 7.5kW where the product from one of the manufacturers is more clearly below the proposed Standard. Although we have contacted the manufacturer of this product (through their New Zealand agent) with a view to establishing whether any price increase would result from the introduction of MEPS, we have not been able to resolve this issue within the timeframe provided for the study. Nevertheless we have examined the case of these sub-7.5 kW motors in some detail in Section 6.3 below.

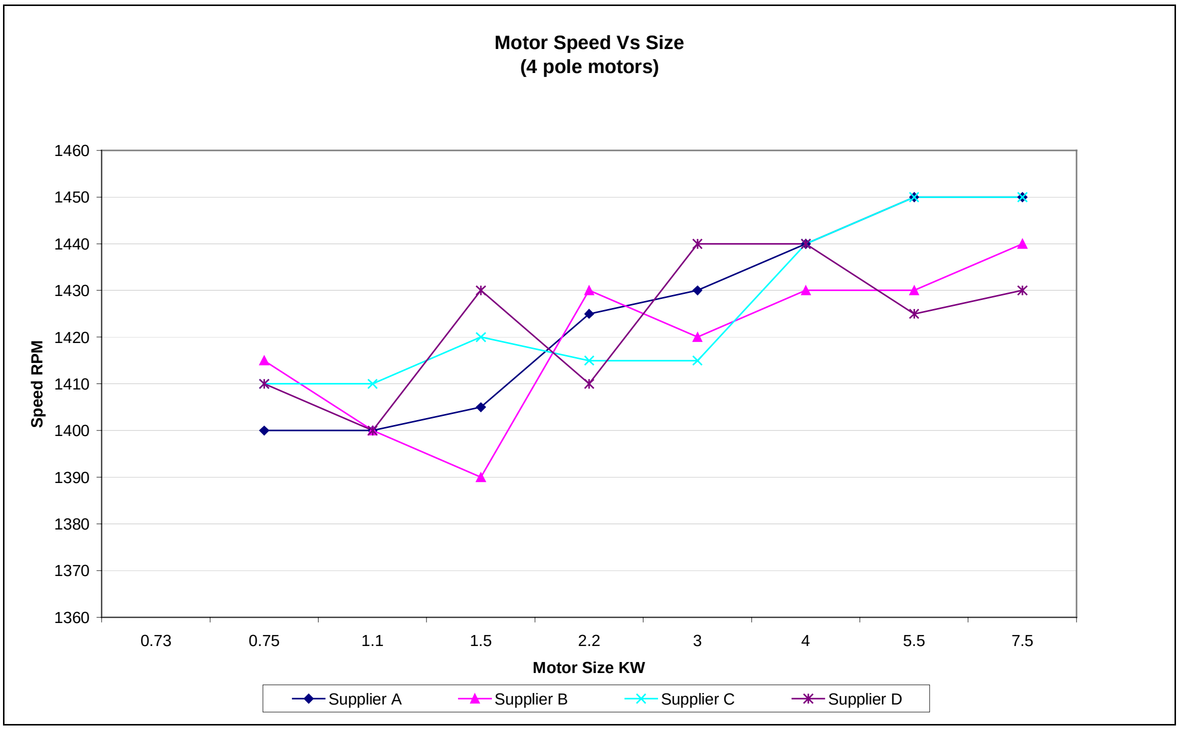
Efficiency and Motor Speed

One of the (potentially) more important technical issues that determines whether the introduction of MEPS is likely to have an impact on the market for motors is that more efficient motors could have less slip, which would result in faster motor speeds. If this was the case, then more efficient motors linked to pumps and fans may use more energy because the pump or fan would operate at a faster speed. As there is a cubic relationship between fan power and fan speed, even a small increase in speed could increase energy consumption by a significant amount. For example, if a failed motor driving a centrifugal pump or fan were replaced with a motor that was 2% faster in speed up to 6% more power would be consumed.

For this reason we have reviewed the extent to which efficiency and motor speed might be related. The graphs in Figure 6 and Figure 7 show the relationship between motor speed and size by manufacturer for common motors in the New Zealand market for respectively 2 and 4 pole motors. The graphs do not show any consistent difference in motor speed from any one supplier. However, we know from our analysis of efficiency levels that the product from some suppliers is consistently more efficient than the product offered by other manufacturers. These two pieces of information have lead us to conclude that more efficient motors do not necessarily run at faster speeds.

Figure 6: Motor Speed vs Size by Manufacturer – 2 Pole Motors

Figure 7: Motor Speed vs Size by Manufacturer – 4 Pole Motors



6.2.3 The Counterfactual

As with domestic refrigeration appliances, we need to form a view about how the market is likely to develop in the absence of the introduction of MEPS. In broad terms, there are two main options. First, the market could continue to move to more efficient product as a consequence (among other things) of initiatives to promote efficiency in other jurisdictions. The high levels of compliance with the Standard already evident coupled with the high degree of supply integration with the Australian market lend support to this scenario. In our opinion, this is the most likely scenario.

Second, as with domestic refrigeration appliances, we need to consider the possibility that the market could in the future revert back to non-compliant product. Indeed, the existence of a highly competitive market where price is the most important factor provides a prima facie case that the New Zealand market could be susceptible to a re-direction of cheap non-compliant motors.

However, there are two additional factors that mitigate against this – already foreshadowed above. First, the strong inter-relationship between the Australian and New Zealand markets suggests that even in the absence of MEPS in New Zealand, existing suppliers to the New Zealand market would probably supply motors that were compliant with the Australian MEPS regime. Second, the opportunity to supply cheap non-compliant motors already exists in New Zealand. If there was significant (price) advantage in supplying the market with non-compliant product, we would expect to see a much greater market share for inefficient product than is currently the case.

Consequently, we consider that the most plausible scenario for cheap non-compliant units flooding the New Zealand market is if standards are implemented rapidly elsewhere in the world without providing manufacturers sufficient time to adjust their plant. As discussed in section 4.2.2, we expect that such a scenario would only have an effect in the short term.

6.3 ECONOMIC IMPACT OF MEPS

6.3.1 Base Case

Motors Above 7.5kW

Given that motors above 7.5kW appear already to be generally MEPS-compliant, and our views about the counterfactual above, we believe that the introduction of MEPS at the levels considered will have no effect on the market. That is it would not affect motor users, either in terms of the capital cost of the motor or in terms of energy consumption.

Motors Below 7.5kW

There is, however, a potential issue with smaller, non-compliant motors. Motors supplied in this size range supplied by one manufacturer in particular are more clearly below the proposed MEPS levels.

Most of these motors are presently supplied to OEMs (original equipment manufacturers) for use in a variety of appliances including fans, hydraulic power packs and air conditioning units. Most of this equipment is sold in New Zealand.

As indicated above we have not been able to obtain from the manufacturer the size (if any) of the price increase that would result if these motors were required to be brought up to the proposed MEPS levels.

In the absence of this information, we have considered three potential applications of the affected motors and modelled the price increase of the motor that would need to occur for the end-consumer of the appliance to be worse off under MEPS. The analysis was conducted for the three discount rate scenarios (5,10 and 20 per cent real) and for the three price path scenarios (base, low cost of carbon, high cost of carbon). The scenarios and results are discussed below. Collectively, they allow us to form a qualitative view about the likelihood that the introduction of MEPS for these motors would result in the end user being worse off.

Example 1: Motor Fitted to a Hydraulic Power Pack

For our first example, we consider a motor fitted to a hydraulic power pack controlling a hoist that is used an average of one hour every day, or 365 hours per year. We assume that the application currently requires 7.5 kW with an efficiency of 81%. Following the implementation of MEPS this motor is replaced with a motor with an efficiency of 87% operating at the same speed. In this application, a total saving of 233 kWh/year would be achieved. Given the modelled industrial electricity prices, the total net present value of this saving is from $97-$220, as shown in Table 14.

Example 2: Extractor Fan

Our second example has the same power motor with the same increase in efficiency, but we now assume the extract fan is fitted to provide ventilation and operates for 8 hours per day, 5 days a week. The total savings will be 1,328 kWh/year. Given the modelled industrial electricity prices, the total net present value of this saving is from $553-$1,254, as shown in Table 14.

Example 3: Continuous Operation

Our third example again has the same motor power with the same increase in efficiency, but the motor operates in a three-shift operation, 24 hours/day 7 days per week. The total savings will be 5,594 kWh/year. Given the modelled industrial electricity prices, the total net present value of this saving is $2,330-$5,282, as shown in Table 14.

In all three examples the savings will be greater if there are reductions in maximum demand charges as a result of the motor operating when the electrical demand peaks.

Table 14: Net Present Value of Energy Savings from MEPS for Small Motors, Industrial Users Only

Discount Scenario	Low	Medium	High
Nominal Discount Rate	(7.19%)	(12.31%)	(22.57%)
Base Price Path			
Hydraulic Power Pack	$188.61	$146.84	$97.03
Extractor Fan	$1,074.98	$836.94	$553.03
Continuous Operation	$4,528.19	$3,525.49	$2,329.58
Low Cost of Carbon			
Hydraulic Power Pack	$202.32	$156.67	$102.50
Extractor Fan	$1,153.15	$892.95	$584.18
Continuous Operation	$4,857.48	$3,761.42	$2,460.77

High Cost of Carbon			
Hydraulic Power Pack	$219.99	$169.32	$109.53
Extractor Fan	$1,253.83	$965.08	$624.30
Continuous Operation	$5,281.57	$4,065.25	$2,629.75

All of these scenarios give reasonably high values in terms of the NPV of energy saved – ranging from $97.03 to over $5000 depending on the scenario. Given that the purchase price of a 7.5 kW motor is typically around $800, coupled with the competitive nature of the market and the lack of any clear relationship between efficiency and capital cost over the efficiency range being considered, we consider it highly unlikely that any end-user will be made worse off with the introduction of MEPS at the proposed levels. In fact, MEPS at the proposed levels are most likely to make all end users considerably better off.

6.3.2 Sensitivity Analysis

As indicated above, while we expect that, in the absence of MEPS, the market will continue to be supplied with MEPS compliant product, we can not rule out the possibility that the price competitive nature of the market would result in an influx of cheap non-compliant motors.

It is difficult to determine the precise extent to which this could occur. However, as with domestic refrigeration appliances, we can conduct sensitivity analyses so as to determine just how much cheaper a less-efficient motor would need to be for an end-user to be better off without MEPS (ie made worse off under MEPS).

As with domestic refrigeration appliances, we have conducted the analysis with respect to a range of parameters:

- Efficiency reductions of 5 percent;
- Motor sizes of 7.5, 11, 22 and 30 kW, with annual operating hours of 365, 2080 and 8760;
- Real discount rates of 5, 10 and 20 percent;
- Domestic electricity prices:
  - In the absence of a cost of carbon;
  - Under the low cost of carbon scenario; and
  - Under the high cost of carbon scenario.

The results are presented in the tables below. The logic of the tables follows that outlined in Section 5.2.2 with respect to domestic refrigeration appliances. However, in order to keep the tables to a manageable size, we have presented just the difference in the present value of the running costs between the efficient and the inefficient motor and related these values to the capital cost of the motor in both dollar and percentage terms.

Thus the first block of figures *"Change in NPV of Energy Consumption"* shows the *difference* in the present value of the energy consumption between typical MEPS compliant motors of 7.5kW, 11kW, 22kW and 30kW (Column 1) and hypothetical alternatives that are 5% less efficient. The operating scenarios, in terms of annual hours of operation are given in Column 2. The purchase price of the MEPS compliant motor is given in Column 3. The values under the different discount rate assumptions are given in Columns 4,5 and 6.

The second block of figures *"Required Maximum Price (Redirected Models)"* subtracts the figures generated in Block 1 from the price of the motor. The resultant price figures (in columns 4,5 and 6) give the break even point (ie the point at which the price of the motor exactly offsets the present value of the additional energy consumption). The third block of figures *"Minimum Price Reduction (Redirected Models)"* gives these price differentials in percentage terms. Table 15 assumes an electricity price that does not include a value for carbon. Table 16 employs the low cost of carbon scenario; Table 17, the high cost of carbon scenario.

Thus, in Table 15, for example, we can see that if a 7.5 kW motor was 5 per cent less efficient and the motor was being run 365 hours per year (one hour per day) under the high discount rate scenario, and the price of electricity did not include the cost of carbon, the price of the motor would need to decrease by at least $48.05 (5.6%) to $813.95 for the consumer to be made worse off by the introduction of MEPS. If the decrease in price were less than this the consumer would be made better off by the introduction of MEPS.

More generally the tables show that in virtually all cases the price of the motor would need to decrease very significantly to compensate for the increased energy consumption. In the extreme, the price of the motor would need to be negative. This means that it is highly unlikely that inefficient motors could be brought to the New Zealand market at a price cheap enough to compensate for the increased running costs. This in turn reinforces the conclusion that it is highly unlikely that any end-user would be made worse off by the introduction of MEPS for motors at the proposed levels.

Table 15: Motors: Required Reduction in Retail Price for 5% Less Efficient Motors Assuming No Cost of Carbon

		Discount Scenario	Low	Medium	High
Size of Motor (kWh)	**Annual Hours of Operation**	**Price of Motor**	**7.19%**	**12.31%**	**22.57%**
Change in NPV of Energy Consumption					
7.5	365	$862.00	$105.89	$77.74	$48.05
7.5	2080	$862.00	$603.43	$442.97	$273.80
7.5	8760	$862.00	$2,541.40	$1,865.59	$1,153.15
11	365	$1259.00	$153.77	$112.88	$69.77
11	2080	$1259.00	$876.30	$643.27	$397.62
11	8760	$1259.00	$3,690.57	$2,709.17	$1,674.57
22	365	$2210.00	$303.23	$222.60	$137.59
22	2080	$2210.00	$1,727.94	$1,268.44	$784.04
22	8760	$2210.00	$7,277.28	$5,342.10	$3,302.02

		Discount Scenario	Low	Medium	High
Size of Motor (kWh)	**Annual Hours of Operation**	**Price of Motor**	**7.19%**	**12.31%**	**22.57%**
30	365	$3077.00	$409.06	$300.28	$185.61
30	2080	$3077.00	$2,331.05	$1,711.17	$1,057.70
30	8760	$3077.00	$9,817.32	$7,206.69	$4,454.55
Required Maximum Price (Redirected Models)					
7.5	365		$756.11	$784.26	$813.95
7.5	2080		$258.57	$419.03	$588.20
7.5	8760		-$1,679.40	-$1,003.59	-$291.15
11	365		$1,105.23	$1,146.12	$1,189.23
11	2080		$382.70	$615.73	$861.38
11	8760		-$2,431.57	-$1,450.17	-$415.57
22	365		$1,906.77	$1,987.40	$2,072.41
22	2080		$482.06	$941.56	$1,425.96
22	8760		-$5,067.28	-$3,132.10	-$1,092.02
30	365		$2,667.94	$2,776.72	$2,891.39
30	2080		$745.95	$1,365.83	$2,019.30
30	8760		-$6,740.32	-$4,129.69	-$1,377.55
Minimum Price Reduction (Redirected Models)					
7.5	365		12.3%	9.0%	5.6%
7.5	2080		70.0%	51.4%	31.8%
7.5	8760		294.8%	216.4%	133.8%
11	365		12.2%	9.0%	5.5%
11	2080		69.6%	51.1%	31.6%
11	8760		293.1%	215.2%	133.0%
22	365		13.7%	10.1%	6.2%
22	2080		78.2%	57.4%	35.5%
22	8760		329.3%	241.7%	149.4%

		Discount Scenario	Low	Medium	High
Size of Motor (kWh)	**Annual Hours of Operation**	**Price of Motor**	**7.19%**	**12.31%**	**22.57%**
30	365		13.3%	9.8%	6.0%
30	2080		75.8%	55.6%	34.4%
30	8760		319.1%	234.2%	144.8%

Table 16; Motors: Required Reduction in Retail Price for 5% Less Efficient Motors Assuming Low Cost of Carbon

		Discount Scenario	Low	Medium	High
Size of Motor (kWh)	**Annual Hours of Operation**	**Price of Motor**	**7.19%**	**12.31%**	**22.57%**
Change in NPV of Energy Consumption					
7.5	365	$862.00	$113.60	$82.94	$50.76
7.5	2080	$862.00	$647.32	$472.61	$289.22
7.5	8760	$862.00	$2,726.21	$1,990.43	$1,218.09
11	365	$1259.00	$164.95	$120.43	$73.70
11	2080	$1259.00	$940.02	$686.32	$420.01
11	8760	$1259.00	$3,958.94	$2,890.46	$1,768.87
22	365	$2210.00	$325.28	$237.49	$145.34
22	2080	$2210.00	$1,853.59	$1,353.33	$828.19
22	8760	$2210.00	$7,806.49	$5,699.59	$3,487.97
30	365	$3077.00	$438.81	$320.38	$196.06
30	2080	$3077.00	$2,500.56	$1,825.68	$1,117.26
30	8760	$3077.00	$10,531.23	$7,688.95	$4,705.40
Required Maximum Price (Redirected Models)					
7.5	365		$748.40	$779.06	$811.24
7.5	2080		$214.68	$389.39	$572.78
7.5	8760		-$1,864.21	-$1,128.43	-$356.09
11	365		$1,094.05	$1,138.57	$1,185.30

		Discount Scenario	Low	Medium	High
Size of Motor (kWh)	**Annual Hours of Operation**	**Price of Motor**	**7.19%**	**12.31%**	**22.57%**
11	2080		$318.98	$572.68	$838.99
11	8760		-$2,699.94	-$1,631.46	-$509.87
22	365		$1,884.72	$1,972.51	$2,064.66
22	2080		$356.41	$856.67	$1,381.81
22	8760		-$5,596.49	-$3,489.59	-$1,277.97
30	365		$2,638.19	$2,756.62	$2,880.94
30	2080		$576.44	$1,251.32	$1,959.74
30	8760		-$7,454.23	-$4,611.95	-$1,628.40
Minimum Price Reduction (Redirected Models)					
7.5	365		13.2%	9.6%	5.9%
7.5	2080		75.1%	54.8%	33.6%
7.5	8760		316.3%	230.9%	141.3%
11	365		13.1%	9.6%	5.9%
11	2080		74.7%	54.5%	33.4%
11	8760		314.5%	229.6%	140.5%
22	365		14.7%	10.7%	6.6%
22	2080		83.9%	61.2%	37.5%
22	8760		353.2%	257.9%	157.8%
30	365		14.3%	10.4%	6.4%
30	2080		81.3%	59.3%	36.3%
30	8760		342.3%	249.9%	152.9%

Table 17; Motors: Required Reduction in Retail Price for 5% Less Efficient Motors Assuming Low Cost of Carbon

		Discount Scenario	Low	Medium	High
Size of Motor (kWh)	**Annual Hours of Operation**	**Price of Motor**	**7.19%**	**12.31%**	**22.57%**
Change in NPV of Energy Consumption					
7.5	365	$862.00	$123.52	$89.64	$54.24
7.5	2080	$862.00	$703.84	$510.80	$309.09
7.5	8760	$862.00	$2,964.23	$2,151.21	$1,301.73
11	365	$1259.00	$179.36	$130.16	$78.76
11	2080	$1259.00	$1,022.09	$741.76	$448.85
11	8760	$1259.00	$4,304.59	$3,123.94	$1,890.35
22	365	$2210.00	$353.68	$256.68	$155.32
22	2080	$2210.00	$2,015.43	$1,462.64	$885.07
22	8760	$2210.00	$8,488.04	$6,159.97	$3,727.50
30	365	$3077.00	$477.10	$346.25	$209.52
30	2080	$3077.00	$2,718.88	$1,973.16	$1,193.99
30	8760	$3077.00	$11,450.68	$8,310.03	$5,028.53
Required Maximum Price (Redirected Models)					
7.5	365		$738.48	$772.36	$807.76
7.5	2080		$158.16	$351.20	$552.91
7.5	8760		-$2,102.23	-$1,289.21	-$439.73
11	365		$1,079.64	$1,128.84	$1,180.24
11	2080		$236.91	$517.24	$810.15
11	8760		-$3,045.59	-$1,864.94	-$631.35
22	365		$1,856.32	$1,953.32	$2,054.68
22	2080		$194.57	$747.36	$1,324.93
22	8760		-$6,278.04	-$3,949.97	-$1,517.50
30	365		$2,599.90	$2,730.75	$2,867.48
30	2080		$358.12	$1,103.84	$1,883.01

		Discount Scenario	Low	Medium	High
Size of Motor (kWh)	**Annual Hours of Operation**	**Price of Motor**	**7.19%**	**12.31%**	**22.57%**
30	8760		-$8,373.68	-$5,233.03	-$1,951.53
Minimum Price Reduction (Redirected Models)					
7.5	365		14.3%	10.4%	6.3%
7.5	2080		81.7%	59.3%	35.9%
7.5	8760		343.9%	249.6%	151.0%
11	365		14.2%	10.3%	6.3%
11	2080		81.2%	58.9%	35.7%
11	8760		341.9%	248.1%	150.1%
22	365		16.0%	11.6%	7.0%
22	2080		91.2%	66.2%	40.0%
22	8760		384.1%	278.7%	168.7%
30	365		15.5%	11.3%	6.8%
30	2080		88.4%	64.1%	38.8%
30	8760		372.1%	270.1%	163.4%

7. PACKAGED AIR-CONDITIONING UNITS

7.1 SCOPE

The analysis in this section focuses on three-phase ducted and non-ducted air conditioners of the vapour compression type intended for household, commercial and similar uses, up to a rated cooling capacity of 65 kW. It covers only those units with a single refrigeration circuit with one evaporator and one condenser. It does not cover multi-split systems or evaporative coolers.

7.2 THE NEW ZEALAND MARKET

7.2.1 The Current New Zealand Market[24]

Price is the Most Important Factor

The market for packaged air conditioning units is very competitive. Equipment suppliers and mechanical services contractors agree that price is the single most important factor, (followed by delivery time).

The nature of the forces driving the New Zealand market is reflected in the mission statement of the largest supplier; “Temperzone’s mission is to provide the most competitively priced, reliable and efficient air conditioning equipment available to the international market.” Temperzone consider the order of these words to be significant. If suppliers can source a less efficient unit and bring it to the market more cost effectively, it will sell and continue to do so as long as it is reliable.

Market Share

The largest New Zealand manufacturer is Temperzone, supplying somewhere between 60% and 80% of the New Zealand market. Carrier is the second of the major players supplying between 10% and 25% of the units sold in New Zealand.

Beyond these two, there are a number of other manufacturers who in the past have specialised in small single-phase units of a size up to around 10 kW cooling capacity but are now also beginning to make inroads into the market for larger three phase machines. Brands available include Fujitsu, Mitsubishi, Toshiba, Panasonic, Carrier, Delongi and Daikyn.

The remainder of the market in New Zealand is made up of York, Trane, Alcair and Lennox. (Often, however, product sourced from the USA is not cost competitive with other brands.)

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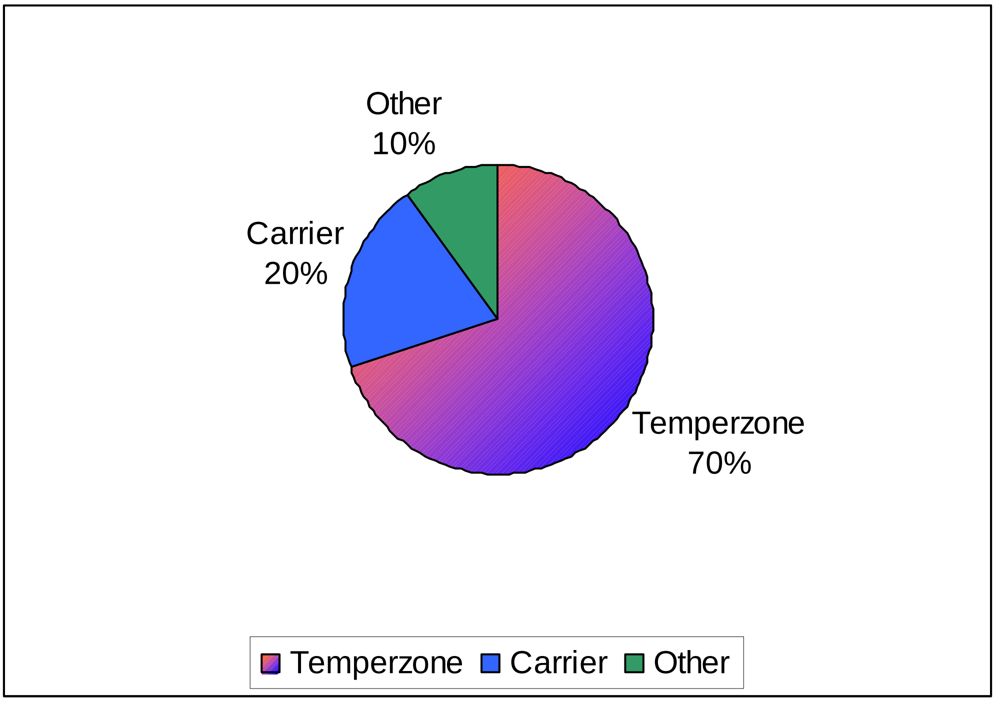
[24] Much of the information in this section was collected during telephone discussions with equipment suppliers, mechanical service contractors and building services consultants. While no guarantees can be made with respect to the degree of accuracy of this information, we believe it provides as realistic a picture as possible of the situation as it now stands. We did attempt to cross check this information with import data for air conditioning equipment, however this was made difficult by the fact that the import data includes small single phase equipment as well as water cooled chillers which are not of interest in this study.

Figure 8: Estimated Market Share in the New Zealand Packaged Air Conditioning Market



Inter-Relationship Between Australia and New Zealand

The markets for packaged air conditioning units in New Zealand and Australia are strongly inter-linked. For example, New Zealand's largest supplier, Temperzone, also exports units to Australia (as well as elsewhere in Asia). Of Temperzone's total production, approximately 30% is sold in New Zealand, 60% is exported to Australia and the remaining 10% is exported to other countries. Temperzone has a factory in Auckland and another in Sydney. Cases are pre-cut in Auckland and then sent to Sydney for assembly. Although, some product lines are common to both New Zealand and Australia, country-specific product lines re also marketed.

In Australia, Carrier have a dominant position with approximately 50% of the total market. (Temperzone have approximately 25% of the Australian market with the remaining 25% shared amongst 5 smaller suppliers.) Carrier has a factory in Perth that manufactures product for both the New Zealand and the Australian Market. Carrier does not manufacture unique equipment for the New Zealand market.

Availability and Quality of Energy Efficiency Information

Although some product literature includes energy efficiency information, this is not always the case. For example, Temperzone, has two main lines of product, one line (OPA) includes stocked standard units the other line (PA) includes custom built units. More custom-built units are sold than standard units. There is no published efficiency data for the PA line of products. Furthermore, no suppliers could provide part-load energy performance information. In addition, even when efficiency performance is quoted, the basis for the efficiency test (including the ambient conditions) is often not stated.

To complicate the picture further, product literature often presents efficiency information in a confusing or misleading manner (and at variance with what is used in the draft standard). For example, some equipment suppliers provide an energy efficiency rating (EER) in terms of Btu/hr/W without stating the units, this means that an air conditioner with a COP of 3 is shown as having an EER of 10.2.

Some literature states that the COPs are calculated at Air-Conditioning and Refrigeration Equipment Manufacturers Association (AREMA) test conditions. The AREMA certification programme is aimed at ensuring that the stated capacities of air-conditioning units can be verified. We have contacted AREMA to determine how their test conditions compare with those specified in draft standard, but have not been able to obtain a response in the time available for this study.

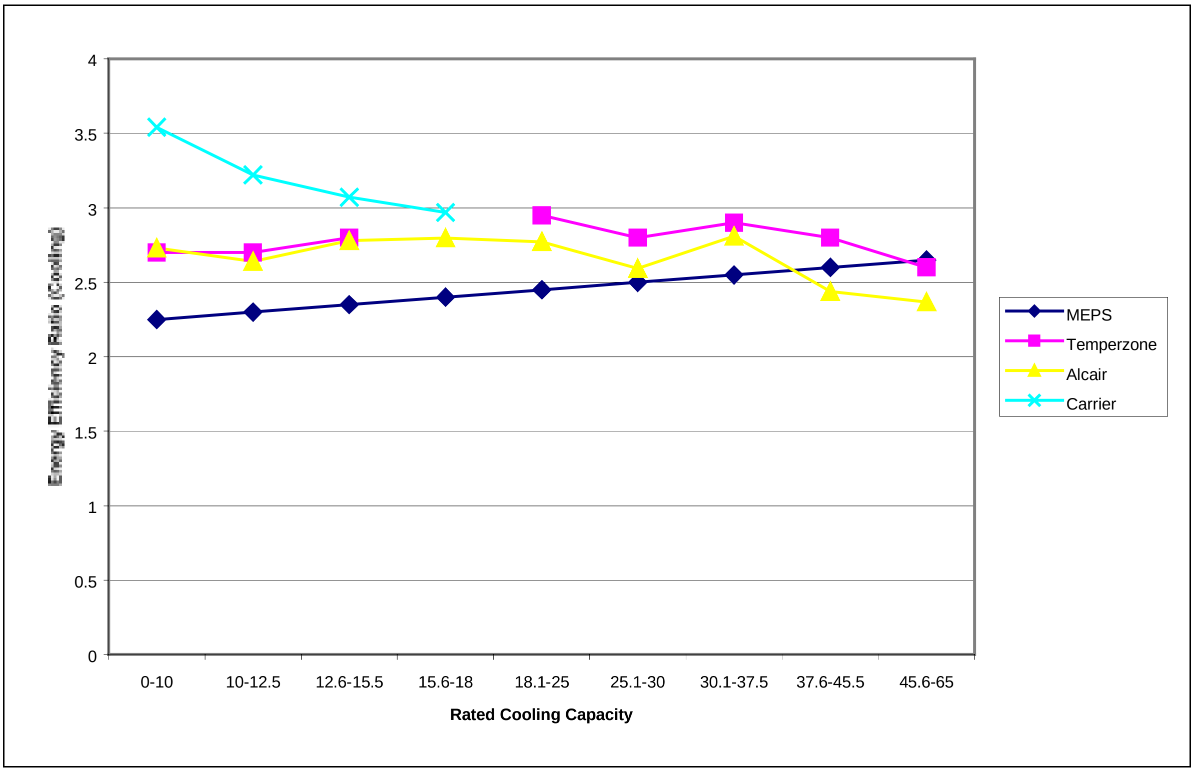
Compliance of Existing Units

Figure 9 shows the efficiency of 3-phase equipment suggested by the available literature up to a rated capacity of 65 kW, along with the levels implied by the Standard.

Note however that not all of the units represented on the graph are necessarily covered by the Standard. In particular, PACs from 50 kW upwards generally have two compressors and two independent refrigeration circuits – and thus fall outside the scope of the Standard. (PACs smaller than 25 kW generally have a single compressor and a single refrigeration circuit. Units from 25 kW – 40 kW have a single refrigeration circuit with one or two compressors, these are know in the industry as tandem units.)

In practice this means that the draft standard is likely to cover only cover 3-phase equipment up to 40 kW. Certainly, the Temperzone units in the OPA series from 50 kW upwards all have two compressors and two independent refrigeration circuits – and therefore are not covered by the proposed Standard.

Figure 9: Performance of Existing Packaged Air Conditioning Units vs MEPS



7.2.2 Impact of MEPS

Price Changes

We expect that, at the margin, there will be little change in price as a result of the introduction of MEPS. PAC units already employ technology that enables them to meet the standards considered in this study. We are not aware of any particular capital cost saving to be had from switching to the manufacture of less efficient product. Further, most units are either imported from (or exported to) countries that already have or are contemplating MEPS-type regulations.

7.2.3 The Counterfactual

As with the two previous product classes, it is necessary to form a view about how the market might develop in the absence of MEPS. In particular, we need to determine whether it is likely that the market would revert back from its current high level of compliance to non-compliant product.

The existence of a highly competitive market where price is the most important factor provides a prima facie case that the New Zealand market could be highly susceptible to dumping of cheap inefficient PAC units. However, there are two additional factors that mitigate against this. First, the strong inter-relationship between the Australian and New Zealand markets suggests that even in the absence of MEPS in New Zealand, existing suppliers to the New Zealand market would probably supply units that were largely compliant with the Australian MEPS regime. Secondly, the opportunity to supply cheap non-compliant units already exists in New Zealand. However, as shown in Figure 9, all units within the scope of the proposed standard already comply with the standard.

We consider that the only possible scenario for cheap non-compliant units flooding the New Zealand market is if standards are implemented rapidly elsewhere in the world without providing manufacturers sufficient time to adjust their plant. As discussed in section 4.2.2 we expect that such a scenario would only have an effect in the short term, while manufacturers adjusted their plant.

7.2.4 Second Hand Market

There is no second hand market for packaged air-conditioning units. The cost of installing a packaged air-conditioning unit on top of a building is such that the overriding consideration is to obtain a reliable unit. A second hand unit not only needs to be removed from an existing building, but will not have the reliability of a new unit.

Thus, we assume that the second hand market for packaged air-conditioning units is so small that it is insignificant, therefore no analysis will be performed on the second hand market.

7.3 ECONOMIC IMPACT OF MEPS

7.3.1 Base Case

Given that the PAC units covered by the proposed standard are already MEPS-compliant, and the price-competitiveness of the New Zealand market, we consider that the introduction of MEPS will have no effect on the market for packaged air-conditioning units.

7.3.2 Sensitivity Analysis

The critical assumption underpinning our base case is that there is no re-direction of non-compliant product to New Zealand. As is the case for the highly competitive motor market, it is not impossible that the price-sensitive PAC market could be supplied with cheap non-compliant motors in the absence of MEPS. It is difficult to determine the precise extent to which this could occur. However, as with the other product classes, we have conducted sensitivity analyses to determine how much cheaper a less-efficient PAC would need to be for an end-user to be better off without MEPS (worse off with MEPS).

As with the sensitivity analysis conducted for the other product classes we have considered a range of electricity prices (corresponding to a range of values of carbon) and a range of discount rates. The analysis focuses on two of Temperzone's existing products (OPA 210 and OPA 410). The first is rated at 21.5 kW, the second 41 kW. It looks at the following variations of key parameters;

- Efficiency differentials compared to MEPS compliant product where EERineffficient = ((EERefficient-1)*x)+1 with x equals 0.7 and x equals 0.8;
- Operating scenarios where:
  - The machine operates 40 hours per week, 50 weeks per year at a diversity[25] factor of 65%;
  - The machine operates 60 hours per week, 50 weeks per year at a diversity factor of 65%; and
  - The machine continuously 24 hours per day, 365 days per year at a diversity factor of 50%;
- Real discount rates of 5, 10 and 20 percent;
- Domestic electricity prices:
  - In the absence of any cost of carbon;
  - Under the low cost of carbon scenario; and
  - Under the high cost of carbon scenario.

The results of the analysis are presented in the following tables. Again, as with the sensitivity analysis presented for motors, we have focussed on the difference in the present value of the running costs between the efficient and the inefficient appliance and related these values to the capital cost of the air conditioning unit in both dollar and percentage terms.

Thus in each of the tables the first block of figures *"Change in NPV of Energy Consumption"* shows the *difference* in energy consumption, the second block *"Required Maximum Price (Redirected Models)"* shows the break even purchase price and the third block expresses the break even purchase price differential in percentage terms.

[25] The diversity factor indicates the percentage of the time the appliance is actually working. When the appliance is being used solely during the day we have assumed a diversity factor of 65% indicating that it would be working 65% of the time in which it is switched on. A lower diversity factor (50%) is assumed when the appliance is switched on day and night under the assumption that less cooling would be required during the night.

Thus in Table 18 for example, we can see that if a 21.5 kW PAC was less efficient by an amount given by x=0.7 in the formula above and the motor was being run 1300 hours per year (40 hours per week, 50 hours per year at a diversity factor of 0.65) under the high discount scenario, the price of the unit would need to decrease by at least $728.25 (9.4%) to $7034.75 for the consumer to be made worse off by the introduction of MEPS. If the decrease in price were less than this the consumer would be made better off by the introduction of MEPS.

More generally, the tables show that, like motors, the running costs are relatively high compared to the capital cost of the appliance. This means that it is highly unlikely that the consumer would be made worse off under MEPS, even in the unlikely event that the market was about to revert from its current high level of compliance to non-compliant products.

Table 18; Packaged Air Conditioners: Required Reduction in Retail Price for Less Efficient Units (X=0.7) Assuming No Cost of Carbon

		Discount Scenario	Low	Medium	High
Capacity (kWh)	Hours of Operation	Price	7.19%	12.31%	22.57%
Change in NPV of Energy Consumption					
21.5	1300	$7,763	$1,604.99	$1,178.19	$728.25
41	1300	$13,703	$3,173.69	$2,329.74	$1,440.04
21.5	1950	$7,763	$2,407.48	$1,767.28	$1,092.38
41	1950	$13,703	$4,760.54	$3,494.61	$2,160.06
21.5	4380	$7,763	$5,407.42	$3,969.47	$2,453.58
41	4380	$13,703	$10,693.42	$7,849.81	$4,852.07
Required Maximum Price (Redirected Models)					
21.5	1300		$6,158.01	$6,584.81	$7,034.75
41	1300		$10,529.31	$11,373.26	$12,262.96
21.5	1950		$5,355.52	$5,995.72	$6,670.62
41	1950		$8,942.46	$10,208.39	$11,542.94
21.5	4380		$2,355.58	$3,793.53	$5,309.42
41	4380		$3,009.58	$5,853.19	$8,850.93
Minimum Price Reduction (Redirected Models)					
21.5	1300		20.7%	15.2%	9.4%
41	1300		23.2%	17.0%	10.5%
21.5	1950		31.0%	22.8%	14.1%
41	1950		34.7%	25.5%	15.8%
21.5	4380		69.7%	51.1%	31.6%
41	4380		78.0%	57.3%	35.4%

Table 19 Packaged Air Conditioners: Required Reduction in Retail Price for Less Efficient Units (X=0.8) Assuming No Cost of Carbon

		Discount Scenario	Low	Medium	High
Capacity (kWh)	Hours of Operation	Price	7.19%	12.31%	22.57%
Change in NPV of Energy Consumption					
21.5	1300	$7,763	$986.02	$723.82	$447.40
41	1300	$13,703	$1,959.48	$1,438.41	$889.10
21.5	1950	$7,763	$1,479.38	$1,085.98	$671.26
41	1950	$13,703	$2,939.23	$2,157.62	$1,333.65
21.5	4380	$7,763	$3,322.33	$2,438.85	$1,507.48
41	4380	$13,703	$6,602.79	$4,846.97	$2,995.97
Required Maximum Price (Redirected Models)					
21.5	1300		$6,776.98	$7,039.18	$7,315.60
41	1300		$11,743.52	$12,264.59	$12,813.90
21.5	1950		$6,283.62	$6,677.02	$7,091.74
41	1950		$10,763.77	$11,545.38	$12,369.35
21.5	4380		$4,440.67	$5,324.15	$6,255.52
41	4380		$7,100.21	$8,856.03	$10,707.03
Minimum Price Reduction (Redirected Models)					
21.5	1300		12.7%	9.3%	5.8%
41	1300		14.3%	10.5%	6.5%
21.5	1950		19.1%	14.0%	8.6%
41	1950		21.4%	15.7%	9.7%
21.5	4380		42.8%	31.4%	19.4%
41	4380		48.2%	35.4%	21.9%

Table 20: Packaged Air Conditioners: Required Reduction in Retail Price for Less Efficient Units (X=0.7) Assuming Low Cost of Carbon

		Discount Scenario	Low	Medium	High
Capacity (kWh)	**Hours of Operation**	**Price**	**7.19%**	**12.31%**	**22.57%**
Change in NPV of Energy Consumption					
21.5	1300	$7,763	$1,721.70	$1,257.03	$769.27
41	1300	$13,703	$3,404.48	$2,485.65	$1,521.14
21.5	1950	$7,763	$2,582.56	$1,885.55	$1,153.90
41	1950	$13,703	$5,106.73	$3,728.47	$2,281.71
21.5	4380	$7,763	$5,800.65	$4,235.11	$2,591.76
41	4380	$13,703	$11,471.04	$8,375.12	$5,125.32
Required Maximum Price (Redirected Models)					
21.5	1300		$6,041.30	$6,505.97	$6,993.73
41	1300		$10,298.52	$11,217.35	$12,181.86
21.5	1950		$5,180.44	$5,877.45	$6,609.10
41	1950		$8,596.27	$9,974.53	$11,421.29
21.5	4380		$1,962.35	$3,527.89	$5,171.24
41	4380		$2,231.96	$5,327.88	$8,577.68
Minimum Price Reduction (Redirected Models)					
21.5	1300		22.2%	16.2%	9.9%
41	1300		24.8%	18.1%	11.1%
21.5	1950		33.3%	24.3%	14.9%
41	1950		37.3%	27.2%	16.7%
21.5	4380		74.7%	54.6%	33.4%
41	4380		83.7%	61.1%	37.4%

Table 21: Packaged Air Conditioners: Required Reduction in Retail Price for Less Efficient Units (X=0.8) Assuming Low Cost of Carbon

		Discount Scenario	Low	Medium	High
Capacity (kWh)	**Hours of Operation**	**Price**	**7.19%**	**12.31%**	**22.57%**
Change in NPV of Energy Consumption					
21.5	1300	$7,763	$1,057.73	$772.26	$472.60
41	1300	$13,703	$2,101.98	$1,534.67	$939.17
21.5	1950	$7,763	$1,586.96	$1,158.66	$709.06
41	1950	$13,703	$3,152.96	$2,302.01	$1,408.76
21.5	4380	$7,763	$3,563.93	$2,602.06	$1,592.38
41	4380	$13,703	$7,082.94	$5,171.32	$3,164.69
Required Maximum Price (Redirected Models)					
21.5	1300		$6,705.27	$6,990.74	$7,290.40
41	1300		$11,601.02	$12,168.33	$12,763.83
21.5	1950		$6,176.04	$6,604.34	$7,053.94
41	1950		$10,550.04	$11,400.99	$12,294.24
21.5	4380		$4,199.07	$5,160.94	$6,170.62
41	4380		$6,620.06	$8,531.68	$10,538.31
Minimum Price Reduction (Redirected Models)					
21.5	1300		13.6%	9.9%	6.1%
41	1300		15.3%	11.2%	6.9%
21.5	1950		20.4%	14.9%	9.1%
41	1950		23.0%	16.8%	10.3%
21.5	4380		45.9%	33.5%	20.5%
41	4380		51.7%	37.7%	23.1%

Table 22: Packaged Air Conditioners: Required Reduction in Retail Price for Less Efficient Units (X=0.7) Assuming High Cost of Carbon

		Discount Scenario	Low	Medium	High
Capacity (kWh)	**Hours of Operation**	**Price**	**7.19%**	**12.31%**	**22.57%**
Change in NPV of Energy Consumption					
21.5	1300	$7,763	$1,872.02	$1,358.57	$822.09
41	1300	$13,703	$3,701.72	$2,686.42	$1,625.60
21.5	1950	$7,763	$2,808.03	$2,037.85	$1,233.14
41	1950	$13,703	$5,552.57	$4,029.63	$2,438.39
21.5	4380	$7,763	$6,307.08	$4,577.20	$2,769.73
41	4380	$13,703	$12,472.54	$9,051.61	$5,477.27
Required Maximum Price (Redirected Models)					
21.5	1300		$5,890.98	$6,404.43	$6,940.91
41	1300		$10,001.28	$11,016.58	$12,077.40
21.5	1950		$4,954.97	$5,725.15	$6,529.86
41	1950		$8,150.43	$9,673.37	$11,264.61
21.5	4380		$1,455.92	$3,185.80	$4,993.27
41	4380		$1,230.46	$4,651.39	$8,225.73
Minimum Price Reduction (Redirected Models)					
21.5	1300		24.1%	17.5%	10.6%
41	1300		27.0%	19.6%	11.9%
21.5	1950		36.2%	26.3%	15.9%
41	1950		40.5%	29.4%	17.8%
21.5	4380		81.2%	59.0%	35.7%
41	4380		91.0%	66.1%	40.0%

Table 23: Packaged Air Conditioners: Required Reduction in Retail Price for Less Efficient Units (X=0.8) Assuming High Cost of Carbon

		Discount Scenario	Low	Medium	High
Capacity (kWh)	**Hours of Operation**	**Price**	**7.19%**	**12.31%**	**22.57%**
Change in NPV of Energy Consumption					
21.5	1300	$7,763	$1,150.07	$834.63	$505.05
41	1300	$13,703	$2,285.49	$1,658.64	$1,003.67
21.5	1950	$7,763	$1,725.51	$1,252.25	$757.75
41	1950	$13,703	$3,428.24	$2,487.95	$1,505.50
21.5	4380	$7,763	$3,875.08	$2,812.24	$1,701.73
41	4380	$13,703	$7,701.33	$5,589.04	$3,382.01
Required Maximum Price (Redirected Models)					
21.5	1300		$6,612.93	$6,928.37	$7,257.95
41	1300		$11,417.51	$12,044.36	$12,699.33
21.5	1950		$6,037.49	$6,510.75	$7,005.25
41	1950		$10,274.76	$11,215.05	$12,197.50
21.5	4380		$3,887.92	$4,950.76	$6,061.27
41	4380		$6,001.67	$8,113.96	$10,320.99
Minimum Price Reduction (Redirected Models)					
21.5	1300		14.8%	10.8%	6.5%
41	1300		16.7%	12.1%	7.3%
21.5	1950		22.2%	16.1%	9.8%
41	1950		25.0%	18.2%	11.0%
21.5	4380		49.9%	36.2%	21.9%
41	4380		56.2%	40.8%	24.7%

8. CONCLUSIONS

Overall, the product classes considered are notable for the current high level of compliance with the MEPS standards. It appears that the product being supplied to New Zealand is strongly influenced by international trends towards more efficient product. In particular, the forthcoming introduction of MEPS in Australia and the very close relationship between the New Zealand and Australian markets mean that the market in New Zealand has largely already been transitioned. The must probable outcome, thus, is that MEPS will have very little impact (if any) on the end-user.

This means that, in general, the only scenario in which it would be possible for the introduction of MEPS to have an *adverse* effect on the end-user is if the markets were to switch from their current high level of compliance to non-compliant product in the future *and* that product was put on the market at a discount to current prices insufficient to outweigh the on-going increase in energy costs.

While we do not consider this outcome to be particularly likely, it is not a scenario that can be ruled out. In particular, there is some evidence from Europe of inefficient product being re-directed to markets with less stringent energy efficiency requirements. The risk of this occurring in New Zealand is a matter that is relevant to the wider policy questions surrounding the possible introduction of MEPS.

Domestic Refrigeration Appliances

The New Zealand market for domestic refrigeration appliances appears to be strongly influenced by the pending introduction into Australia of MEPS and by the labelling regime already in place. We have not been able to identify any product currently available within New Zealand that would not meet the proposed Standard.

With respect to low income earners, four new models appear to be popular – particularly two of the LG product range. These appliances are all demonstrably MEPS compliant. Our analysis of the second hand market for domestic refrigeration appliances shows that the market is competitive with prices typically well below new price levels.

We think it is unlikely that the market would revert back to non-compliant product in the absence of MEPS. Markets world-wide are progressively moving to more (not less) efficient product to meet increasingly demanding efficiency standards. This progression in efficiency can be seen in New Zealand (even in the absence of standards) with each generation of appliance being more efficient than the superseded model.

The possibility of some re-direction of less efficient product to New Zealand if New Zealand failed to introduce MEPS however can not be ruled out. If this were to happen, the relatively low running costs (compared to the capital cost) means that it is possible that an inefficient product could be put on the New Zealand market at a discount that would more than offset the increased running costs. Under this scenario, the consumer would be made worse off with the introduction of MEPS at the proposed levels.

Overall, however, notwithstanding the scenario above, we conclude that it is most unlikely that the introduction of MEPS would adversely impact on the end-user.

Three Phase Cage Motors

As with domestic refrigeration appliances, there are strong links between the Australian and New Zealand markets with the industry tending to view these markets as one. Some

New Zealand suppliers combine orders with their sister companies in Australia as a means of increasing the volume of the order and achieving more competitive pricing.

Published data on efficiency levels is, arguably less reliable, than that available for domestic refrigeration appliances. For example many of the lower cost motors imported from China do not include within their product literature the Standards underpinning the efficiency data supplied.

Importers of this product acknowledge that higher efficiencies may be required if mandatory Standards enforced by audits were introduced. However, they felt that, in the event that this did impose additional cost, it would most likely be absorbed by the manufacturers.

Aside from the uncertainty with respect to efficiency levels discussed above, it appears that one supplier currently imports non-compliant product in one segment of the market (motors less than 7.5kW). Typically these motors are sold to Original Equipment Manufacturers (OEMs) for inclusion in products such as extractor fans etc.

In the time frame given for this assignment, we have been unable to determine from the manufacturer the extent, if any, of a price increase associated with bringing the affected motors up to the required Standard. However, a comparison of the size of the present value of energy savings with the typical capital cost of the affected motors strongly suggests that affected consumers would be made better off with the introduction of MEPS.

As with domestic refrigeration appliances, we have considered the possibility that the market could, in the absence of the introduction of MEPS, revert to non-compliant product. We do not think this is likely. However, even if it did occur, the high running costs (compared to the capital cost) of motors means that it is highly unlikely that product could be brought to the New Zealand market at a discount to current prices sufficient to outweigh the higher running costs.

In conclusion, we think it is highly unlikely that MEPS will have any adverse impact on the end user.

Packaged Air Conditioners

In many respects, the market for air conditioners is similar to that for motors, and to an extent, domestic refrigeration appliances. In particular, the market in New Zealand is strongly interconnected with the Australian market.

In addition, as with motors, there is a degree of doubt surrounding the published energy efficiency data. In particular, it is unclear how the published efficiency data might compare with testing done to the draft Australian/New Zealand Standard. (On this note, manufacturers have indicated to us that they are reluctant to invest in the required testing while the Standard is still in draft form and thus subject to change.)

Notwithstanding these reservations about the quality of the data, the information available suggests that all existing product would comply with the draft Standard. Furthermore, the fact that ninety percent of manufacturing units come from either New Zealand or Australian manufacturing plants combined with the considerable trans-Tasman trade in product means that the pending introduction of MEPS for packaged air conditioners in Australia suggests that the product will continue to be MEPS compliant in New Zealand in the future.

While we do not consider it likely that the New Zealand market will revert to non-compliant product, we have considered what this would mean for the end user should it occur. The results of the analysis are similar to that for motors. That is, even if it inefficient product was re-directed to the New Zealand market, the high running costs (compared to the capital cost) means that it is highly unlikely that product could be brought to the New Zealand market at a discount to current prices sufficient to outweigh the higher running costs.

Thus, in conclusion, we feel that it is most unlikely that the introduction of MEPS for air conditioners at the proposed levels will have an adverse impact on the end-user.

The standard formula for calculating the post-tax weighted average cost of capital (WACC) for a firm is:

$$\text{WACC} = \frac{D}{D+E} \cdot K_D(1-t) + \frac{E}{D+E} \cdot K_E$$

where D is the firm's debt, E is the firm's equity, K_D is the firm's average cost of debt, t is the marginal corporate tax rate, and K_E is the firm's cost of equity. Additional adjustments are sometimes made to reflect the ability of the firm's owners to utilise dividend imputation credits, but such adjustments are not significant in the context of this study.

The cost of equity is given by:

$$K_E = R_F + \beta_E \cdot PTMRP$$

where R_F is the risk-free rate of return, β_E is the risk of the firm relative to the risk of the market, and $PTMRP$ is the "post-tax market risk premium" – the additional after-tax return that investors require for bearing a risk the same as that of the market. We assume that the average firm has the average market risk, so that $\beta_E = 1$. This may tend to understate the cost of capital faced by smaller firms, which will be under-represented in the stock market and will tend to be more risky than the market average. Hence, we also conduct a sensitivity analysis on the cost of capital for small firms using a value of $\beta_E = 2$. The PTMRP is typically assumed to be 9% for the New Zealand market. We assume that R_F equals the secondary market yields on 10-year Government Stock.

Given secondary market yields on 10-year Government Stock of 6.7%, we therefore have K_E = 15.7% for $\beta_E = 1$, and K_E = 24.7% for $\beta_E = 2$.

A.1 LARGE FIRMS

We assume that large firms can access debt at a margin of 0.5% above the risk-free rate. Thus, with secondary market yields on 10-year Government Stock of 6.7%, we therefore have K_D = 7.2%. Assuming a debt:equity ratio of 60:40 then provides a post-tax WACC of 9.2%, and a debt:equity ratio of 40:60 provides a post-tax WACC of 11.3%.

A.2 SMALL AND MEDIUM SIZE FIRMS

We assume that the cost of debt finance for small and medium size firms lies between the retail banks' base lending rate and the average interest rate on credit card debt. This provides a range of 10.56% - 19.2%.

For medium size firms, we adopting K_D = 10.6%. Assuming a debt:equity ratio of 60:40 then provides a post-tax WACC of 10.5%, and a debt:equity ratio of 40:60 provides a post-tax WACC of 12.3%.

For small firms, we adopt K_D = 14.9%, the mid-point of the assumed range for the cost of debt. We also assume that small firms have twice the risk of the market average, so that

$\beta_E = 2$ and K_E = 24.7%. Assuming a debt:equity ratio of 40:60 provides a post-tax WACC of 18.8%, whereas a debt:equity ratio of 20:80 provides a post-tax WACC of 21.8%, and a debt-equity ratio of 60:40 provides a post-tax WACC of 15.9%.

APPENDIX B: INFORMATION SOURCES AND INDIVIDUALS CONTACTED

B.1 INFORMATION SOURCES

The information used in this study was obtained from the following sources.

B.1.1 Domestic Refrigeration Appliances

1. Fisher & Paykel, Technical and Sales & Marketing
2. Email NZ, Sales and Marketing
3. Email Australia, Technical
4. Australian Greenhouse Office
5. Prestige Appliances
6. LV Martin, Noel Leemings, Tharcolds, the Warehouse, Wishart Appliances
7. Statistics NZ, Customs Import Data
8. National Tariff Advisory Unit
9. EECA, Standard Engineering
10. Charles Waldegrave, Peter King, and Shane Stuart, *The Monetary Constraints and Consumer Behaviour in New Zealand Low Income Households*, 21 September 1999
11. Charles Waldegrave and Bob Stevens, *Poverty: The Litmus Test of Social and Economic Policy Failure*, presented DEVNET 18 January 2000
12. Ministry of Economic Development, *Dumping and Countervailing Duties Act Dumping Application Non-Confidential Initiation Report Refrigerators-Freezers and Refrigerators from Korea* December 2000

B.1.2 Motors

1. AS/NZS1359.5 Rotating electrical machines General requirements. Three-phase cage induction motors – High efficiency and minimum energy performance standard requirement
2. New Zealand Research and Development Committee Report # 145 June 1987
3. Motors & Drives in New Zealand. A study of potential Savings EECA September 1995
4. Draft, for public comment, Regulatory Impact Statement - MEPS for Electric Motors - Prepared for the AGO by George Wilkenfeld & Assocs. - Sept 2000
5. A Review of EECA's Energetics / Wilkenfeld report on MEPS - NZIER March 1996
6. Consultation paper: Draft standards for MEPS for Electric Motors - prepared for the AGO by SRCI Pty - April 99
7. Economic Benefits and Costs for New Zealand of Mandatory Energy Labelling and Minimum Energy Performance Standards Prepared for the Energy Efficiency and Conservation Authority by George Wilkenfeld and Associates Pty Ltd June 2000
8. Minimum Energy Performance Standards And Minimum Energy Performance Labelling Current Status And Options For Implementation Of Mandatory Regimes - Doug Clover, Doug Clover Consultancy - 30 June 2000

B.1.3 Packaged Air-Conditioning Units

1. Draft AS/NZS2970.2 Performance of household electrical appliances – Air-conditioners and heat pumps. Part 2: Energy labelling and minimum energy performance standard requirements
2. Operating Performance Handbook – Office Buildings & Shopping Centres, Property Council of New Zealand, 1998/99
3. Energy Wise Monitoring Quarterly – Energy Use Patterns and Trends in the Commercial Sector, Energy Efficiency and Conservation Authority, 1997
4. Property Update, Darroch Research, 2000
5. Draft, for public comment, Regulatory Impact Statement - MEPS for Air conditioners and Heatpumps - Prepared for the AGO by George Wilkenfeld & Assocs. - Sept 2000
6. A Review of EECA's Energetics / Wilkenfeld report on MEPS - NZIER March 1996
7. Economic Benefits and Costs for New Zealand of Mandatory Energy Labelling and Minimum Energy Performance Standards Prepared for the Energy Efficiency and Conservation Authority by George Wilkenfeld and Associates Pty Ltd June 2000
8. Minimum Energy Performance Standards And Minimum Energy Performance Labelling Current Status And Options For Implementation Of Mandatory Regimes - Doug Clover Doug Clover Consultancy - 30 June 2000.

B.2 INDIVIDUALS CONTACTED

During the course of this investigation we made contact with the following individuals. We are grateful for the assistance they provided.

ABB
Danny Young (09) 276 6016

Abode Air Conditioning Limited (Daikin Agent)
Alan Strawbridge (04) 589 9752

Appliance and Electronic Industry Association
Dennis Amiss (09) 573 1332

Aquaheat Industries Limited
Greg McCarthy (04) 232 5179

Atmosphere Engineering Services Ltd
Masoud Moinfar (04) 568 5595

Australian Greenhouse Office
Shane Holt (00 61 2) 6274 1825

Brook Hansen
Graham Larkman (09) 274 5353

Carrier Air Conditioning (NZ) Ltd
Pascal Pinguet (04) 473 5990
David Boyens (09) 274 1390

EECA
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Frank Pool (04) 470 2200
David Cogan (04) 470 2200

Email Appliances Ltd
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Energy Products
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Tina Fawcett (+44) (0) 1865 281208

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Motor Technologies Limited
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National Tariff Advisory Unit
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Statistics New Zealand
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Allan Channels (00612) 9671 5055

The Family Centre
Peter King (04) 569 7112

Topline Group 1998 Limited
Steve Wilkinson (09) 299 6957

Trane (NZ) Limited
Graeme Barker (04) 473 7117

Weg (SVEDALA)
Kevin Thomas (07) 888 5696

York (NZ) Ltd
Paul Parks (04) 566 0101

This appendix provides statistics on volumes and country of origin for the markets for domestic refrigeration appliances, motors, and packaged air-conditioning units.

C.1 DOMESTIC REFRIGERATION APPLIANCES

Table 24: Domestic Refrigeration: Estimated Market Size[26] and Imported Items[27]

Product Type	Estimated Market Size	Imports
Fridges and Fridge Freezers	**105,000**	**55,661**
Upright Freezers	**8,000**	**1,824**
Chest Freezers	**14,000**	**4,112**
Total	**127,000**	**61,597**

A survey of the second hand fridge and freezer market in “Trade and Exchange” showed an average price of $358 dollars per item. The numbers of each type of brand advertised are shown in the table below. Fisher and Paykel brands clearly dominate the second hand market with Simpson and Westinghouse (Email brands) having a small showing.

[26] Estimated market size numbers from Email.

[27] Overseas Trade Statistics supplied by Statistics New Zealand using customs categories 8418.10.00.02, 8418.10.00.05, 8418.10.00.07, 8418.10.00.11, and 8418.10.00.14 (fridge freezers), 8418.21.00.01, 8418.21.00.03, 8418.21.00.05, 8418.21.00.07, and 8418.21.00.12 (fridges) and 8418.30.00.02, 8418.30.00.05, 8418.40.00.02, and 8418.40.00.05 (freezers).

Table 25: Number of Appearances by Brand in "Trade and Exchange"

Brand	Total
Unspecified	105
F&P	97
F&P Kelvinator	53
F&P Frigidaire	24
Simpson	20
Prestcold	16
Leonard	13
Westinghouse	9
Sharp	7
Samsung	4
Shacklock	2
AEG	1
Bosch	1
Gaggenau	1
GEC	1
GM Frigidair	1
Goldstar	1
Hoover	1
McAlpine	1
Merc	1
National	1
Whiteway	1
Grand Total	361

Figure 10: Fridge Freezer Imports from 1996 - 2000 by Category[27]

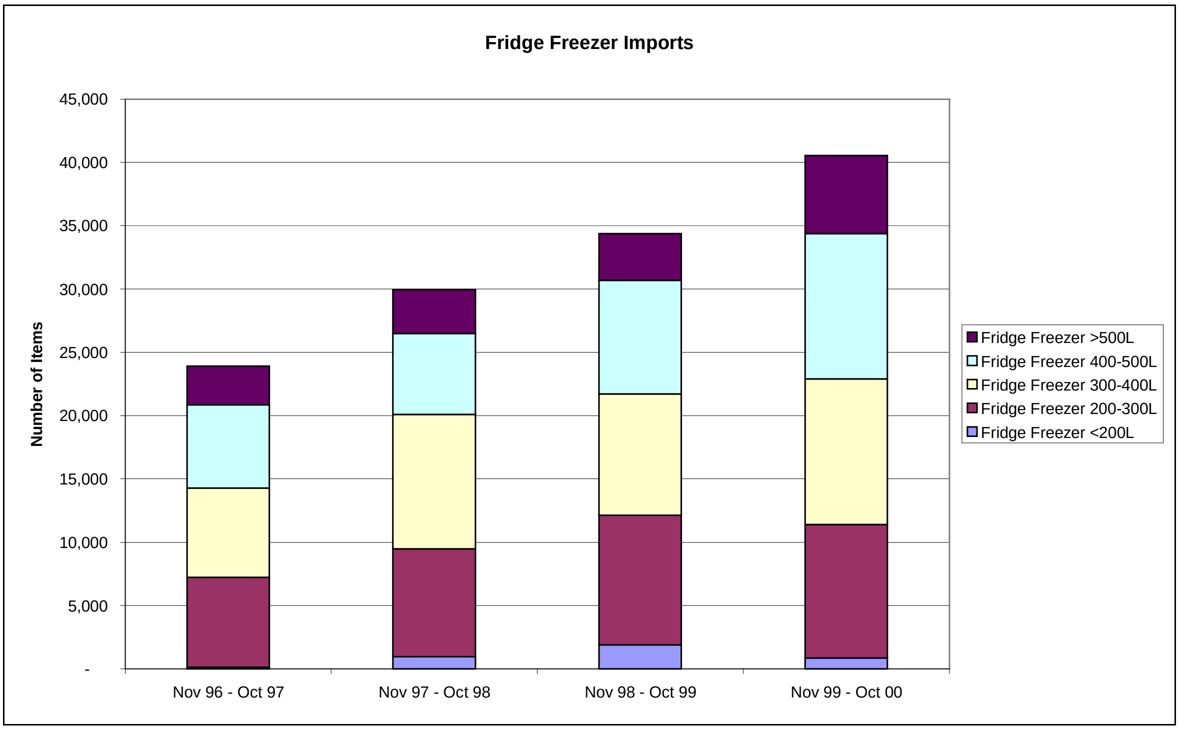


Figure 10 shows that for the combined fridge-freezer market, imports have been growing steadily for all size groups above 200L. The majority of the market is evenly distributed through the 200 – 500L range. There is a very small market for fridge-freezers below 200L.

Figure 11 below shows that the fridge only market is made up predominantly of small fridges (less than 200L). The overall market size fell slightly over the last year.

Figure 12 shows that the import market for freezers is split roughly into two-thirds chest freezers and one-third upright freezers. The larger models of both types are the more popular.

Figure 11: Fridge Imports from 1996 - 2000 by Category[27]

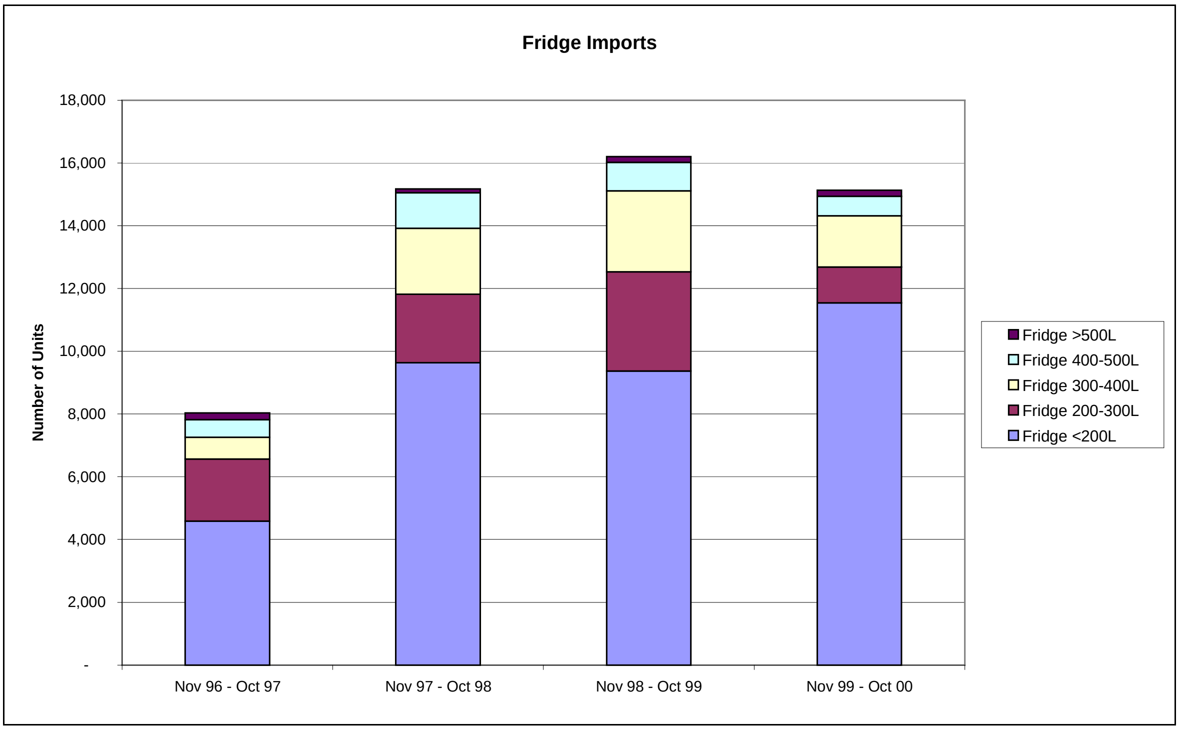


Figure 12: Freezer Imports from 1996 - 2000 by Category[27]

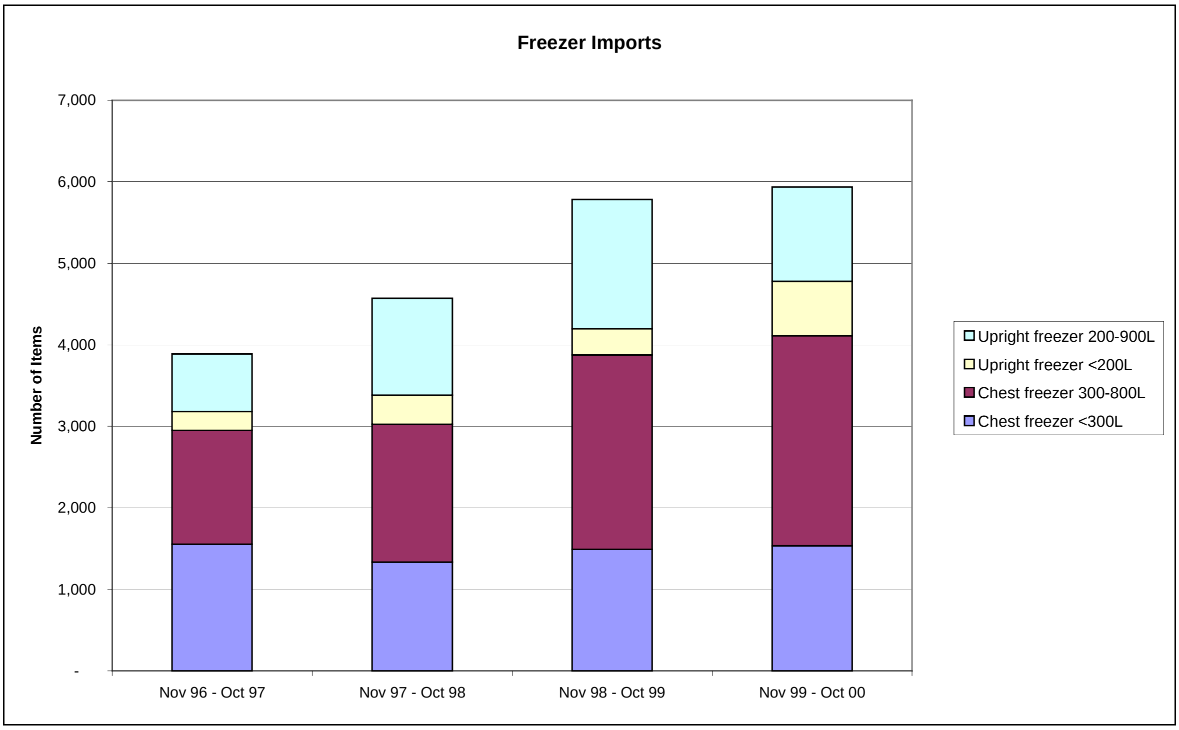


Figure 13: Percentage Breakdown by Country of Imported Fridges and Freezers[27]

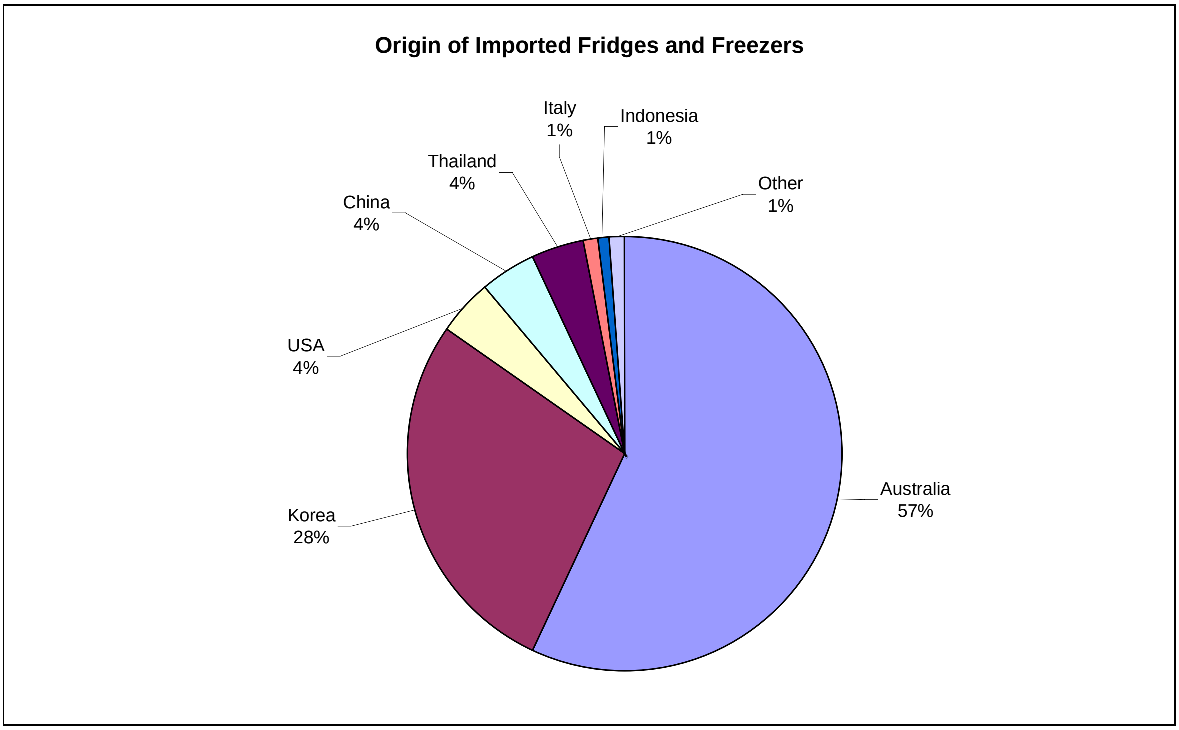


Figure 13 shows that 85% of imported fridges and freezers are from Australia and Korea, with Australia accounting for over 50% of imports. The USA, China, and Thailand account for another 12% with even market shares.

An analysis of the 1999-2000 fridge-freezer import data indicates that:

- The less than 200L range is split evenly between Australia and Korea;
- The 200-300L range is roughly three quarters Korean and one quarter Australian;
- The 300-400L range is roughly sixty percent Korean and forty percent Australian;
- The 400-500L range is predominantly Australian; and
- The over 500L range is roughly forty percent Australian, forty percent American and twenty percent Korean.

This seems to indicate that the majority of Korean imports are popular for smaller size models, Australian imports are popular for the mid-large range models and American imports are popular in the large range models (see Figure 14).

The fridge only imports are mainly from Korea, Australia and China (see Figure 15). Freezer only imports are dominated by Australian models in all categories apart from small upright freezers that are supplied almost completely from Korea and China (see Figure 16).

Figure 14: One-Year Breakdown of Fridge Freezer Imports by Category and Country[27]

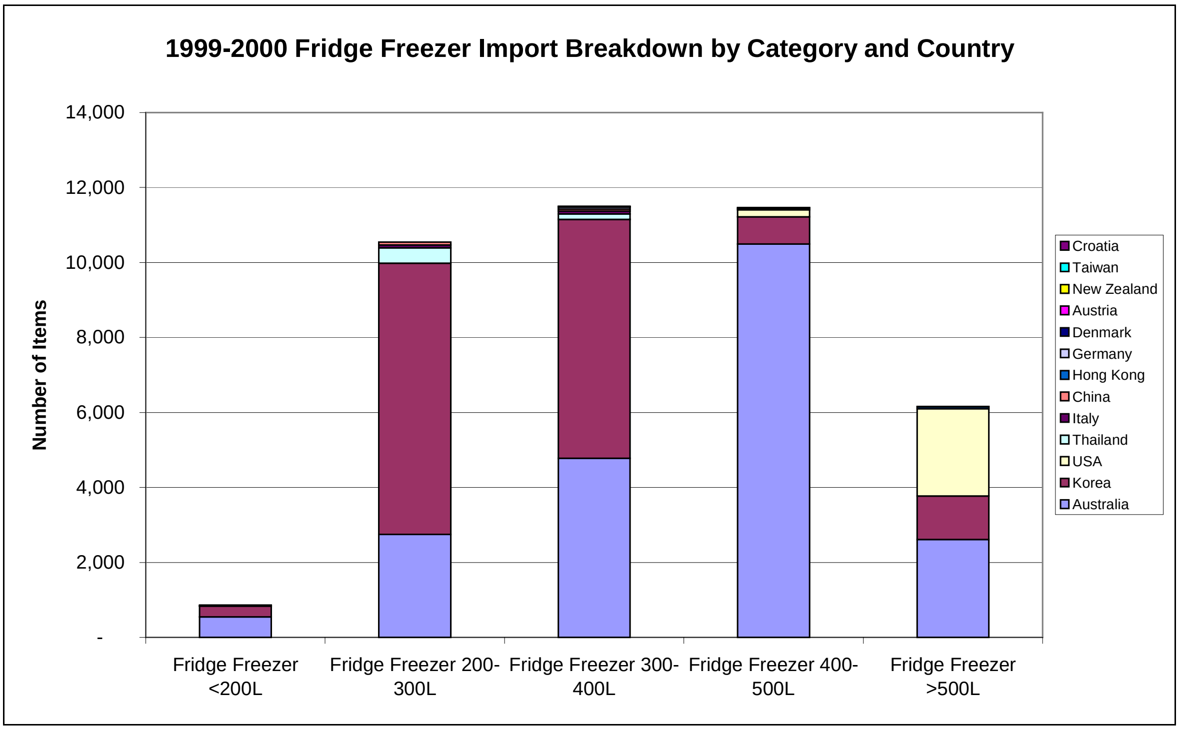


Figure 15: One-Year Breakdown of Fridge Imports by Category and Country[27]

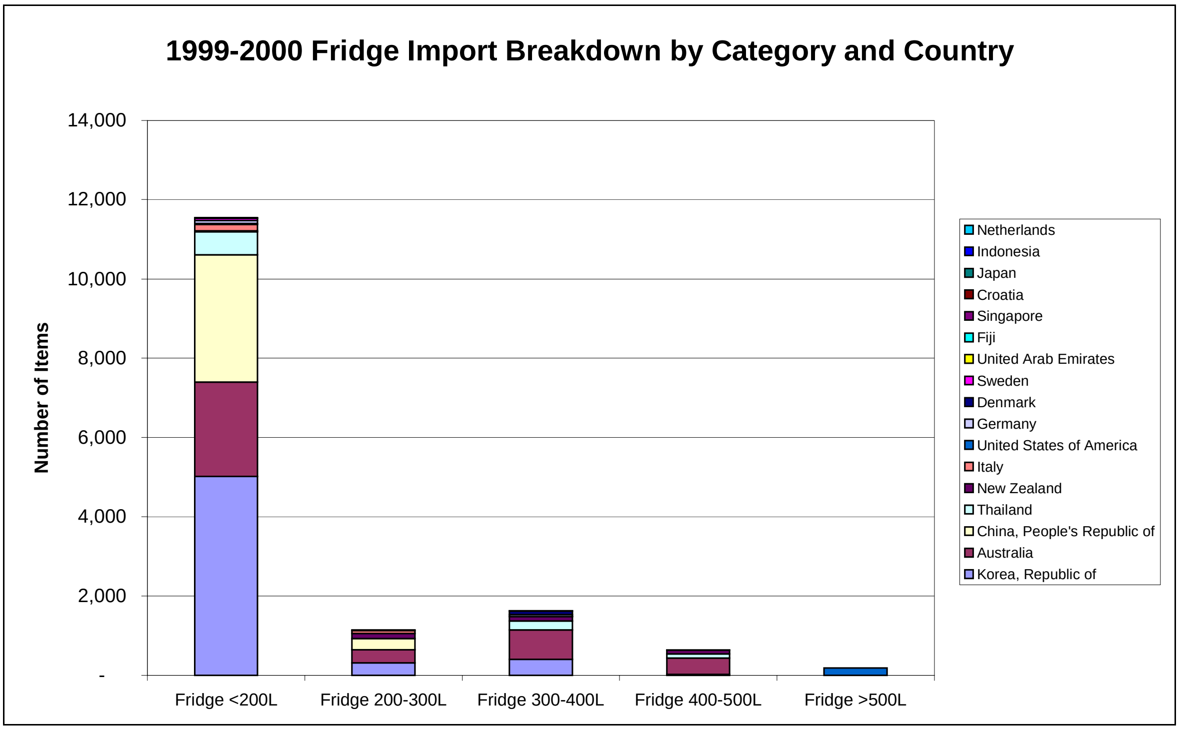
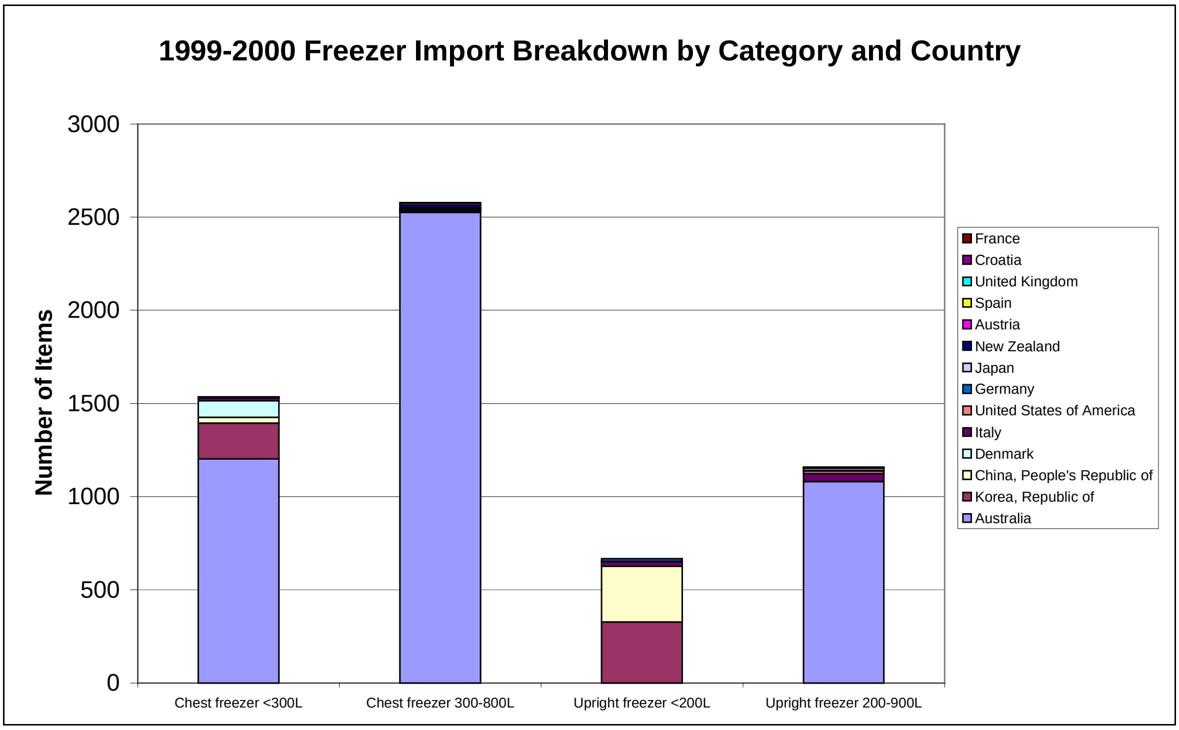


Figure 16: One-Year Breakdown of Freezer Imports by Category and Country[27]



C.2 MOTORS

The New Zealand Customs Import Statistics divide motors into 5 size categories:

- Less than 373W;
- 373W to 750W;
- 750W to 55kW;
- 55kW to 75kW; and
- Exceeding 75kW.

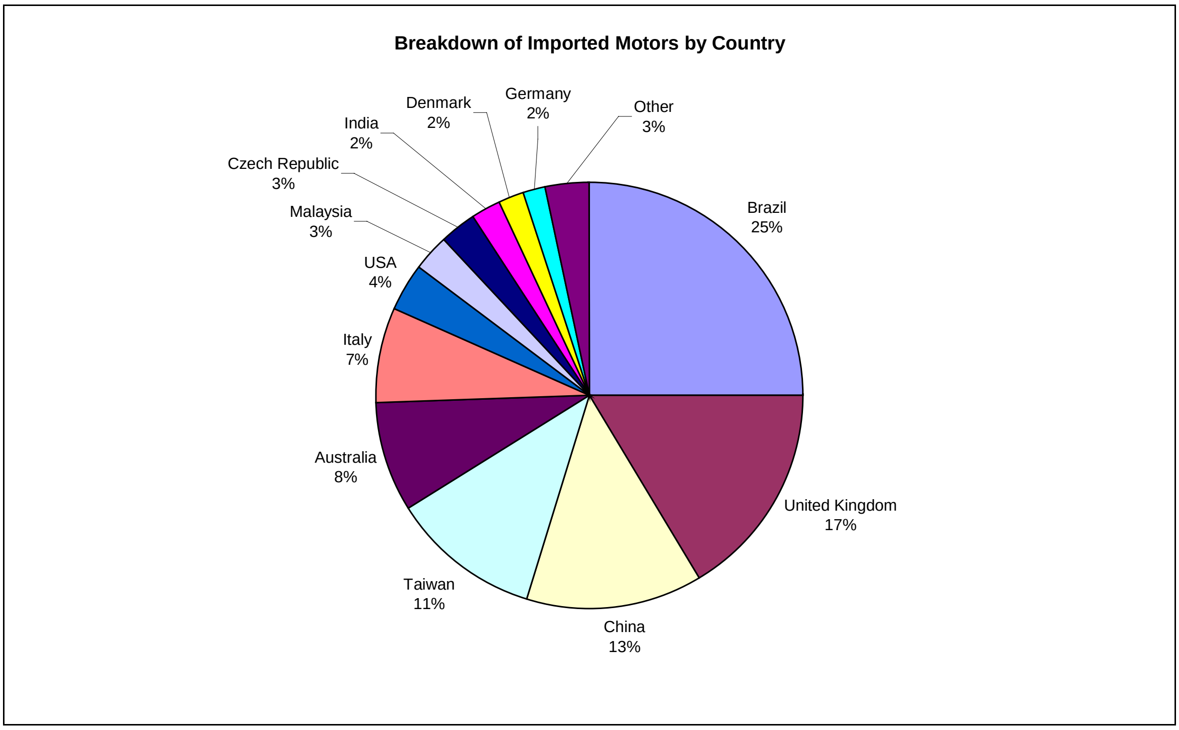
MEPS standards cover three-phase cage induction motors with ratings from 730W up to but not including 185 kW. The import statistics categories do not clearly match up with the MEPS range so only the first category can be excluded. The second category is likely to contain very few MEPS affected motors, but has been included for completeness.

Figure 17 shows the country of origin of imported motors with Brazil, the U.K., China, Taiwan and Australia being the biggest sources.

Figure 18 shows the breakdown of motors imported into New Zealand over the last five years. The majority of motors imported fall into the 750W to 55kW category. A very small percentage of motors imported are larger than 55kW. Import numbers have tended to remain at similar levels over the past few years with no clear trends apparent.

Figure 19 and Figure 20 show the imported motors by size and country of origin over five years and one year respectively. Brazil is the single biggest source of imported motors with China and the U.K. following. China, Australia and Italy have gained market share over the period, while Taiwan and the U.K. have lost some market share. The larger motors are imported from Brazil, Taiwan and the U.S.A, but in the last year large motors were imported from China and not the U.S.A. The U.K. and Brazil are the largest suppliers of the smaller motors.

Figure 17: Percentage Breakdown by Country of Imported Motors > 373W[28]



[28] Overseas Trade Statistics supplied by Statistics New Zealand using customs categories 8501.51.01.00, 8501.52.01.00, 8501.52.09.00, and 8501.53.00.00.

Figure 18: Imported Motor Breakdown by Size and Year[28]

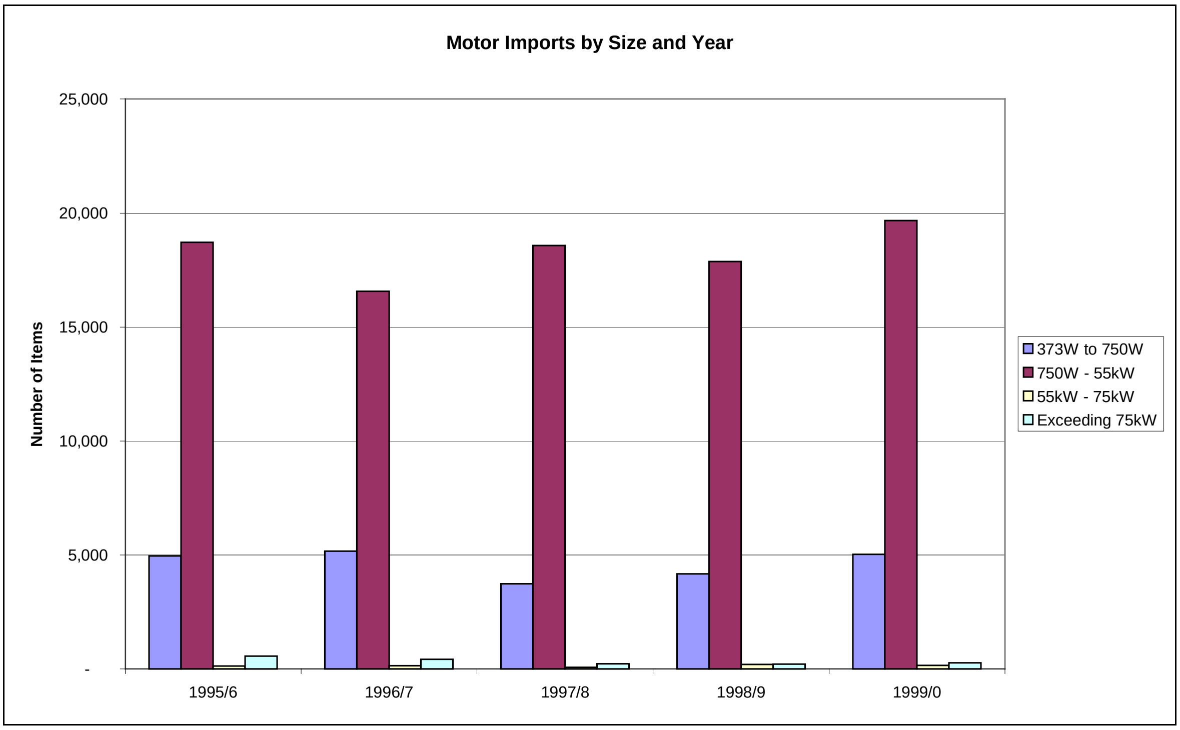


Figure 19: Five Year Imported Motor Breakdown by Size and Country[28]

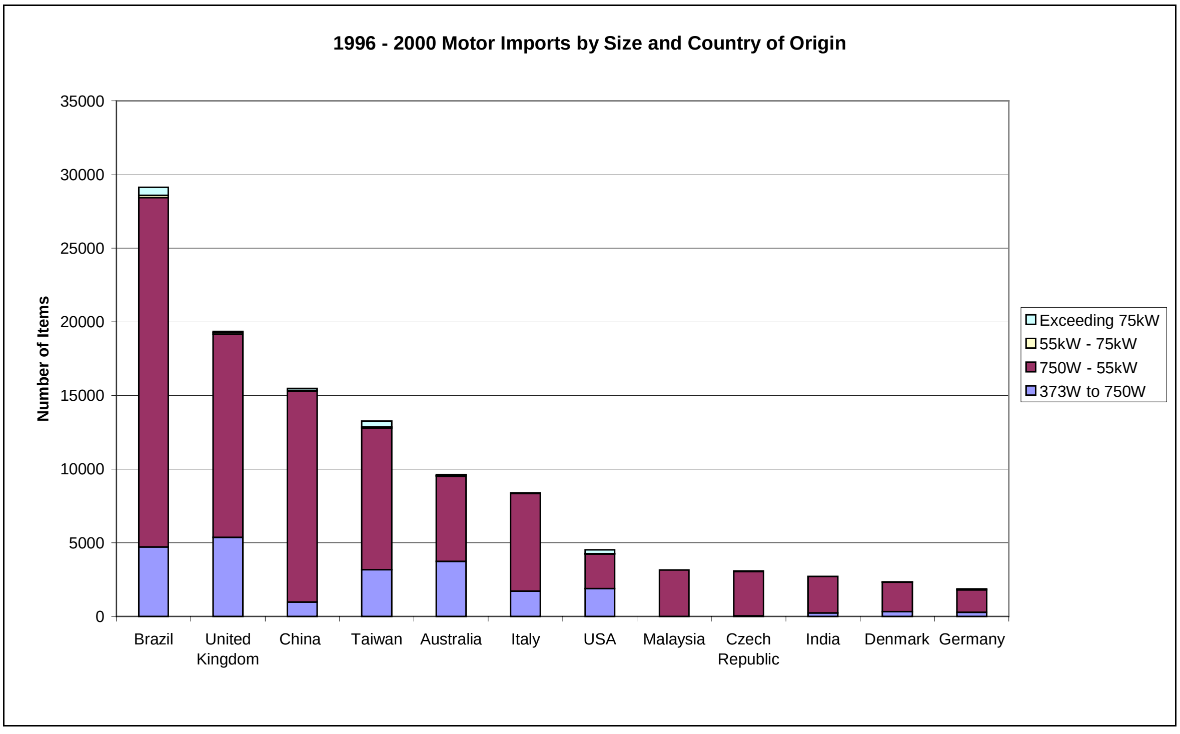
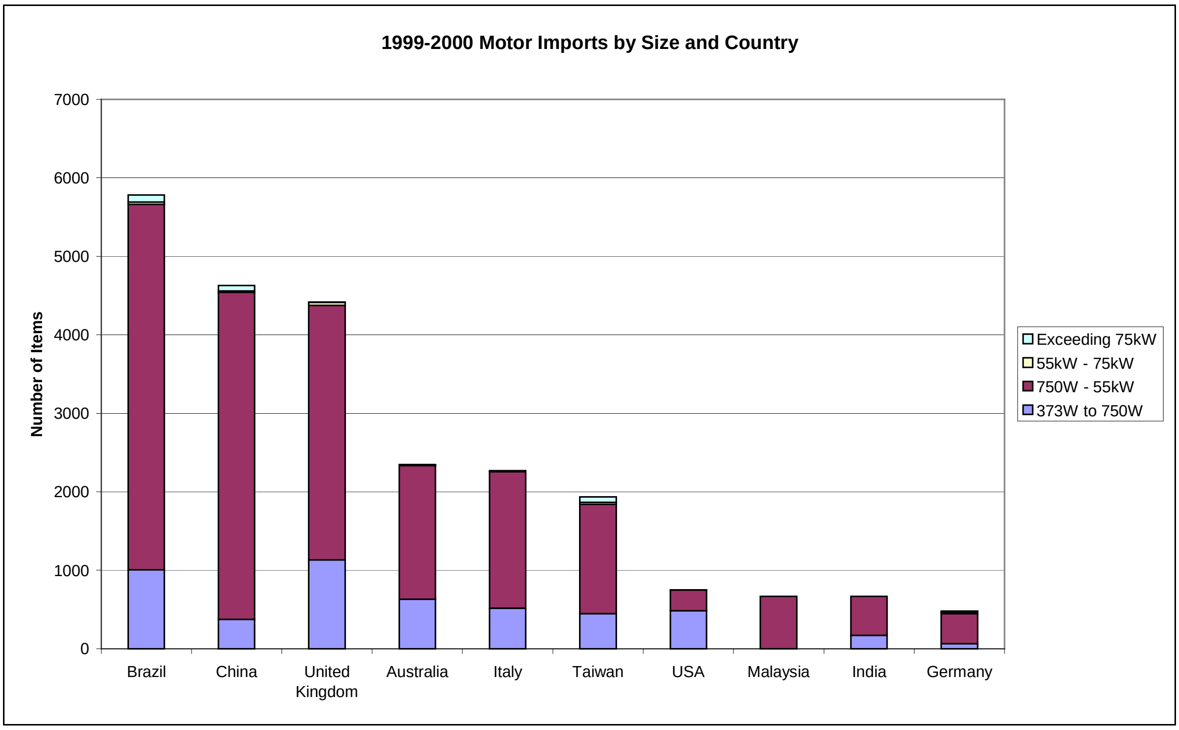


Figure 20: One Year Imported Motor Breakdown by Size and Country[28]



C.3 PACKAGED AIR-CONDITIONING UNITS

NZ Customs Information classifies air conditioners into three groups:

- Air conditioning machines; comprising a motor-driven fan and elements for changing the temperature and humidity, window or wall types, self-contained;
- Air conditioning machines; incorporating a refrigerating unit but not a valve for reversal of the cooling or heat cycle, other than window or wall type; and
- Air conditioning machines; incorporating a refrigerating unit and a valve for reversal of the cooling or heat cycle, other than window or wall type, motor driven fan.

MEPS standards apply to air conditioners which are three-phase ducted and non-ducted air conditioners of the vapour compression type intended for household, commercial and similar use, up to a rated cooling capacity of 65 kW. It covers only those units with a single refrigeration circuit with one evaporator and one condenser. It does not cover multi-split systems or evaporative coolers.

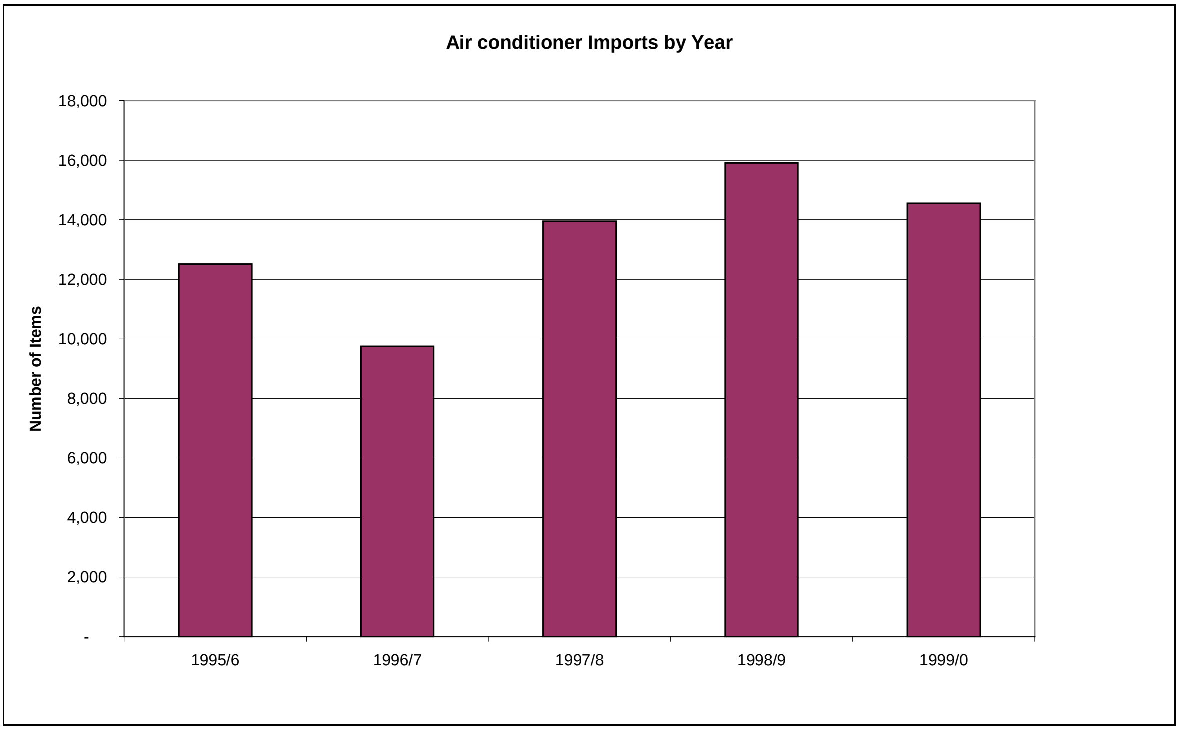
Since the two classification systems are so different it is difficult to extract detailed data from the customs information. The self contained window or wall types can be omitted on the assumption that most of these air conditioners are small and because of this are most likely to be single phase rather than 3 phase machines. All machines which do not include a valve for the reversal of the cooling and heating cycle can be eliminated on the basis that these machines are most likely to be water based systems including evaporative coolers or cooling towers.

This leaves only the air conditioning machines incorporating a refrigerating unit and a valve for reversal of the cooling or heat cycle, other than window or wall type, with a motor driven fan. However this is not exact as the size of machines is indeterminate. These air conditioning units are supplied with capacities up to 150 kW. The customs data does not allow us to consider only 3 phase machines with a capacity up to 65 kW. We have also found that above about 45 kW most manufacturer's units have more than one refrigerant circuit, and therefore not covered by the proposed Standard.

Nevertheless, we present the available Overseas Trade Statistics from Statistics New Zealand for air conditioners in the customs class 8415.81.00.10. These figures give an indication of the likely imported air conditioners that make up roughly thirty percent of the market in New Zealand.

Figure 21 shows air conditioner imports by year, Figure 22 shows the imports by country of origin and Figure 23 shows imports by both year and origin. Thailand, Malaysia and Japan are the largest sources of imported air conditioners along with China and Korea. Imports from China and Thailand have grown steadily over the past few years, while those from Korea and Malaysia have decreased.

Figure 21: Air Conditioner Imports by Year



C. Import Data

Figure 22: Air Conditioner Imports by Country

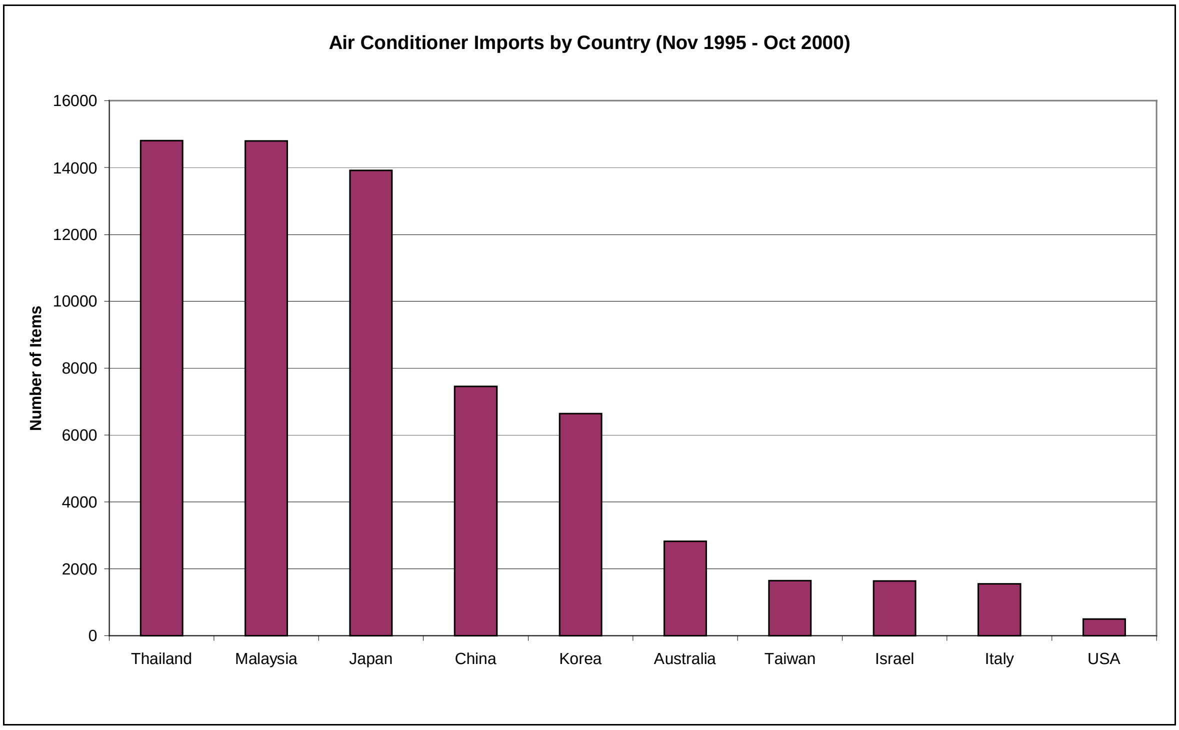


Figure 23: Air Conditioner Imports by Country and Year