DRAFT FOR PUBLIC COMMENT

REGULATORY IMPACT STATEMENT:

Minimum Energy Performance Standards and Alternative Strategies for ELECTRIC MOTORS

Prepared for the Australian Greenhouse Office

by

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September 2000

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Executive Summary

Three-phase cage induction electric motors are used in every aspect of manufacturing, in primary production and throughout the commercial sector. It is estimated that they account for nearly 30% of all electricity use in Australia, and this share is projected to increase. As electricity is the most greenhouse-intensive energy form, this contributes significantly to growth in greenhouse gas emissions.

In most applications, electricity cost represents the great majority of the lifetime cost of the motor. It would be expected that decision makers would give at least equal weight to energy consumption as to capital cost in the purchase of motors. However, this does not appear to be the case.

The market for electric motors is subject to information failure – where purchases do not have accurate and consistent information about product energy efficiency, efficiency classifications or the full lifetime costs (purchase costs and operating costs) of each product. This information failure could be corrected by mandatory labelling. However, electric motor are often sold integral with other equipment (e.g. crushers, conveyors, refrigeration equipment, etc.), and in may cases the choice as to which motor to purchase is made by the Original Equipment Manufacturer (OEM), importer or wholesaler rather than by the final purchaser/operator. Equipment suppliers have little incentive to select more efficient motors: a survey of OEMs by Energetics (1997) found that purchase price, and the reliability and availability were the most important criteria for selecting electric motors.

Mandatory labelling of electric motors would not correct this market failure. Mandating minimum energy performance standards (MEPS) for electric motors would address both information and market failures, and have been proposed as an option to meet the objective of increasing energy efficiency, and hence reducing greenhouse gas emissions.'

The National Greenhouse Strategy states that "improvements in the energy efficiency of domestic appliances and commercial and industrial equipment will be promoted by extending and enhancing the effectiveness of existing energy labelling and minimum energy performance standards [MEPS] programs." (NGS 1998).

The prospect of MEPS for motors was first raised within government in 1994, and first formally discussed between government and the industry in March 1995.

The Proposal

The proposal is to introduce mandatory minimum energy performance standards for all electric motors falling within the scope of AS/NZS Australian and New Zealand Standard AS/NZS 1359.5 *Rotating electrical machines – General requirements Part 5: Three-phase cage induction motors – High efficiency and minimum energy performance standards requirements.*

The draft Standard containing the MEPS levels was published in April 2000. Public comment concentrated on technical issues with few representations about the MEPS levels. The final Standard, incorporating the same MEPS levels, will be published shortly though possibly after the government decision is taken on the proposal.

The proposal would be given effect if all States and Territories agreed to amend the schedule of products in the existing regulations which govern energy labelling and MEPS for household products in their jurisdictions.

Regulatory Impact Statement

The Council of Australian Governments (COAG) requires that proposals of this type be subject to a Regulatory Impact Statement (RIS).[1] The present RIS estimates the benefits, costs and other impacts of the proposal, assesses the likelihood of the proposal meeting its objective, and considers a range of alternatives to the proposal.

The primary objective of the proposed regulation is to bring about reductions in Australia's greenhouse gas emissions from the use of electric motors below what they are otherwise projected to be (ie the "business as usual" case).

The following alternative options are considered in the RIS:

1. Status quo (termed business as usual, or BAU);

2. The proposed regulation (mandatory MEPS) which adopts all the requirements contained in the Australia and New Zealand Standard;

3. An alternative regulation which only adopts those parts of the Standard that are essential to satisfy regulatory energy objectives (targeted regulatory MEPS);

4. Voluntary MEPS, where industry is not compelled to adhere to the proposed levels;

5. Another regulatory option involving a levy imposed upon inefficient equipment to fund programs to redress the greenhouse impact of equipment energy use;

6. A levy on electricity reflecting the impact it has on greenhouse gas emissions.

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[1] The COAG Guidelines state that:
"The purpose of preparing a regulation impact statement (RIS) is to draw conclusions on whether regulation is necessary, and if so, on what the most efficient regulatory approach might be. Completion of a RIS should ensure that new or amended regulatory proposals are subject to proper analysis and scrutiny as to their necessity, efficiency and net impact on community welfare. Governments should then be able to make well-based decisions. The process emphasises the importance of identifying the effects on groups who will be affected by changes in the regulatory environment, and consideration of alternatives to the proposed regulation.
Impact assessment is a two step process: first, identifying the need for regulation; and second, quantifying the potential benefits and costs of different methods of regulation. In demonstrating the need for the regulation, the RIS should show that an economic or social problem exists, define an objective for regulatory intervention, and show that alternative mechanisms for achieving the stated objective are not practicable or more efficient" (COAG 1997).

In addition to assessing whether the alternatives would meet the primary objective of the proposed regulation, they were also reviewed according to the following secondary objectives:

1. Does the option address market failures, so that the average lifetime costs of electric motors are reduced, when both capital and energy costs are taken into account?

2. Does the option address information failures, so buyers have ready access to product descriptions that are consistent and accurate with regard to energy efficiency?

3. Does the option minimise negative impacts on product quality and function?

4. Does the option minimise negative impacts on manufacturers and suppliers?

Benefits and Costs

The RIS estimates the costs and benefits of implementing the proposed MEPS levels using a detailed computer model of the market, and using data on product energy efficiency, sales and prices provided by the industry.

The projected costs and benefits are summarised in Table S1. The net present value at a 10% discount rate of the projected savings over the period 2000-15 is $M 165, compared with projected costs of $ 92 M, giving a benefit/cost ratio of 1.8. The projected impact on motor purchase costs is an increase of 8%, whereas the impact on energy purchase costs is a reduction of 0.7%. Administration ("program") costs are little more than 1% of total costs, and make little difference to the outcome of the cost-benefit analysis, although they have been included for completeness.

A national benefit/cost ratio of 1.8 is favourable for a program of this type, and the ratio for all jurisdictions is favourable. These estimates pertain to the mandatory MEPS option alone. The introduction of common criteria for "high efficiency" motors that would accompany the introduction of MEPS would assist buyers to identify and select even more efficient motors, and would add considerably to the effectiveness of voluntary programs such as the Australian Motor Systems Challenge. These potential additional benefits of addressing information failure have not been modelled.

Energy savings are projected to build up rapidly. The greenhouse reductions associated with the electricity savings are projected to reach about 0.33 Mt CO_2-e per annum in 2010, the midpoint of the Kyoto Protocol commitment period, and then peak at about 0.45 Mt per annum (Table S2, Figure S1).

Table S1 Estimated costs and benefits of MEPS for electric motors

	National Total	NSW & ACT(a)	VIC	QLD	SA	WA	TAS	NT
NPV, BAU costs	$M 1,149	$M 416.2	$M 260.2	$M 239.4	$M 67.3	$M 79.0	$M 75.6	$M 11.3
NPV, with-MEPS costs	$M 1,241	$M 449.4	$M 280.9	$M 258.4	$M 72.6	$M 85.3	$M 81.7	$M 12.2

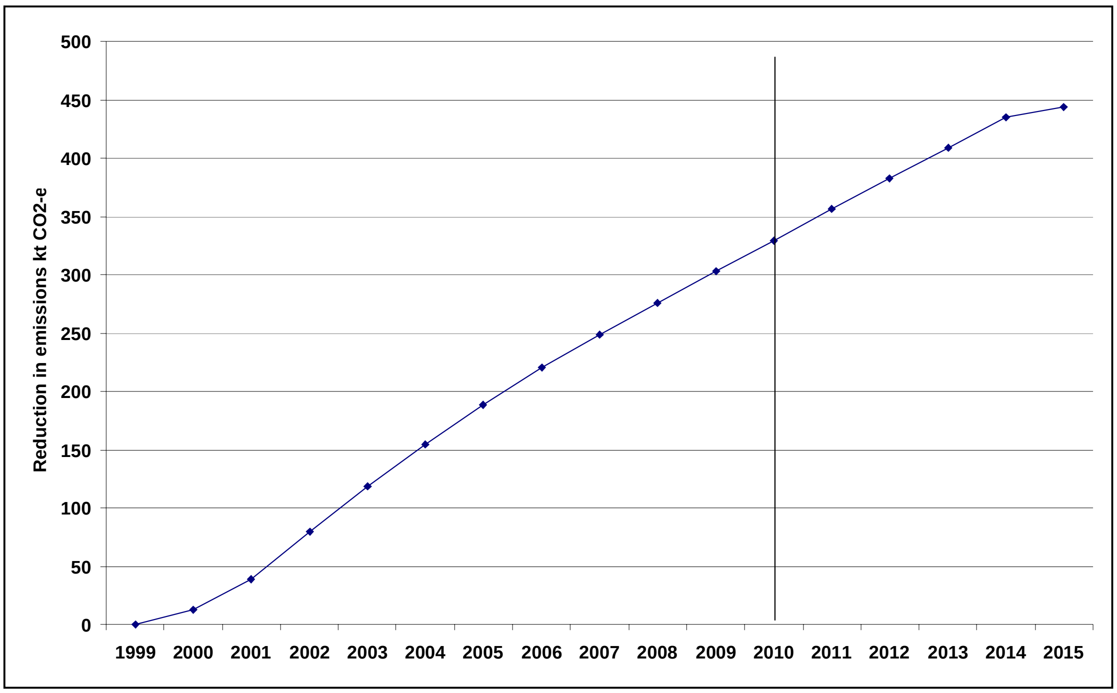
Difference (Cost)	$M 92	$M 33.2	$M 20.7	$M 19.1	$M 5.4	$M 6.3	$M 6.0	$M 0.9
NPV, BAU energy costs	$M 24,138	$M 8,046	$M 5,448	$M 5,463	$M 1,535	$M 2,270	$M 934	$M 441
NPV, with-MEPS energy	$M 23,973	$M 7,991	$M 5,411	$M 5,425	$M 1,525	$M 2,255	$M 928	$M 438
Difference (Benefit)	$M $165	$M 55.0	$M 37.2	$M 37.3	$M 10.5	$M 15.5	$M 6.4	$M 3.0
Benefit/cost ratio	**1.8**	**1.7**	**1.8**	**2.0**	**2.0**	**2.5**	**1.1**	**3.3**

NPV is Net Present Value at 10% discount rate (a) ACT data not separable from NSW data.

Table S2 Projected energy and emission savings, 2000-15

Period modelled	Implement-ation date	GWh energy saved over period	% BAU energy saved	Mt CO_2-e saved during period	Emission saving 2010 Mt CO_2-e
2000 – 2015	1 July 2001	4,099	5.9%	4.0	0.33

Figure S1 Projected greenhouse gas reductions, 2000-15



The projections were based on a 1 July 2001 implementation date. Some stakeholders argue that a short delay may facilitate industry's capacity to manage the implementation of MEPS. If implementation were deferred to say December 2001, the accumulation of benefits would also be deferred by half a year. Total energy and greenhouse savings over the period 2000-2015 would be reduced by about 5%, and the emissions savings in 2010 would be about 14 kt (4%) lower.

Supplier and Trade Issues

About 10% of the units sold on the Australian market are locally assembled; the rest are fully imported. Firms have a range of response options in the event that their products fail the MEPS level. An importer can request the supplier to improve the design, to substitute a more efficient model from the supplier's range, or - if the importer is not tied to a particular brand – it could change suppliers. Electric motors are manufactured in nearly all developed countries and many of the developing countries in the Asia Pacific region, and are freely traded. It is not difficult to source product of different price and efficiency levels, given reasonable notice.

The MEPS option would have some impact on the competition between suppliers, since the suppliers with more models falling below the MEPS levels would need to make more efforts to alter their patterns of imports (or manufactures) than suppliers with few or no models falling below the MEPS levels.

The available market data suggest that:

- the compliance costs for suppliers are likely to be low: not more than about 1% of the total value of additional investment in energy efficiency that buyers would be forced to make;

- the impact of the proposed regulations on suppliers is likely to be moderate overall, relatively widely spread (in that most firms will have some models affected), but difficult to predict for specific firms, since the model range changes;

- the tendency to rewind motors in preference to purchasing new ones may increase slightly, and this may offset to some degree the projected energy benefits of the mandatory MEPS options;

- the above effects are likely to be very small and have little effect on price and supplier competition, or the competition between imports and local manufactures.

The RIS concludes that the proposed regulations are fully consistent with the GATT *Technical Barriers to Trade* Agreement.

Assessment

Objective: Reduce greenhouse emissions below business as usual

The mandatory MEPS option is the only one for which the extent of likely reduction can be quantified, and the one where reductions have the highest probability of occurring.

Address market failures

The mandatory MEPS option would address the market's lack of concern with operating costs by enforcing investment in more efficient products so that the total life cycle cost of motors to users would be lower than otherwise, irrespective of whether they changed their purchase behaviour.

An efficiency-related levy on appliances could address the market failure by making the more efficient products cheaper than the less efficient, and so encourage their purchase by all buyers, including those concerned exclusively with capital cost. If such an option could be implemented – and there is no obvious legal or taxation mechanism - the cost to suppliers would be no lower, and the administrative costs higher than under the proposed regulations.

An emissions-related levy on electricity prices would be less effective than the efficiency-related levy on appliances, since it addresses running costs rather than capital costs. It would have economy-wide implications that are beyond the scope of the present analysis. Given that any decision to implement such a levy would need to be taken at the highest levels of Government, it is not considered a direct alternative to the proposed regulation.

Address information failures

The mandatory MEPS option would address two modes of information failure:

- It would introduce consistency in the designation of models as "High Efficiency"
- It would put reliable data on the energy efficiency of every motor in the public domain for the first time.

Buyers may access this data in the future via the State government regulatory registers of products and via the Australian Motor Systems Challenge (a federal government program operated by the AGO and the Department of Industries, Science and Resources), which would have comprehensive market data on available electric motors. Some of the other options could also achieve this objective, though not necessarily as completely, effectively or as cost-effectively.

Minimise negative impact on product quality

None of the options are expected to have any significant effect on product quality or function (ie apart from energy-efficiency).

Minimise negative impacts on suppliers

The mandatory MEPS option would clearly require suppliers to withdraw, replace or improve non-complying products. The other options would have lower costs for suppliers but they would be less effective in meeting the objectives of savings energy costs and reducing environmental impacts. At the extreme, the voluntary MEPS option would have least impact on suppliers because it is unlikely that many (if any) would undertake this extra cost on a voluntary basis.

Conclusions [Draft]

After consideration of the mandatory MEPS option and the provisions of the Standard in this RIS, it is concluded that:

1. The mandatory MEPS option is likely to be effective in meeting its stated objectives

2. None of the alternatives examined appear as effective in meeting all objectives, some would be completely ineffective with regard to some objectives, and some appear to be far more difficult or costly to implement.

3. The projected monetary benefits of the mandatory MEPS option appear to exceed the projected costs by a ratio of about 1.8 to 1, without assigning monetary value to the reductions in CO_2 emissions that are likely to occur.

4. Given that the proposed MEPS levels have been in the public domain since June 1997, and issued in a draft standard in April 2000, the program could be implemented as early as 1 July 2001. Implementation in December 2001 would reduce the projected energy and CO_2 savings in the period to 2015 by about 5%.

Recommendations [Draft]

It is recommended that:

1. States and Territories implement the proposed mandatory minimum energy performance standards by mandating AS/NZS 1359 under existing regulations governing appliance energy labelling and MEPS in each State and Territory.

2. The mode of implementation be through amendment of the existing regulations governing appliance energy labelling and MEPS in each State and Territory.

3. The amendments should:
   – add electric motors to the schedule of products for which minimum energy performance standards are required, and refer to the MEPS levels in Section 2 of the proposed AS/NZS 1359.5;
   – add electric motors to the schedule of products requiring energy labelling, so that any supplied motor for which the claim of "high efficiency" or "energy efficient" are made must meet the energy efficiency criteria Section 3 of the proposed AS/NZS 1359 Section 3 (but without requiring physical energy labelling of the products themselves);
   – require registration of models, so invoking Part 4.1 of the proposed Standard.
   – require compliance with the scope and general provisions of Section 1 of the proposed AS/NZS 1359.

4. Governments make the register of electric motor model characteristics publicly accessible, so prospective purchasers can compare their energy efficiencies.

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Contents

Glossary

AEEMA	Australian Electrical and Electronics Manufacturers Association
AGO	Australian Greenhouse Office
AMSC	Australian Motor Systems Challenge
ANZMEC	Australian and New Zealand Minerals and Energy Council
APEC	Asia-Pacific Economic Cooperation
AS/NZS	Australian Standard/New Zealand Standard
BAU	Business as usual
COAG	Council of Australian Governments
DISR	Department of Industry, Science and Resources
EASA	Electrical Apparatus Servicing Association
GATT	General Agreement on Tariffs and Trade
HE	High Efficiency
HEM	High Efficiency Motor
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronic Engineers (USA)
IPCC	Intergovernmental Panel on Climate Change
MEPS	Minimum energy performance standards
NAEEEC	National Appliance and Equipment Energy Efficiency Committee
NGGI	National Greenhouse Gas Inventory
NGS	National Greenhouse Strategy
ODPD	Open drip proof design
OE	Original equipment (incorporating an electric motor)
OEM	Original equipment manufacturer
RIS	Regulatory Impact Statement
TEFC	Totally enclosed motors design
TTMRA	Trans-Tasman Mutual Recognition Agreement
UNFCCC	United Nations Framework Convention on Climate Change

1. The Problem

COAG Guidelines:

- ***Statement of the problem:*** *why is government action being considered in the first place? What is the problem being addressed? For example, this should state the market failure that the proposal seeks to remedy.*

1.1 Energy-Related Greenhouse Gas Emissions

In recognition of the risks and costs of climate change, the Australian government is cooperating with other countries on a global strategy to reduce greenhouse gas emissions below what they would otherwise be. The Commonwealth, State and Territory governments have adopted a National Greenhouse Strategy to give effect to this objective (NGS 1998).

The United Nations Framework Convention on Climate Change (UNFCCC) was agreed in 1992 and came into force in 1994. It places most of the responsibility for taking action to limit greenhouse gas emissions on the developed countries, including Australia, which are referred to collectively as Annex I countries. Annex I countries are required to report each year on the total quantity of their greenhouse gas emissions and on the actions they are taking to limit emissions.

The Kyoto Protocol to the UNFCCC was agreed in December 1997, but has yet to be ratified by its signatories, which include Australia. When ratified, it will place a legally binding obligation on Annex I countries to limit their average annual greenhouse gas emissions during the "first commitment period" 2008 – 2012 to agreed targets, expressed as a proportion of their 1990 emissions. Australia's target would be 108% of its 1990 emissions. While this is higher than the average for Annex 1 countries, it is nevertheless challenging, representing a reduction of more than 20% compared with business-as-usual projections (NGS 1998).

Table 1 summarises Australia's greenhouse gas emissions in 1990 and 1998, the latest year for which a national greenhouse gas inventory (NGGI) has been prepared. Net emissions increased by 16.9% over the period, and the energy sector accounted for nearly all of this increase.[2] The growth in electricity generation emissions represented nearly 60% of the total net increase in Australia's emissions. The next highest contributor to emissions growth was road transport (15% of the total net increase).

ABARE (1999) projects total electricity use to increase by a further 24% between 1998 and 2010, the mid-point of the Kyoto protocol commitment period. Electricity use in agriculture, mining and manufacturing is projected to increase by 25%, commercial sector electricity use by 37%, and residential electricity use by 11%. Slowing, and ultimately reversing the growth in electricity-related emissions is thus a high priority in Australia's greenhouse gas reduction strategy.

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[2] By convention, emissions from land use change are reported separately. These were substantially lower in 1998 than in 1990.

Table 1 Change in Greenhouse Gas Emissions, 1990 to 1998

	1990 Mt CO_2-e	1998 Mt CO_2-e	Change 1990 to 98 Mt CO_2-e	Change 1990 to 98 %	% of Energy Sector change
1A Fuel Combustion	270.0	331.3	61.3	22.7%	96.9%
1A1 Energy Industries	142.3	187.9	45.6	32.1%	72.1%
Electricity generation	129.1	168.6	39.5	30.6%	62.4%
Other	13.2	19.3	6.2	46.7%	9.7%
1A2 Manufacturing & Construction	50.3	51.7	1.4	2.7%	2.2%
1A3 Transport	61.5	72.6	11.1	18.0%	17.5%
Road	54.9	64.8	9.9	18.1%	15.7%
Other	6.6	7.8	1.2	17.7%	1.9%
1A4 Small combustion	14.2	16.7	2.5	17.4%	3.9%
1A5 Other	1.7	2.4	0.7	43.0%	1.1%
1B Fugitive	29.5	31.5	2.0	6.7%	3.1%
Solid Fuels	15.9	18.7	2.8	17.4%	4.4%
Oil and Natural Gas	13.6	12.8	-0.8	-5.8%	-1.3%
Sector 1. All Energy (sum of 1A, 1B)	299.6	362.9	63.3	21.1%	100.0%
Sector 2. Industrial Processes	12.0	9.8	-2.2	-18.4%	
Sector 4. Agriculture	90.6	92.2	1.6	1.8%	
Sector 5 (part). Forestry and Other (a)	-27.2	-24.5	2.7	-10.1%	
Sector 6. Waste	14.9	15.5	0.6	4.2%	
Gross emissions	417.1	480.4	63.3	15.2%	
Net emissions	389.8	455.9	66.1	16.9%	

Source: NGGIC 2000a (a) Land use change excluded. Sector 3, Solvent and Other Product Use, contains only indirect greenhouse gases that fall outside the scope of the Kyoto Protocol.

1.2 Contribution of Electric Motors to Emissions

The National Greenhouse Gas Inventory does not indicate directly the contribution of economic sectors (eg the manufacturing or services sector) or technology types (eg motors) to national greenhouse gas emissions. Further analysis is required, especially the allocation of electricity use to sectors, end uses and technology types.

The electricity consumed by electric motors in 1995 was estimated by Energetics (1997). Business electricity use in 1998 was 15.7% higher than in 1995, and if motors maintained their share of consumption, total motor use in 1998 would have been about 45,900 GWh, or 29.2% of total electricity use (Table 2). Applying this ratio to the total electricity emissions in Table 1 suggests that about 49 Mt of greenhouse gas emissions were attributable to electric motors in 1997/98. This is estimated to have increased to 52 Mt in 1999/2000.[3]

Electric motors are used in every aspect of mining and manufacturing. The estimated share of energy used by particular types of industrial electric drives systems is summarised in Table 3. Large numbers of motors are also used in the commercial sector, to drive airconditioning, refrigeration and other equipment. It is estimated that

[3] By comparison, 41 Mt CO_2-e were attributable to cars and station wagons in 1997/98, and the rate of increase was much lower than for electric motors (AGO 2000a).

in 1995 there were about 1.7 million motors used across about 400,000 sites in Australia (Energetics 1997).

Table 2 Estimated electricity use by three-phase motors up to 150kW

	1994/95 (a)	**1997/98**	**2000 (est)**	**2010 (proj)(c)**
Primary & manufacturing sectors	32,300	37,400	39,700	46,900
Commercial sectors	7,300	8,500	9,000	11600
Total motor energy use	**39,600**	**45,900**	**48,700**	**58,500**
Total "business" electricity use	95,300	110,100(b)	116,800	155,000
Total electricity use	140,200	157,300(b)	166,000	195,700

All values GWh: (a) Energetics (1997a) (b) *Electricity Australia 1999* (c) Based on ABARE (1999)

Table 3 Estimated share of industrial motor energy use by application

	Share of motor drive energy
Crushing, grinding and mixing	19%
Fans	19%
Pumps	17%
Materials conveying	10%
Air compressors	8%
Refrigeration compressors	9%
Other	18%
All industrial applications	100%

Source: CENA – Assessing the energy needs if the industrial customer, Pacific Power 1993 (via AMSC website)

1.3 The Industry and the Market

Energy Efficiency and Product Selection

The motors market appears to be subject to both information failure – where users do not have access to accurate and consistent information about products or the full costs of owning and operating products – and to market failure – where the most cost-effective products and solutions are passed up because of distortions in the market.

For purchasers and users of motors, the lifetime electricity cost represents a large component – in most cases the major part – of the cost of owning and operating. The estimated average annual energy consumption for units installed in 1995 was 16,640 kWh (Energetics 1997). Assuming a 15 year operating life, and a constant electricity price of 8c/kWh (about the Australian average for non-residential consumers) the net present value of the lifetime energy consumption would be $ 10,003 (at 10% discount rate) or nearly 17 times the average motor purchase price. Energy cost would account for about 94% of the lifetime cost of the motor.[4] For motors that are rarely used, of course, the proportion is much lower.

[4] For comparison, energy cost represents about two thirds of the lifetime cost of packaged airconditioners, for which MEPS are also under consideration (GWA 2000a), and about half of the lifetime costs for household refrigerators, for which MEPS were introduced in October 1999.

Table 4 Average capital and lifetime energy costs, electric motors

Size range (kW)	Average cost per unit	Average energy cost per unit(a)	Energy/total cost
0.75 - 2.2	$ 218	$ 1,284	86%
3 - 7.5	$ 402	$ 5,269	93%
11 - 37	$ 998	$ 25,762	96%
45 - 90	$ 3,229	$ 89,497	97%
110 - 150	$ 5,836	$ 201,593	97%
	$ 593	$ 10,003	94%

Source : Energetics (1997) (a) NPV of 15 year energy costs, 8c/kWh, 10% discount rate

Motors vary in their energy efficiency. Figure 1 illustrates the maximum, minimum and average efficiencies of models offered in 1995 and 2000 by four suppliers (representing 612 models in 1995 and 518 models in 2000).[5]

Figure 1 Maximum, model average and minimum efficiencies, selected suppliers

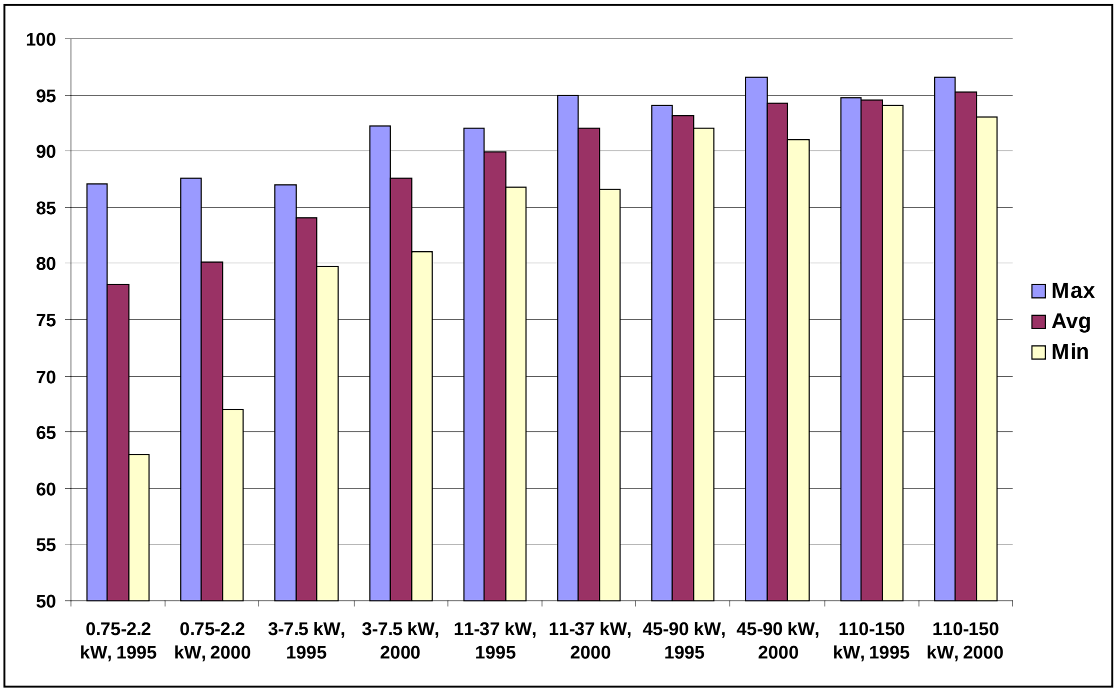


Figure 1 This shows that:

- average efficiencies are higher for larger motors than for smaller motors,
- the range of efficiencies (from lowest to highest) is much wider for smaller motors than for larger motors; and
- there was some increase in model average efficiencies between 1995 and 2000.

[5] The averages are "model" averages (the average efficiency of all models offered) not "sales-weighted" efficiencies, which are calculated from the actual (or estimated) market share of each model. There are efficiency data on 12 suppliers' models for 1995, but for only 4 suppliers in 2000: for a direct comparison, the model average values for the same 4 suppliers are shown for 1995.

The efficiency values Figure 1 are all based on Australian Standard 1359.102.1 *Rotating electrical machines – General requirements: Methods of determining losses and efficiency-General.* This is technically equivalent to International Electro-technical Commission (IEC) standard 60034-2, which is generally used in Europe.

The test method generally used in the USA is the Method of the Institute of Electrical and Electronic Engineers (IEEE) 112-B. This is technically equivalent to IEC 61972 (currently in draft) and to Australian Standard 1359.102.3 *Rotating electrical machines – General requirements: Methods of determining losses and efficiency-three-phase cage induction motors.*

Both tests are used in Australia, and both are accepted in the forthcoming AS/NZS Australian and New Zealand Standard AS/NZS 1359.5 *Rotating electrical machines – General requirements Part 5: Three-phase cage induction motors – High efficiency and minimum energy performance standards requirements.* In this Standard, the test methods based on AS 1359.102.3 and 1359.102.1 are termed, for brevity, Test Method A and Test Method B respectively.

It is important to be clear about which method has been used to determine the stated efficiency[6] Test method A will give a lower value for the same motor. The difference is about 1.7 percentage points for a small motor (ie the difference between efficiencies of 72.3% and 74.0% for a 0.75 kW motor) diminishing to about 0.5 percentage points for a large motor (ie the difference between efficiencies of 94.0% and 94.5% for a 150 kW motor). The efficiency values in Figure 1 and those used in the remainder of this RIS are based on Method B, unless otherwise stated.

The lack of consistency in the way that efficiencies have been calculated has been one barrier to customer interest in taking energy costs into account in motor choice. Some suppliers have tried to assist those customers who are interested in efficiency by designating some of their model range as “high efficiency motors” (HEMs), and selling these at a cost premium of 25-30% over the “standard” efficiency range.

However, this has further confused the issue rather than clarified it, because there has been no general agreement of the criteria for a HEM. AS/NZS 1359.5 will, for the first time, define a “high efficency” level for motors. Table 5 and Table 6 analyse the 1995 model ranges of the 12 main suppliers, and the 2000 model range of four of the same suppliers, with regard to whether models designated as “high efficiency” actually meet the HEM criteria in the forthcoming Standard. It should be emphasised that as there were no standard criteria at the time, suppliers were (and still are) free to use whatever definition of HE suited them.

[6] There is a third method as well, based on Japanese Industrial Standards, which is also used in some parts of the Asian region.

Table 5 High efficiency motors –designated and meeting AS/NZS 1359.5, 1995

	Number of models(a)	HE % of models(c)	Designated HEM(b)	Actual HE(c)	HE % of Designated	Designated Standard(d)	Actual HE(c)	HE % of Standard
A	190	22.6%	57	39	68.4%	133	4	3.0%
B	50	0.0%				50	0	0.0%
C	30	93.3%	30	28	93.3%			
D	81	0.0%				81	0	0.0%
E	198	33.8%	81	54	66.7%	117	13	11.1%
F	191	32.5%	60	45	75.0%	131	17	13.0%
G	79	64.6%				79	51	64.6%
H	84	7.1%				84	6	7.1%
I	137	11.7%	60	13	21.7%	77	3	3.9%
J	81	34.6%				81	28	34.6%
L	152	7.9%	84	12	14.3%	68	0	0.0%
M	71	0.0%				71	0	0.0%
All of above	1344	23.3%	**372**	**191**	**51.3%**	**972**	**122**	**12.6%**
4 brands(d)	612	23.0%	**225**	**111**	**49.3%**	**387**	**30**	**7.8%**
Rest	732	23.5%	**147**	**80**	**54.4%**	**585**	**92**	**15.7%**

(a) Model family may contain several models with different mounting brackets, case protection etc. but same efficiency (b) Terms such as "high efficiency" or "premium efficiency" used in model descriptor. (c) Meets "high efficiency" criteria in forthcoming AS/ NZS 1359.5 (d) All other models. (e) Brands E,F,L,M, for which data are available for both 1995 and 2000. All comparisons based on test method B.

Table 6 High efficiency motors –designated and meeting AS/NZS 1359.5, 2000

	Number of models(a)	HE % of models(c)	Designated HEM(b)	Actual HE(c)	HE % of Designated	Designated Standard(d)	Actual HE(c)	HE % of Standard
E	240	49.6%	117	104	88.9%	123	15	12.2%
F	158	44.9%	62	58	93.5%	96	13	13.5%
L	58	100.0%				58	58	100.0%
M	62	90.3%				62	56	90.3%
4 brands(e)	518	58.7%	**179**	**162**	**90.5%**	**339**	**142**	**41.9%**

(a) Model family may contain several models with different mounting brackets, case protection etc. but same efficiency (b) Terms such as "high efficiency" or "premium efficiency" used in model descriptor. (c) Meets "high efficiency" criteria in forthcoming AS/ NZS 1359.5 (d) All other models. (d) Brands E,F,L,M, for which data are available for both 1995 and 2000. All comparisons based on test method B.

Table 5 and Table 6 indicate that about 23% of models on the market in 1995 met HE criteria, and that this increased to nearly 59% in 2000 for the brands for which data are available in both years.[7] However, buyers have had very little guidance in identifying true HE motors, given the following:

- Little more than half the models designated "HE" in 1995 met the HE criteria;

[7] The data for 2000 were volunteered by the 4 suppliers concerned for the Australian Motor Systems Challenge website, which is described later. As such, it would be expected that the models of these suppliers are more efficient than the rest, have improved more in average efficiency between 1995 and 2000 than the rest over the 5 year, and are more likely to meet the HE criteria than the rest.

- About 13% of the models *not* designated HE in 1995 met the HE criteria;
- Some suppliers (brand G in 1995, Brands L and M in 2000) had no models designated HE, yet most or all of their “standard” range actually met HE criteria;
- For the brands for which there are data in both years, the share of “HE” models which met HE criteria increased from less than 50% in 1995 to more than 90% in 2000;
- For the same group of brands, the share of non-HE models which actually met HE criteria increased from less than 8% in 1995 to more than 42% in 2000.

Thus there is evidence of at least two distinct modes of information failure affecting the motors market:

1. Suppliers may quote efficiency values to different Standard tests, derived from the tests used in the motor’s country of origin (most motors are imported).

2. Where suppliers attempt to give some indication of which of their model range is more energy efficient, there is no consistency of criteria used: indeed the designation is as likely to mislead as to inform the buyer.

This information failure, which undermines buyer ability to compare different products and reduces buyer confidence in supplier statements about efficiency, could be addressed through requiring efficiency data to be disclosed using consistent criteria, as is the case with the appliance energy labelling program.

However, correction of the information failure would not by itself correct market failures. There is evidence that even buyers who were made aware of the energy efficency of alternative models chose not to make the most cost-effective choices.

Original Equipment Manufacturers (OEMs) purchase about 40% of the electric motors supplied to the Australian market, to install in the drive systems (eg crushers, conveyors, fans) that they assemble or manufacture for sale to the end users. As informed motor buyers, they should be in a good position to assess the costs and benefits. Energetics carried out a survey of OEMS, and reported:

> “Nearly all of the respondents indicated that price is the main factor in the selection criteria. Motor reliability and availability were considered to be the next most important considerations, while motor efficiency was generally regarded the least important” (Energetics 1997)

The reasons appears to be split incentives: the party bearing any additional capital costs associated with a more energy efficient motor purchase is different from the party bearing the running costs, and the nature of their market relationship means that additional capital costs are difficult to recover and efficiency options that are cost-effective over the lifetime of the installation are generally passed up.

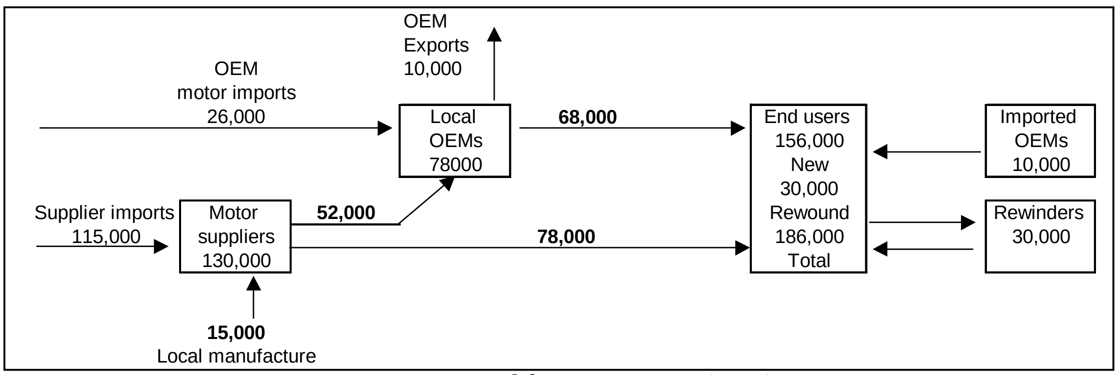
A separate survey of 12 OEMs and 43 end user firms conducted by the Bureau of Industry Economics in 1994 found similarly clearcut views among the OEMs, who ranked energy efficiency as fifth out of 5 selection criterion. End users also placed energy efficiency last, but by a lesser margin (BIE 1994).

The motors market

The product flows in the Australian motors market are illustrated in Figure 2 (the actual values are for 1995 when about 156,000 new motors entered service; the market has increased since but the data are not in the public domain). New electric motors enter the market in four ways: local manufacture (about 10% of supplies), imports by motor suppliers, imports directly by OEMs and as part of imported OEs. The OEMs absorb about half the total motor supply, and end users the rest. End users use some of these motors in new applications designed and engineered on site, and some as replacements in existing applications.

In addition to new motors, end users send about 30,000 motors a year for rewinding. Rewound motors cost between 20% and 40% less than a new motor of standard efficiency, and between one third and one half less than a new HE motor.

Figure 2 Electric motors market flows, 1995



Source: Derived from Energetics (1997)

There are 12 major motor suppliers in Australia. They supplied about 130,000 units in 1995, for a total market value of $ 81 M (Energetics 1997).

ABB Industrial Systems Pty Ltd, Melbourne
Australian Baldor Pty Ltd, Sydney
Brook Hansen Pty Ltd, Melbourne
CMG Electrical Motors Pty Ltd, Melbourne
Leroy Somer, Sydney
Pope Electric Motors (Australia) Pty Ltd, Adelaide
SEW Eurodrive Pty Ltd, Melbourne
Siemens Ltd, Melbourne
TECO Australia Pty Ltd, Sydney
Toshiba International Corporation Pty Ltd, Sydney
Western Electric Motors Pty Ltd, Perth
WEG Australia, Melbourne

The only firm still manufacturing locally is Pope, which also imports some of its motors. Most suppliers are local agencies of international brands. Between them the 12 suppliers source product from Brazil, China, Denmark, Eastern Europe, Finland, France, Germany, Malaysia, Netherlands, South Africa, Sweden, Taiwan, UK and USA.

2. Objectives

COAG Guidelines:

- ***Objective:*** *the objective which the regulation is intended to fulfil must be stated in relation to the problem. The objectives of a regulation are the outcomes, goals, standards or targets which governments seek to attain to correct the problem.*

2.1 Primary Objective

The primary objective of the proposed regulation is to bring about reductions in Australia's greenhouse gas emissions from the use of electric motors below what they are otherwise projected to be (ie the "business as usual" case).

2.2 Secondary Objectives

The following secondary objectives have been adopted:

1. Does the option address market failures, so that the average lifetime costs of motors are reduced, when both capital and energy costs are taken into account?

2. Does the option address information failures, so that buyers have ready access to product descriptions that are consistent and accurate with regard to cooling capacity and energy efficiency?

3. Does the option minimise negative impacts on product quality and function?

4. Does the option minimise negative impacts on manufacturers and suppliers?

3. Options

COAG Guidelines:

- ***Statement of the proposed regulation and alternatives:*** *this should describe the proposed regulation and distinct alternatives in sufficient detail to allow comparative assessment and evaluation in the rest of the RIS.*

The following options for achieving the objectives were considered.

1. Status quo (termed business as usual, or BAU);

2. The proposed regulation (mandatory Minimum Energy Performance Standards, or MEPS);

3. A regulation which only adopts those parts of the Australian Standards that are essential to satisfy regulatory objectives (targeted regulatory MEPS);

4. Voluntary MEPS;

5. Another regulatory option involving a levy imposed upon inefficient equipment to fund programs to redress the greenhouse impact of equipment energy use;

6. A levy on electricity reflecting the impact it has on greenhouse gas emissions abatement.

The following sections describe the options in more detail, and assess the non-MEPS options (5 and 6). The MEPS options (2,3 and 4) have been subject to detailed cost-benefit analysis, which is reported in the next chapter.

3.1 Status quo (BAU)

Improvements in energy efficiency are likely to take place even in the absence of any market intervention. A "BAU" motors energy use projection has been developed, taking into account likely improvements in average product energy efficiency. This projection forms the baseline for quantitative analyses of the impacts of the MEPS options.

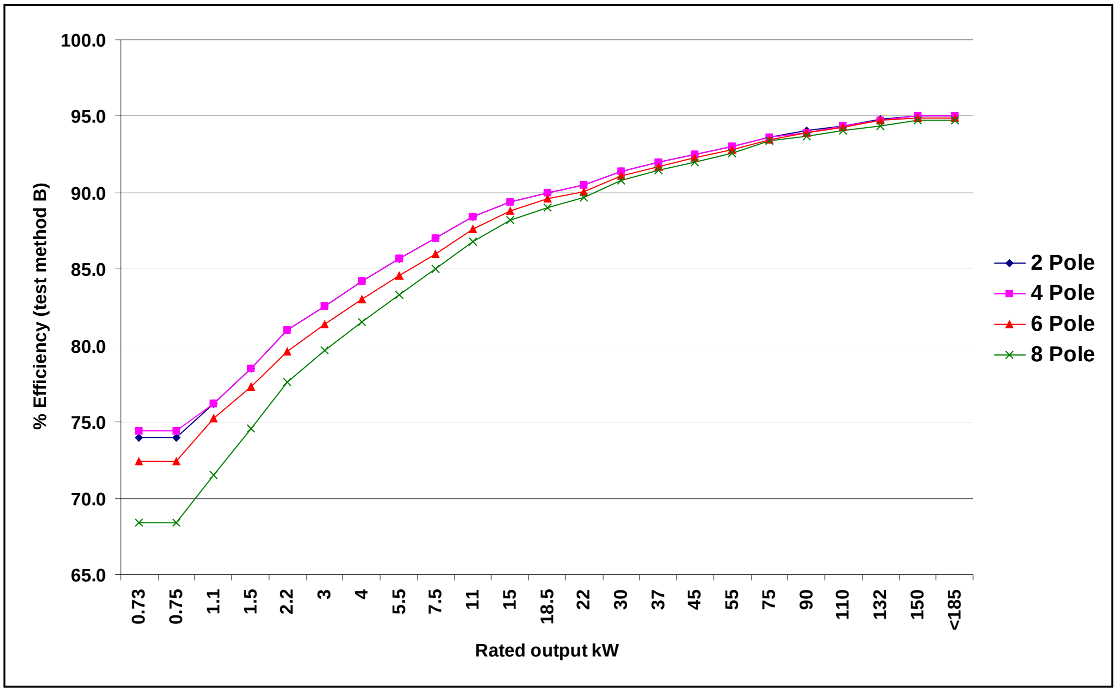
The Status Quo option would, by definition, fail to meet the objective of the regulation. There would be no reduction in Australia's greenhouse gas emissions below the BAU case, and there would be no correction of identified market failures or information failures. On the other hand, there would be no negative impact on product quality or function, or negative impacts on manufacturers, suppliers and consumers.

3.2 Mandatory MEPS

Proposal

The proposal is to introduce minimum energy performance standards (MEPS) for electric motors falling within the scope of Australian and New Zealand Standard AS/NZS 1359.5 *Rotating electrical machines – General requirements Part 5: Three-phase cage induction motors – High efficiency and minimum energy performance standards requirements.* The proposed MEPS levels are included in Appendix 2, and illustrated in Figure 3. Different MEPS levels are prescribed for 2 pole, 4 pole, 6 pole and 8 pole motor configurations.[8]

Figure 3 Proposed MEPS levels



The Standard applies to three-phase cage induction motors with ratings from 0.73 kW (1 Horsepower) up to but not including 185 kW. Since motors tend to be supplied at discrete power steps, the largest commonly available capacity covered would be 160 kW. The following classes of motor are specifically excluded from the MEPS requirements (although not necessarily from the other provisions of the Standard):

(a) Submersible (sealed) motors specifically designed to operate wholly immersed in a liquid (but this exclusion does not apply to motors that normally operate with a surrounding medium of air but that may withstand inundation);
(b) Motors that are integral with, and not separable from, a driven unit (an example is a motor constructed on the same shaft as a compressor for an air-conditioning unit);
(c) Multi-speed motors;

[8] The higher the number of poles, the lower the speed of rotation.

(d) Motors that have been granted exemption by the relevant Australia/New Zealand regulatory authority due to their application placing restraints on the motor dimensions or other key design aspects;
(e) Motors for use only for short-time duty cycle applications (eg. those used for hoists, roller doors and cranes) which have a duty type rating of S2 under the IEC 60034-12;
(f) Rewound motors.

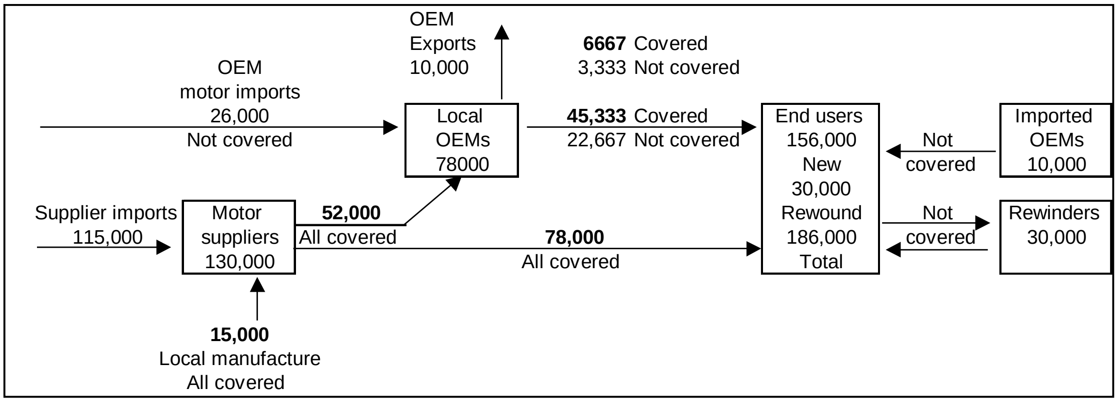
It is proposed that the MEPS requirements would be put into effect by amending the schedule of products in the regulations governing energy labelling and MEPS in each State and Territory (see example at Appendix 1). The amended schedules would refer to all parts of AS/NZS 1359.5, and so would make compliance with *all* the Standard requirements mandatory. The target date for implementation is 1 July 2001, although some stakeholders have argued that 1 December 2001 would facilitate implementation by the motor supply industry.

The regulations would affect all motors *supplied* in Australia, whether manufactured or imported, and whether supplied to OEMs or to end users. However, the regulations would not cover motors imported directly by OEMs (because these are not supplied in Australia), or motors in OE products, whether locally made or imported (since these come under exclusion (b) in the Standard: "motors that are integral with, and not separable from, a driven unit"). Therefore the extent to which the regulation covers the new motors reaching end users depends on:

(a) the balance between local sourcing and direct importing in the motors used by the OEMs;
(b) the balance between locally sourced and directly imported motors in the OEs that are supplied to end users within Australia (which may differ from (a) depending on the balance used in exported OEs); and
(c) the number of fully imported OEs.

If local OEM's used the same ratio of directly imported to locally supplied motors in all their products, whether exported or locally sold, and if the balance of product flows were similar to 1995, then the pattern of motor coverage would be as in Figure 4. About 80% of the motors reaching end users would be covered by the MEPS requirements. About 130,000 supplied motors would have been covered, of which about 5% would have ended up in exported OEs and the rest used within Australia.

Figure 4 Product supply covered and not covered by proposed regulation



If it were decided to limit (or extend) the scope of the regulations in some way it would be necessary to specify this. For example, if governments wished to exclude motors that are exported, either as separate motors or integral with OEs, it would be necessary to specify in the regulation that an intention to export is legitimate grounds for exemption. The Standard itself refers to the possibility of exemption by regulatory authorities but limits the grounds to the "application [of the motor] placing restraints on the motor dimensions or other key design aspects." However, any exemptions beyond those in the Standard would complicate the administration of the regulation. It would be difficult to verify that a batch of motors claimed to be supplied to an OE for use in exports did not end up in equipment supplied to users in Australia.

The MEPS and "high efficiency" values in AS/NZS 1359.5 were recommended following an analysis of the market which considered the costs and benefits of alternative MEPS options along with extensive consultation (Energetics 1997). It is not within the scope of this RIS to consider other MEPS levels.

If the regulation is framed in a similar way to the existing regulations for household appliances, motors will have to comply not only with the MEPS levels but with the other provisions in the Standard:

- A motor cannot be designated "high efficiency" unless it meets the criteria in the Standard;
- The efficiency marked on the motor nameplate, specified in technical literature or otherwise claimed shall not exceed the measured motor efficiency (subject to specified tolerances);
- Claims of energy efficiency are to be subject to check testing, using the procedure specified in Part 1.6 (subject to specified tolerances);
- State or Territory regulatory authorities may require product details are to be registered (this includes exempt products, for which the ground for exemption need to be stated).[9]

The criteria for "high efficiency" are detailed in Appendix 2. As with MEPS, there are different values for 2-, 4-, 6- and 8-pole motors.

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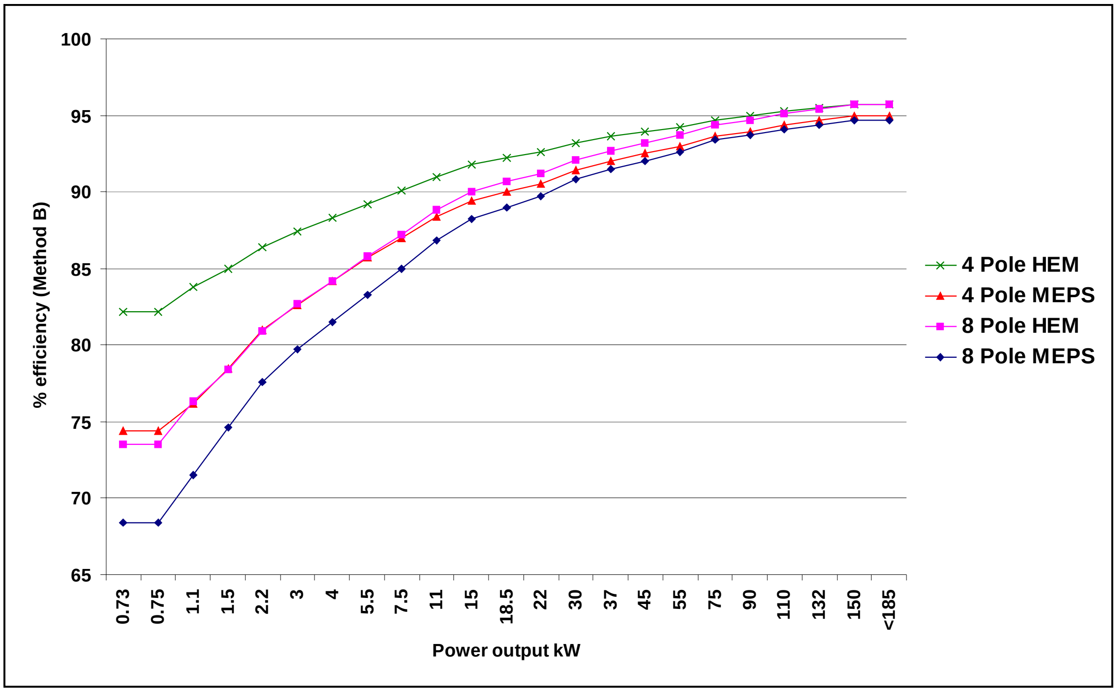
[9] The Standard also provides for a possibility where registration is not required, in which case the data need to be retained by the supplier and made available to the regulatory authority on request. It is understood that this is being considered in New Zealand, in the event that motors MEPS are made mandatory there. However, registration – and the possibility of deregistration - is a key factor in the existing Australian compliance regime.

The Standard also offers the following options for demonstrating compliance with the specified MEPS levels and HE criteria:

- Compliance can be demonstrated at either full rated load or 75% rated load;
- Compliance can be demonstrated using either of two test methods (A and B).

The efficiency margin between HE and MEPS compliance varies with motor size. For small motors, it is in the range 6 to 7 percentage points, but for large motors narrows to about 0.5 percentage points. Figure 5 illustrates the HE and MEPS values for 4-pole motors (the group with the highest efficiencies) and 8-pole motors (the group with the lowest efficiencies, although the difference between the two groups is small).

Figure 5 MEPS and HE criteria and sales-weighted average, 2-pole motors



Background to Proposal

The National Greenhouse Strategy states that "improvements in the energy efficiency of domestic appliances and commercial and industrial equipment will be promoted by extending and enhancing the effectiveness of existing energy labelling and minimum energy performance standards [MEPS] programs. This will be pursued by … developing minimum energy performance standards for a broader range of new appliances and equipment" (NGS 1998).

A high priority in the work program of government through the National Appliance and Equipment Energy Efficiency Committee is to "establish timetables for the introduction of MEPS for packaged air conditioners, electric motors and fluorescent lamp ballasts" (NAEEEC 1999). Each of these products has been the subject of detailed cost-benefit studies, which recommended that MEPS be introduced.

A study was carried out in 1994 of the market conditions in Australia for major energy using products used in large numbers in the industrial and commercial sectors (Energetics and GWA 1994). After applying several evaluation criteria, the study concluded that market intervention was warranted, as a matter of priority, for electric motors, fluorescent lamps ballasts, packaged airconditioners and office equipment.

A subsequent, more detailed study of the motors market was carried out by Energetics (1997). This recommended:

1. MEPS to eliminate the least efficient 40% of the motor market over a three year time span;
2. a "High Efficiency Motor" endorsement process; and
3. a public educational/promotional campaign.

The MEPS and HE levels proposed for AS/NZS 1359.5 differ slightly from the levels proposed in Energetics (1997). The values in the Standard follow a smoother curve, with some values higher and some lower than the recommendations.

Regarding the third recommendation, the Australian Greenhouse Office and the Department of Industry Science and Resources have recently implemented the "Australian Motor Systems Challenge" (AMSC) program.

> "The program addresses barriers to more efficient use of motors, including scepticism, indifference, market structure, payback gaps and lack of relevant information. It covers motor efficiency, appropriate motor application, whole system efficiency including pumps, and efficient rewinding of motors" (background paper for NAEEEC Stakeholders Forum, 28 March 2000)

The main element of the AMSC is an internet site, www.isr.gov.au/motors. The site has information illustrating the monetary value of selecting what it terms "energy efficient motors" (EEMs) in preference to standard efficiency motors and rewound motors. It also offers "motor selector" software with which users can specify their motor requirements (eg power output, operating hours), electricity tariffs and other criteria. The software will then select a number of suitable motors from a database, and calculate the discounted NPV of their capital plus lifetime energy costs,

The AMSC program is voluntary, in that only buyers who are interested in motor efficiency will take the trouble to compare alternatives, and only suppliers who want to take reach those buyers will submit data for the database. However, the effectiveness of the AMSC will depend partly on compliance with parts of the forthcoming Standard, in particular:

- Compliance with the "high efficiency" designation criteria, so that there is a consistent definition of "high efficiency" motors; and

- The registration of motors data, so that the AMSC database can be comprehensive. At present, only 4 of the 12 motor suppliers have submitted data.

3.3 Targeted regulatory MEPS

"Targeted regulatory MEPS" may be defined as "a regulation which only adopts those parts of the Australian Standards that are essential to satisfy regulatory objectives".

It needs to be established whether the adoption of <u>all</u> parts of the Standard, as would be the effect of the regulations in the form currently proposed, is necessary to meet the objectives, or whether it would be sufficient to only adopt the MEPS levels specified in Section 3 of the Standard, together with the physical energy test procedures to which the MEPS levels refer.

The relevance of the other parts to meeting the objective of the regulation is considered in Chapter 4.

3.4 Voluntary MEPS

Under a voluntary MEPS regime, product suppliers would be encouraged to meet certain minimum energy efficiency levels voluntarily without regulation. These levels would require them to incur the costs of changing their model range to eliminate less efficient models and introduce more efficient models sooner than they would otherwise have done. Otherwise, "voluntary MEPS" is in effect "business as usual".

Suppliers would presumably only incur these costs if there were commercial incentive for them to do so. Whether such incentive exists or could be created is considered in Chapter 4.

3.5 Equipment levy

Another option involves "a levy imposed upon inefficient appliances to fund programs to redress the greenhouse impact of equipment energy use." Two variations of this option have been considered:

a) the proceeds from the levy are diverted to greenhouse-reduction strategies unrelated to motor efficiency (ie the levy is "revenue-positive"); or
b) the proceeds are used to subsidise the costs of high efficiency motors, so that any cost differentials between HE and standard motors are narrowed or eliminated (ie the levy is "revenue-neutral").

Imposing and disbursing the levy

Any levy would obviously have to be mandatory. A threshold question for both the "revenue-neutral" and "revenue-positive" options is whether the Commonwealth or State tax regimes could support the raising of the levy. The recent abolition of wholesale sales tax, which could be levied at different rates, in favour of a single-rate GST, removed the most likely vehicle for imposing a levy.

Once funds were raised, then under a “revenue-positive” option they would be applied to a greenhouse reduction activity determined by government – perhaps under competitive project bidding such as the AGO’s current Greenhouse Gas Abatement Program (GGAP). The “revenue-neutral” option would be more complex, in that it would require a mechanism for applying the funds raised to the desired objective of narrowing the cost differential between more efficient and less efficient motors.

Possible approaches include:

- continuous scaling of tariffs and duties on imported motors to energy efficiency (but this would not affect locally made motors);
- step changes in taxes or duties: eg 0% for motors above the HE threshold, 10% for motors below the MEPS threshold and 5% for motors between the two thresholds;
- payments to manufacturers or importers according to a formula based on sales and efficiency;
- rebates direct to the purchasers of energy-efficient motors.

Because most suppliers offer motors across a wide range of efficiencies, they may be largely unaffected by the levy (ie their required contribution to revenues may be close to their nominal receipt of benefits). Alternatively, where suppliers are net recipients they may use the revenues to support product prices in ways that conflict with the objectives of the levy. The only way to ensure that the funds are actually applied to the purchase price of the more efficient motors would be to offer rebates direct to purchasers. However, this would create the following difficulties:

- high fixed costs to establish a publicity, verification and payment infrastructure;
- administrative and transaction costs would probably be high in relation to the value of each payment to buyers;
- “free riders”: a large number of buyers who would have bought the more efficient motors in any case will claim payments.

Conclusions

There are no readily apparent means for raising the proposed levy. It is not likely that differential taxation rates can be implemented under existing Commonwealth or State taxation or licencing laws. A levy would only become feasible if general provisions were introduced to enable import duties or other tax rates to be linked to specific product characteristics, in this case energy efficiency.

The product registration, check testing and ongoing administrative costs to business and government would be no less than under mandatory MEPS.

In the “revenue-positive” case, where the funds raised by the levy were applied to greenhouse gas reduction programs outside the motors sphere, there is no evidence that potential greenhouse gas reductions from other possible application of the funds would be more cost-effective, or even equally cost-effective, to MEPS.

In the "revenue-neutral" case, where the funds raised were to be applied to reducing the cost differential between more- and less-efficient motors, it would be difficult and/or administratively costly to ensure that payments to motor suppliers and/or purchasers were targeted as intended.

If the framework could be established, a "revenue-neutral" levy would act as a form of mandatory MEPS in which regulations would enforce the payment of the levy rather than prescribe characteristics to be met for lawful sale. Suppliers would be free to sell motors less efficient than the reference level, but each sale would carry a financial cost. With the MEPS regime currently proposed, suppliers who sell non-compliant motors would also be subject to financial penalty under the regulations. The main difference is that the levy provides an in-built mechanism for scaling the penalty to the extent by which MEPS is exceeded, whereas the proposed regulations do not. However, if such a feature is considered desirable it may be more straightforward to incorporate it into the regulations than to establish a levy regime.

The proposed levy, even if legally feasible, appears to offer no cost savings, no greater greenhouse gas reductions (in fact, probably less greenhouse gas reductions) and probably higher lifetime appliance costs to purchasers, compared with the MEPS proposals. Some form of levy *in association with* MEPS may produce greater energy savings, but more information about the form and design of a levy proposal would be necessary in order to form a judgement.

3.6 Electricity levy

At present, the electricity prices faced by consumers reflect – however imperfectly - the cost of the capital invested in the electricity generation and distribution system, operating and maintenance costs, and taxes. They may also reflect the costs of controlling pollutants such as oxides of nitrogen and sulphur (NOx and SOx), for which emissions standards are currently in force in some areas. They do not reflect the value of greenhouse gas emissions, or rather they implicitly assign a value of zero to such emissions. In other words, greenhouse costs are not internalised in the electricity price.

It may be possible to introduce a levy on the price of electricity to reflect the cost of greenhouse gas emissions from the production and combustion of the fuels used to generate it – in effect, a carbon tax. Alternatively, if a cap and trade emissions permit scheme were implemented, electricity generators and other major emitters would have to obtain sufficient permits to cover their emissions. Some of these may be obtained free (ie by "grandfathering") and some may have to be purchased, but if there is an open market then all permits will ultimately have the same monetary value. The permit value would thus be reflected in the price of electricity and all greenhouse-intensive goods and services. The effect of a permit trading scheme would be similar to a carbon tax in its pervasiveness, but the magnitude of the electricity price impact would vary with the market price of permits.

The decision to introduce an electricity levy or an emissions trading scheme is a matter for the highest levels of Commonwealth, State and Territory Government. In that respect the options are not direct alternatives to the proposed mandatory MEPS regime.

4. Costs, Benefits and Other Impacts

COAG Guidelines:

- ***Costs and benefits:*** *there should be an outline of the costs and benefits of the proposal(s) being considered. This should include direct and indirect economic and social costs and benefits. There should also be analysis of distinct alternatives (including ‘ do nothing’) to the proposed regulation.*

The major economic benefit of Minimum Energy Performance Standards MEPS would be the value of the electricity saved. The major economic cost would be the increase in the average price of motors. This chapter summarises the cost-benefit modelling carried out to estimate these benefits and costs. Manadatory, targeted and voluntary MEPS are examined.

A reduction in electricity consumption would also produce social benefits in the form of lower greenhouse gas emissions. These are estimated, but not given monetary value. The economic costs and benefits are likely to be passed on to motor buyers, owners and operators, but there will also be impacts on manufacturers, importers and exporters. These are also covered in this chapter.

4.1 Benefits and Costs of Mandatory MEPS

The purpose of the cost-benefit modelling is to project the motor purchase costs and running costs in the medium term, both nationally and at a State level, and hence to compare the net present value of owning and operating motors under both business as usual and “with-MEPS” scenarios.

Data

The costs and benefits of the proposed MEPS levels have been projected using a computer model first developed by Energetics (1997). The key assumptions and outcomes are detailed in Appendix 3. The modelling was based on two data collections: a large scale survey involving all major motor suppliers (representing the market in 1995) and a recent sample of 4 suppliers (representing the market in 2000).

The 1995 data set contains 1,344 individual models (or model families) in the capacity range 0.75 to 150 kW. For each model, the physical characteristics of kW capacity, efficiency, pole configuration (ie whether 2, 4, 6 or 8 pole) and type (ie whether totally enclosed (“TEFC”) or open drip-proof (“ODPD”)) are recorded. Sales data were provided for 400 models and price information for 470 models. This allowed statistical analyses of the relationship between price and efficency, and the construction of a market model with which to test the impacts of various MEPS levels (see Appendix 3).

The 2000 data set contains information on the physical characteristics of 518 models, supplied by 4 of the 12 suppliers. Table 7 summarises the estimated characteristics of the group (or “cohort”) of motors sold in Australia in 2000. It is estimated that the total market was 185,000 motors. The estimated share by type was 21% 2-pole, 72% 4-pole, 5% 6-pole and 2% 8-pole.

Table 7 Estimated characteristics of motors sold in Australia, 2000

Size range	Number sold	Share of sales	Average kW	Average Efficiency	Average Hrs/yr(a)	kWh/yr per unit	GWh/yr	Share of energy
0.75 - 2.2	87,300	47.2%	1.35	77.8%	1,200	2,082	182	4.8%
3 - 7.5	62,200	33.6%	4.9	86.2%	1,500	8,584	534	14.1%
11 - 37	24,700	13.4%	19.2	91.2%	2,000	42,105	1,040	27.5%
45 - 90	8,400	4.6%	59.6	93.6%	2,300	146,453	1,235	32.7%
110 - 150	2,400	1.3%	125.1	94.7%	2,500	330,253	784	20.8%
Totals/Avgs	185,000	100.0%	9.2	83.3%	1,475	16,279	3,776	100.0%

Source: Update of modelling in Energetics (1997) (a) At full load equivalent: eg 1500 hours @ 80% load = 1200 hrs full load equivalent

The sales-weighted average energy efficiency of new motors in 2000 was estimated at 83.3%, compared with 82.5% in 1995, due to BAU improvements in efficiency. The larger the motor, the more energy it uses during operation and the greater the average hours of annual use. Therefore, although motors in the smallest size range accounted for nearly half the sales, they accounted for less than 5% of the total cohort energy.

The total annual consumption of the 2000 cohort of new motors was about 3,800 GWh, or about 1/13 of the estimated 48,700 GWh used by the entire stock of electric motors in this size range in 2000 (Table 2). A large proportion of the motors sold replaced motors retired from service in existing applications, and the rest were used in new applications.

For purposes of modelling, motor energy use has been allocated to States and the NT in the same proportion as general non-residential energy use (Table 8). The energy prices used for modelling benefits in each jurisdiction are also indicated.

Table 8 Estimated State and Territory shares of motor use, 2000

	NSW & ACT	VIC	QLD	SA	WA	TAS	NT	TOTAL
Share of total non-res energy use(a)	36.2%	22.6%	20.8%	5.9%	6.9%	6.6%	1.0%	100.0%
Estimated energy use by new motors GWh	1368	855	787	221	260	249	37	3776
Tariff c/kWh(a)	7.2	7.8	8.5	8.5	10.7	4.6	14.5	8.0

(a) Source: ESAA Electricity Australia 2000

Monetary benefits and costs

The computer model of the motors market operates in the following way (the model parameters are further documented in Appendix 3).

For products such as motors, where energy efficiency is related to quality and quantity of materials used and the precision of component assembly, it would be expected that there is a relationship between manufacturing cost and energy efficiency. However, this is not necessarily reflected directly in the price to buyers.

Price differentials are often determined by the economics of marketing rather than manufacturing. A manufacturer may produce fewer high efficiency models than standard ones, but be able to sell them at a higher margin (or at a lower discount) due to their “premium” status. If the more efficient model becomes the standard product as a result of MEPS, its production volumes will rise and the “premium” status will disappear. The resulting price increase to buyers, if any, will be much lower than would have been predicted by prior analysis of the market.

Despite these uncertainties, it was necessary to characterise a price vs relationships in order to estimate the costs and benefits of MEPS. Linear regression yielded the following general relationship between normalised price and normalised efficiency (the concept of normalisation is explained in Appendix 3):

$$\text{Normalised Price} = 1.1877 \times \text{Normalised Efficiency} - 0.289$$

The impact of MEPS on the motors market is calculated in the following steps.

An implementation date is selected: for the purpose of this RIS this has been set at 1 July 2001. However, it is assumed that the market composition begins to change in advance of this date, because suppliers take action during the lead-in period so that their sub-MEPS models are removed by the implementation date. Therefore energy savings first show up in the modelling in the two lead-in years, 1999/2000 and 2000/01. (Indeed, there is evidence that suppliers have already begun to change their model ranges in anticipation of MEPS; see Appendix 3).

As a result of MEPS, the average efficiency of motors in all classes is higher than it would otherwise be because sub-MEPS models are removed from the market. The computer algorithm analyses each of the 21 market segments (ie 0.75kW, 1.1 kW, 2.2 kW etc) and allocates sales that would have gone to sub-MEPs models to the remaining models in proportion to their pre-MEPS market share. For example, if Model A (the least efficient) has a 20% market share, Model B 50% and Model C (the most efficient) 30%, then if Model A is eliminated by MEPS, the sales of model B are assumed to account for 50/80 of the post-MEPS market and Model C 30/80.

Following this redistribution:

- The total purchase price of motors sold in each MEP-affected year will be somewhat higher than if the MEPS constraint had not been applied (based on the price-efficiency relationship discussed above); and

- The average energy efficiency of motors sold in each MEP-affected year will also be higher than if the MEPS constraint had not been applied.

The period selected for cost-benefit analysis is 2000 to 2015 inclusive. There is little point in extending the modelling further, for three reasons:

- the longer the projection period the lower the confidence that the motors market is accurately represented;

- the time discounting of costs and – especially – benefits (which accrue further into the future, after the time of motor purchase) means that if cost-effectiveness over 15 years cannot be demonstrated, the program is not reliably cost-effective; and

- it is quite possible that more stringent MEPS levels would be imposed some time in the next 15 years, at which point the benefits of the currently proposed levels would be overridden.

The cost of MEPS is the net present value of the increase in the total price paid by buyers for electric motors in the period 2000-15. This is calculated by projecting purchase costs under a BAU scenario, and purchase costs under the with-MEPS scenario. This cost captures the additional investment that motor buyers would be forced to make in motor energy efficiency as a result of MEPS.

There are no capital cost involved in developing new product, since all suppliers already have models in excess of the MEPS levels. Indeed, about 60% of all models in 1995 already passed MEPS, and for some suppliers this has risen to 90% in 2000, although this increase may have been prompted partly by the anticipation of the MEPS requirement.

The program costs associated with motors MEPS are relatively minor. Suppliers already test or calculate the energy efficiency of nearly all their products in accordance with either Test Method A or Test Method B in AS/NZS 1359.5. Given that either method may be used to demonstrate MEPS compliance or claim HE status, the extent of additional testing by suppliers would be minor.

The fees for registration of articles with the regulatory authorities is currently $150 per annum (see Appendix 1). There are about 1500 models (or model families) now on the market, so the initial registration fees would be $ 225,000. If suppliers incur internal administrative cost of similar magnitude, the initial costs to suppliers – passed on to buyers - would be $ 450,000.

New models are added each year, and models remaining on the market after 5 years would need to be re-registered, so ongoing supplier costs are estimated at $ 100,000 per year. The costs to government would be the one-off cost involved in adding electric motors to the product schedules in the existing regulations (say $ 50,000), and the ongoing cost of check testing and market monitoring (say $ 50,000 per annum).

Therefore the program costs would be $ 500,000 in year 1 (2001/02), and $ 150,000 in subsequent years: a total of $ 2.45 M (undiscounted) over the projection period. This compares with estimated investment costs of about $ 200 M (undiscounted) over the same period. Therefore program costs are little more than 1% of investment costs, and make little difference to the outcome of the cost-benefit analysis, although they have been included for completeness.

The benefit of MEPS is the net present value of the reduction in the cost of electricity purchases by motor users, with respect to the electric motors purchased in the period 2000-15. This is calculated by projecting purchase electricity consumption under both a BAU scenario and a with-MEPS scenario. The energy use over the motor's entire operating life need to be taken into account, because once a more efficient motor is purchased, the energy savings remain "locked in" so long as the motor remains in service.[10] It is assumed that the real costs of electricity to motor users remain at the levels in Table 8. This values benefits conservatively, since those electricity prices represent a historic low point following the reform of the electricity market, and may well rise in real terms.

The projected costs and benefits are summarised inTable 9. The NPV of projected total national savings is $M 165, compared with the projected benefit of $M 92, giving a benefit/cost ratio of 1.8. The projected impact on motor purchase costs is an increase of 8%, whereas the impact on energy purchase costs is a reduction of 0.7%.

A benefit/cost ratio of 1.8 is favourable for a program of this type. The RIS on the implementation of energy labelling and minimum energy performance standards for household appliances estimated that the marginal benefit/cost ratio of adding MEPS to the pre-existing energy labelling program was in the range 2.4 to 2.7 (at a discount rate of 8%, so slightly lower for 10%) (GWA 1999).

These estimates pertain to the mandatory MEPS option alone. The introduction of common criteria for high efficiency motors designation that would accompany the introduction of MEPS would assist buyers to identify and select even more efficient motors, and would add considerably to the effectiveness of voluntary programs such as the Australian Motor Systems Challenge. However these potential additional benefits have not been modelled.

Table 9 Estimated costs and benefits of MEPS for electric motors

	National Total	NSW & ACT(a)	VIC	QLD	SA	WA	TAS	NT
NPV, BAU costs	$M 1,149	$M 416.2	$M 260.2	$M 239.4	$M 67.3	$M 79.0	$M 75.6	$M 11.3
NPV, with-MEPS costs	$M 1,241	$M 449.4	$M 280.9	$M 258.4	$M 72.6	$M 85.3	$M 81.7	$M 12.2
Difference (Cost)	$M 92	$M 33.2	$M 20.7	$M 19.1	$M 5.4	$M 6.3	$M 6.0	$M 0.9
NPV, BAU energy costs	$M 24,138	$M 8,046	$M 5,448	$M 5,463	$M 1,535	$M 2,270	$M 934	$M 441
NPV, with-MEPS energy	$M 23,973	$M 7,991	$M 5,411	$M 5,425	$M 1,525	$M 2,255	$M 928	$M 438
Difference (Benefit)	$M $165	$M 55.0	$M 37.2	$M 37.3	$M 10.5	$M 15.5	$M 6.4	$M 3.0
Benefit/cost ratio	**1.8**	**1.7**	**1.8**	**2.0**	**2.0**	**2.5**	**1.1**	**3.3**

NPV is Net Present Value at 10% discount rate (a) ACT data not separable from NSW data.

State and Territory Impacts

The costs for States and Territories have been estimated by allocating motor purchase costs and motor energy use according to the shares of non-residential energy use in Table 8, since no data are available on motor sales or differences in size or efficiency preferences by State. The benefits have been calculated using the business tariffs in Table 8. In effect, the benefit/cost ratios largely reflect the cost of business electricity.

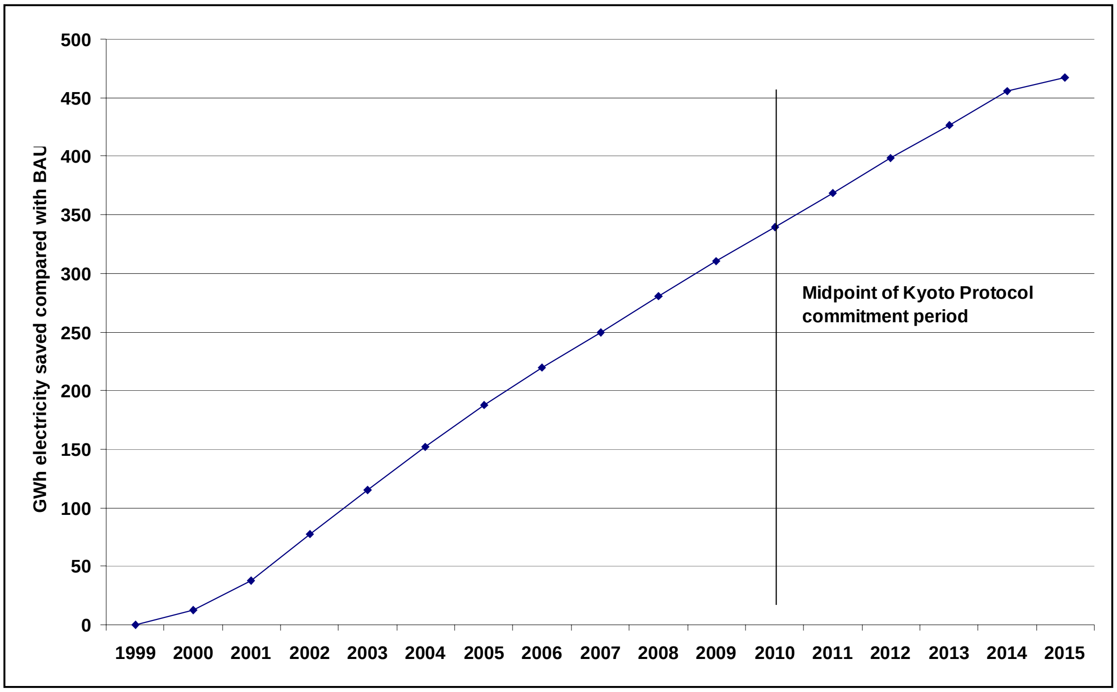
[10] An average operating life of 15 years has been used, with a "decay function" under which all of a cohort survives to 5 years, 50% survives to 15 years and the last motor of the cohort leaves service 25 years from installation. This would mean that the longest-serving of the motors installed in the last year of the projection period, 2105, would still be using energy in 2040. However, energy use has only been projected to 2030.

The ratios are highest for the NT and WA (3.3 and 2.5 respectively) and lowest for Tasmania, where average business tariffs are less than one third those in the NT. Even so, MEPS is projected to be cost-effective in Tasmania (1.1). The benefit/cost ratios on the other jurisdictions range from 1.7 to 2.0.

Energy and Greenhouse Savings

The energy saving in each year is calculated as the difference between the energy consumption of motors in the BAU scenario and in the with-MEPS scenario. As expected, the savings increase as each successive year's cohort of MEPS-influenced motors enters the stock (Figure 6).

Figure 6 Projected energy savings from motors MEPS, 2000-15

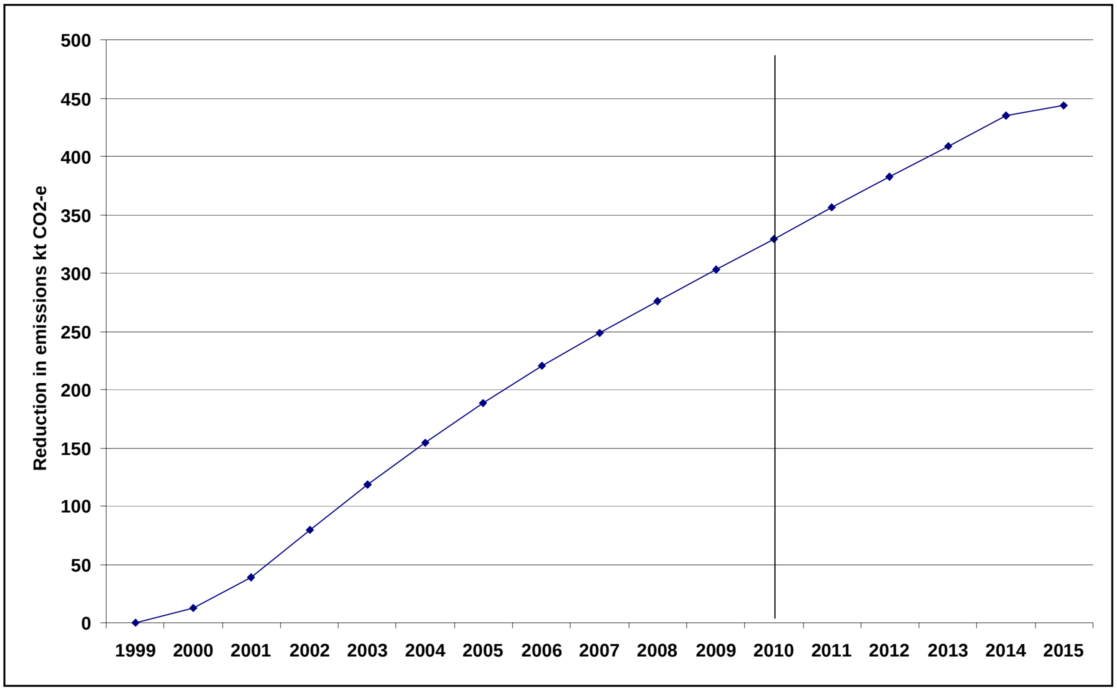


The greenhouse impacts have been calculated at the State level, by multiplying the projected reduction in electricity consumption (GWh) by the projected greenhouse gas intensity of electricity delivered in that State (kt CO_2-e/GWh). Projected intensities for each State are given in Appendix 3. Projected greenhouse reductions are illustrated in Figure 7. Table 10 summarises the projections of accumulated energy and greenhouse savings over the entire period, as well as the emissions reductions in 2010, the midpoint of the Kyoto Protocol commitment period. This is estimated at 330 kt (0.33 Mt) CO_2-e. Delaying implementation by a half year would reduce the impact in 2010 by about 14 kt (4%)

Table 10 Projected energy and emission savings, 2000-15

Period modelled	Implement-ation date	GWh energy saved during period	% of BAU energy saved	Mt CO_2-e saved during period	Emission saving 2010 Mt CO_2-e
2000 – 2015	1 July 2001	4,099	5.9%	4.0	0.33

Figure 7 Projected greenhouse savings from motors MEPS, 2000-15



4.2 Industry, Competition and Trade Issues

Competition

The previous section examined the costs and benefits of the MEPS option from the perspective of electric motor buyers and users. It was assumed that all compliance costs incurred by suppliers are eventually passed on to buyers in the normal course of business, so for the purposes of cost-benefit analysis the cost impact on suppliers as a group is neutral. However, it is likely that some suppliers will be more affected by the MEPS option than others. This section considers the impact on firms, with respect to both domestic and international competition.

Effects on suppliers

About 10% of the units sold on the Australian market are locally assembled; the rest are fully imported. Firms have a range of response options in the event that their products fail the MEPS level. An importer can request the overseas manufacturer to improve the design, to substitute a more efficient model from its product range, or - if the importer is not tied to a particular brand – it could change suppliers.

Electric motors are manufactured in nearly all developed countries and many of the developing countries in the Asia Pacific region, and are freely traded. It is not difficult to source product of different price and efficiency levels, given reasonable notice.

Table 11 summarises the number and proportion of models failing to meet the proposed MEPS levels, in 1995 and 2000. This indicates that, for the brands where data are available for both years ("E,F,L,M") about 36% of the models on the market in 1995 would have failed MEPS, but by 2000 this had fallen to about 10%. Two brands had 100% of models passing.

The non-compliance rate for the other brands ("the rest") was somewhat higher in 1995 (42%). Although it may be expected that this rate will also have declined, due to both BAU improvements in the motors market and early response to anticipated MEPS, it is still likely to be well above the rate in the "E,F,L,M" group. Since the latter group volunteered data for the Australian Motor Systems Challenge database while the rest have not (at the time of writing this RIS) it is reasonable to assume that the "E,F,L,M" model range is more efficient than the rest.

The impact of the proposed regulations is likely to be moderate overall, relatively widely spread, but difficult to predict for specific firms, since the model range changes.

Table 11 Estimated number of models affected by proposed MEPS regulations

	From 1995 motors database				From 2000 motors database			
Brands	Models	Number passing	Number failing	% failing	Models	Number passing	Number failing	% failing
A	190	92	98	51.6%	NA	NA	NA	NA
B	50	12	38	76.0%	NA	NA	NA	NA
C	30	30	0	0.0%	NA	NA	NA	NA
D	81	32	49	60.5%	NA	NA	NA	NA
E	198	141	57	28.8%	240	210	30	12.5%
F	191	136	55	28.8%	158	134	24	15.2%
G	79	76	3	3.8%	NA	NA	NA	NA
H	84	47	37	44.0%	NA	NA	NA	NA
I	137	62	75	54.7%	NA	NA	NA	NA
J	81	77	4	4.9%	NA	NA	NA	NA
L	152	73	79	52.0%	58	58	0	0.0%
M	71	44	27	38.0%	62	62	0	0.0%
All of above	1344	822	522	38.8%	518	464	54	10.4%
E,F,L,M	612	394	218	35.6%	518	464	54	10.4%
The rest	732	428	304	41.5%	NA	NA	NA	NA

Effects on supplier competition

Those suppliers with a higher numbers of non-complying models will clearly need to make more effort to obtain (or in the case of the local manufacturer, to assemble) complying models.

Given the resources of the motor suppliers, their already wide model ranges and their proven ability to source motors of different energy efficiency levels, it is most unlikely than any firm will find the cost of compliance so onerous that it is forced to withdraw from the market. There is not likely to be any significant reduction in supplier or price competition

One aspect of the mandatory MEPS option could enhance competition by helping to overcome information failure. The output capacity and energy efficiency of all motors, determined under common same test criteria, can be made available to the public if governments make the product register information public, as is the case of household appliances. This will be so even for the motors of suppliers who choose not to participate in the AMSC program.

Products will thus be comparable on a consistent basis, so ending the confusion surrounding the arbitrary designation of motors as “high efficiency. ”

Effects on competition with rewound motors

No part of AS/NZS 1359.5 applies to rewound motors, “except where claimed as high efficiency and fully tested following rewinding”.

Rewinders are a major part of the motor industry, with a turnover of some $30 million per annum (SRCI 1999). The initial cost of a rewound motor is lower than a new motor, and in some circumstances gives a shorter turnaround time than ordering a motor not in stock. In addition, the rewind industry has a niche market supplying “new” motors for end–uses with unusual applications.

The rewind industry has a large number of firms. The Electrical Apparatus Service Association (EASA) represents approximately 800 motor rewinders across Australia. In addition to those rewinders represented by the EASA there are a large number of “small” facilities not registered with the Association.

In theory, rewinding can produce a motor with the same efficiency rating it had when it was new. In reality, the quality of a motor rewind, and hence the impact on efficiency, is highly variable; and depends on the materials and techniques used in reassembling the motor.

Rewinding practices for motors of 180 W to 400 kW are specified in Australian Standard AS 4307.1. This Standard states that where motor efficiency is stipulated on a motor nameplate the efficiency of the rewound motor tested to AS 1359 will comply with the nameplate efficiency. However, as many rewind facilities do not have the required test gear the Standard is not generally enforced. In any case, the size range covered differs from the MEPS coverage, which ranges from 0.73 kW up to 185 kW.

If there is an increase in the average price of new motors, and no change in the cost of rewound motors, there would be some increase in the tendency of motor users to select rewinds in preference to new motors. However, if rewinders as a group chose to maintain rather than widen their cost advantage over new motors (ie by increasing their prices in line with any MEPS-induced rise in new motor prices), then there would be no increased preference for rewinds. Furthermore, those decisions to rewind that are driven by turnaround and availability considerations rather than cost differentials would not be affected.

All in all, the impact on the tendency to rewind motors in preference to purchasing new ones may increase slightly, and this may offset to some degree the projected energy benefits of the mandatory MEPS options. It would also reduce the costs, since there would be a smaller rise in average motor prices. These effects are likely to be moderate, and not significantly effect the projected benefit/cost ratios of the MEPS option.

GATT issues

One of the requirements of the RIS is to demonstrate that the proposed test standards are compatible with the relevant international or internationally accepted standards and are consistent with Australia's international obligations under the General Agreement on Tariffs and Trade (GATT) *Technical Barriers to Trade* (GTBT) Agreement. The relevant parts of the GTBT *TECHNICAL REGULATIONS AND STANDARDS Article 2: Preparation, Adoption and Application of Technical Regulations by Central Government Bodies* are addressed below.

The regulations would apply equally to imports and locally manufactured products, and so do not discriminate against imports.

It is a particular concern of the GTBT that where technical regulations are required and relevant international standards exist or their completion is imminent, Members shall use them, or the relevant parts of them, as a basis for their technical regulations. The energy test procedures and conditions in AS/NZS 1359.5 are fully consistent with, and in some cases reproduced verbatim from, the most widely used international standards. Since many countries have motor test standards based on the same international models, it will be possible for importers to use pre-existing test data.

With regard to the HE criteria in AS/NZS 1359.5, there are no international standards. However, the HE levels are generally comparable to the USA MEPS levels.

The GTBT urges GATT members to give positive consideration to accepting as equivalent the technical regulations of other Members, even if these regulations differ from their own, provided they are satisfied that these regulations adequately fulfil the objectives of their own regulations.

There may be scope for accepting the results of motor tests conducted in other countries under IEC 61972, IEEE 112-B and IEC 60034-2. However, there is no scope for accepting a motor that may comply with MEPS in its country of origin, unless it complies with the MEPS levels in AS/NZS 1359.5. Countries with motors MEPS have set different levels according to their own requirements, except for the North America Free Trade Association (NAFTA) countries (Canada, Mexico and USA), who have agreed to harmonise MEPS levels.

In summary, the proposed regulations are fully consistent with the GATT *Technical Barriers to Trade* Agreement, and follow international standards where possible.

Other trade issues

A study of trade in electric motors, air conditioners, refrigerators, and lighting products found that motors trade among APEC economies was worth about US$ 2,500 – 3,000 million in 1996 (APEC 1998).[11] In 1996, Australia imported US$ 95.4 M of AC electric motors, mostly from non-APEC (ie Europe and Brazil).

Table 12 Value of Australian electric motors trade, 1996

	Imports, by Value, $'000 US		Exports, by Value, $'000 US	
Canada	135	0.1%		
Chile			24	0.6%
China	6825	7.2%	1	0.0%
Hong Kong	53	0.1%	27	0.7%
Indonesia			75	1.8%
Japan	5306	5.6%	1845	45.4%
Korea	314	0.3%	12	0.3%
Malaysia	1400	1.5%	643	15.8%
Mexico	1	0.0%		
New Zealand	94	0.1%	938	23.1%
Papua New Guinea			61	1.5%
Philippines			27	0.7%
Singapore	705	0.7%	204	5.0%
Taipei (Taiwan)	14329	15.0%	5	0.1%
Thailand	101	0.1%	2	0.0%
USA	10136	10.6%	78	1.9%
Total APEC	39399	41.3%	3942	97.0%
Non-APEC	55962	58.7%	120	3.0%
World	95361	100.0%	4062	100.0%

Source: APEC (1998); AC motors only

A large proportion of the trade in motors is already affected in some way by minimum energy performance standards (MEPS) and energy labelling programs. Imports into APEC economies that have mandatory MEPS programs for motors accounted for 70% of the value of intra-APEC AC motors trade in 1996 (APEC 1998). If economies with voluntary programs and programs under consideration (including Australia) are included, then more than 80% of intra-APEC electric motor trade is destined for economies with MEPS and/or labelling programs. Table 13 indicates the APEC countries which have, or are planning, MEPS for motors. The European Community is also considering motors MEPS, but deliberations are still at an early stage.

The cost and time needed to comply with different energy efficiency program requirements could add to the cost of traded air conditioners, although in the case of motors is not likely to constitute a barrier to trade. The cost-effectiveness of energy efficiency programs for APEC economies as a group would be higher if the

[11] Air conditioners trade was worth US$ 3,000–3,000 million, refrigerator and freezer trade US$ 1,000–1,100 million, discharge and fluorescent lamps US$ 400–600 million and ballasts for discharge lamps US$ 500–600 million. The study was carried out before Peru, Russia and Vietnam joined APEC.

compliance costs for traded air conditioners were minimised. This would be so if the following conditions were met:

- All economies defined motor product classes and capacities in the same way (there is already a reasonable degree of consistency in this);
- All markets had identical MEPS requirements for each motor size class;
- All authorities accepted the same energy test results as proof of compliance with the MEPS requirements;
- All economies defined High Efficiency motors in the same way.

These conditions are not likely to be met in the near future. However, there are several practical options for reducing energy program compliance costs, to the benefit of all countries participating in motors trade (APEC 1999).

Table 13: APEC Economies with Electric Motor Energy Efficiency Programs

Economy	Comp-arison label	Endorse-ment label	MEPS	Other
AUSTRALIA			U	
CANADA			M(1997)	Provinces
MEXICO			M(1998)	
NEW ZEALAND			U	
CHINESE TAIPEI			M (1981)	
THAILAND			U	
USA		V	M(1997)	

M = Mandatory, V = voluntary, U = Under Consideration. Mexico and Chinese Taipei include single and three phase motors; all other three phase only. Years of implementation indicated.

The proposed MEPS regulations may have some impact on the source countries for motor imports. All products originating in the USA and Canada, which have more stringent MEPS levels, will meet the proposed Australian levels. However, it is possible that not all products from Taipei (Taiwan), another major source of imported motors, will comply, since the current Taipei MEPS are lower than proposed for Australia (Figure 8).[12]

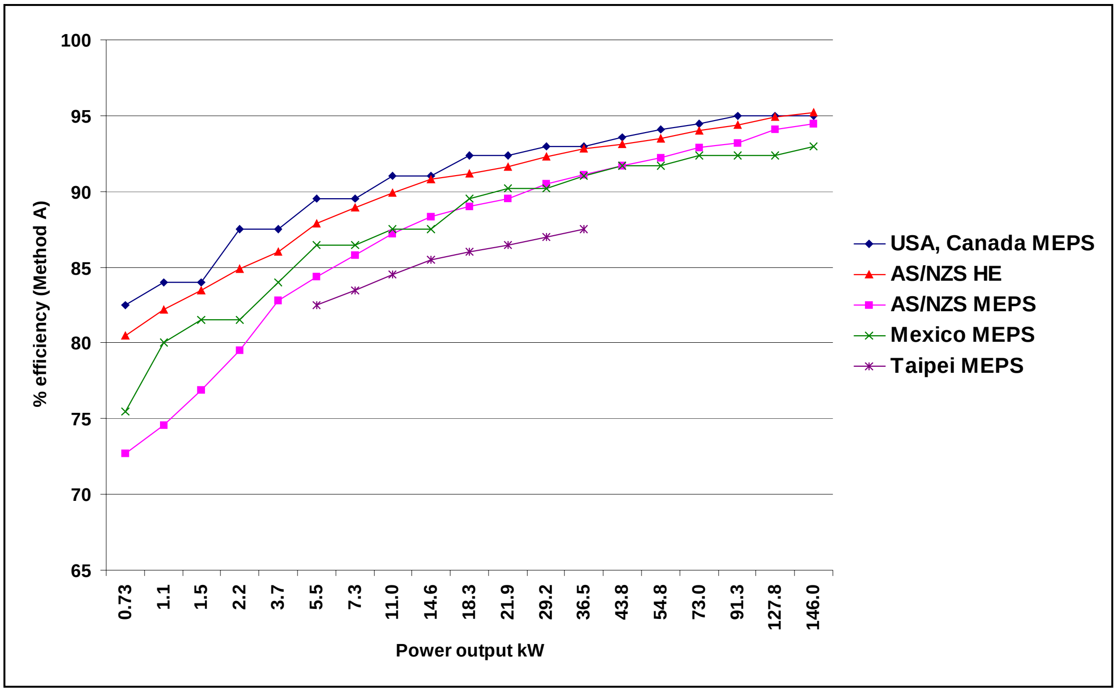
With regard to motor exports from Australia, it is possible that the need to comply with domestic MEPS may increase the price of some products. However, it may be open to suppliers to continue to make less efficient motors for export or import less efficient motors for use in exported OES (if the regulations are framed to allow this). Alternatively, an increase in energy efficiency could lead to some competitive advantage in the export market. As more countries adopt MEPS and MEPS levels increase, any competitive disadvantage from bearing testing and compliance costs should diminish.

Another trade issue is the Trans-Tasman Mutual Recognition Agreement (TTMRA). This states that any product that can be lawfully manufactured in or imported into

[12] The MEPS levels were adopted in 1981, and may be revised in line with US levels in due course.

either Australia or New Zealand may be lawfully sold in the other jurisdiction. The New Zealand government is currently considering implementing MEPS for a range of products, including electric motors. If so, the NZ MEPS would have the same basis as the proposed Australian MEPS, ie AS/NZS 1359.5.[13] If Australia implements MEPS and New Zealand does not, it may be necessary to obtain exemption from TTMRA to prevent the possibility of non-complying products being imported via NZ. ANZMEC has previously endorsed TTMRA exemptions for the Australian mandatory energy labelling program and for household appliance MEPS.

Figure 8 Comparison of international MEPS levels



Conclusions with Regard to Competition

The MEPS option would have some impact on the competition between suppliers, since the suppliers with more models falling below the MEPS levels would need to make more efforts to alter their patterns of imports (or manufactures) than suppliers with few or no models falling below the MEPS levels.

The available market data suggest that

- the compliance costs for suppliers are likely to be low: not more than about 1% of the total value of additional investment in energy efficiency that buyers would be forced to make;
- the impact of the proposed regulations on suppliers is likely to be moderate overall, relatively widely spread (in that most firms will have some models affected), but difficult to predict for specific firms, since the model range changes.

[13] Energy Efficiency and Conservation Authority, New Zealand (Personal communication, June 2000).

- the tendency to rewind motors in preference to purchasing new ones may increase slightly, and this may offset to some degree the projected energy benefits of the mandatory MEPS options.

- the above effects are likely to be very small and have little effect on price and supplier competition, or the competition between imports and local manufactures.

4.3 Targeted and Voluntary MEPS

Targeted MEPS

The provisions of Standard AS/NZS 1359.5 that would be made mandatory by the proposed regulation are reviewed below, to determine whether they are in fact necessary to achieve the objectives of the regulation. If this is not the case, the proposed regulation would need to be targeted more narrowly to avoid introducing unnecessary requirements.

The issues examined in relation to the Standard are: criteria for High Efficiency designation, consistency of efficiency claims, and product registration.

"High Efficiency" criteria

At present, motor buyers have no consistent means of identifying true HE motors (see Table 6). The adoption of a standard set of criteria is a basic consumer information measure.

There would be no additional costs involved for suppliers, since they would have to test for MEPS compliance in any case. There is no obligation on any supplier to designate a motor as "High Efficiency", even if it meets the criteria.

The adoption of consistent HE criteria will also assist the operation of the Australian Motor Systems Challenge. If AMSC users have a quick way to narrow their search criteria by selecting the "HE" category, rather than searching through lists of models along a continuous efficiency band, they are more likely to follow the process through and select a motor with a lower lifetime cost.

Consistency of efficiency claims

The Standard states: "The motor efficiency marked on a nameplate, specified in technical literature or otherwise claimed shall not exceed the actual motor efficiency". This is obviously intended to reduce buyer confusion, but will not necessarily succeed unless two other pieces of information are also available:

- The test used to determine efficiency: the most direct would be a statement whether Method A or Method B in AS/NZS 1359.5 was used (this would be taken as a reference to the standards nominated as "technically equivalent"). Alternatively, the actual test standard (IEEE or IEC) should be nominated;
- Whether the test was carried out at 100% or 75% rated load. The Draft Standard specified that the minimum efficiency levels have to be met at one or the other, and it would assist both users and verifiers to know which.
- The voltage/s at which the claimed efficiency was measured.

This information is required in the forms of Application for Registration which are appended to the Standard. Making the registered information publicly available would reinforce the objective of consistency in product performance claims.

Product registration

It might be feasible for suppliers to satisfy themselves that their motors meet the MEPS provisions in the Standard, but not notify or register that information with any party. However, the administration of the household appliance labelling and MEPS program has been based on State-level registration. A product for which mandatory energy labelling is required can only be lawfully sold in a State or Territory if an energy label is registered for it in that or another State or Territory. All jurisdictions recognise each other's registrations. NSW, Victoria, Queensland and SA maintain an active registration capability, but the other States and Territories do not. The fees are fairly modest: eg in NSW, $150 for registration and $50 for transfer of registration to a new supplier. Registrations last for 5 years, and are renewable.

Applications for registration must be accompanied by copies of the energy test results. This provides some initial quality control over the testing, and errors are often picked up at this stage. Registration is also required for products where MEPS applies but not labelling, currently only water heaters.

These provisions increase the likelihood that suppliers will test their products accurately and ensure the veracity of statements about efficiency. There have been some instances of "compliance shopping" where some suppliers have registered products in States with apparently lower standards of initial scrutiny, but if problems are detected in check testing, the other States apply pressure to withdraw or modify the registration.

The electric motors Standard AS/NZS 1359.5 envisages a form of self-certification as an alternative to registration in some jurisdictions. The responsible authority would decide whether to conduct random checks, or to act only if suspected non-compliance were brought to its attention. If non-compliance were proven, the authority would need to take action against the supplier and require the modification of the motor model or its withdrawal from the market (or a change in designation and documentation if the motor is inaccurately labelled as High Efficency but still meets MEPS).

Compliance under a self-certification regime is not likely to be as high as under a registration regime. The possibility of model deregistration is a powerful sanction against a supplier, and has been found in practice to promote compliance.

Another area where registration has clear advantages is in the ability of regulators to support public information programs. The Australian Greenhouse Office's www.energyrating.gov.au website has a complete list of labelled products and their details, taken from the State registers, to assist consumers. By contrast, product registration for the Australian Motor Systems Challenge is voluntary, and the AMSC website covers only about a third of the market at present.

With complete product information, the AGO is also able to carry out annual tracking surveys which match sales to registrations to allow calculation of sales-weighted energy efficiency trends. These data are used for purposes such as cost-benefit modelling of enhanced MEPS levels. Without registration, the responsible authority would not even necessarily know about the existence of a product unless it was brought to its attention.

On balance, the requirement for mandatory registration is not onerous for suppliers, and is of considerable value for administration of the regulation and for obtaining information for consumers which would not otherwise be accessible.

Voluntary MEPS

Under a voluntary MEPS regime, motor suppliers would incur the costs of changing their model range to eliminate less efficient models and introduce more efficient models sooner than they would otherwise have done.

Suppliers would presumably only take such action if there were commercial incentive for them to do so. Such incentive might perhaps come from an industry association. If suppliers considered membership of the association a commercial advantage, and the association perceived adoption of MEPS to be in the collective interest of all suppliers, it may be feasible for the association to urge or require its members to adopt some level of MEPS. These conditions do not appear to be present in the motors industry.

Alternatively, incentive for voluntary adoption of MEPS might conceivably come from customers. Voluntary compliance might be commercially advantageous for suppliers if buyers thought that MEPS compliance was a desirable product attribute. However, since motor buyers as a group give energy efficiency a low priority, a proprietary “MEPS compliance mark”, or use of the Standards Australia compliance mark, would have little value to customers unless it were very heavily promoted.

The only product designation with some influence on the market at present is “High Efficiency”. Suppliers clearly perceive some value in the designation (however loosely defined at present) because most choose to designate some of their models as HE. The AMSC should increase user awareness of the designation, especially if consistent HE criteria are adopted and enforced. If a new “MEPS compliance mark” were introduced for motors that meet the proposed MEPS levels, it would be divide the market into three segments rather than two, and undermine the potential value of the HE designation.

There have been instances of successful introduction of compliance marks with the support of government or other agencies. The US Environment Protection Agency introduced the *Energy Star* label, initially for office equipment, in the early 1990s. The label now has high recognition in the USA and low to moderate recognition in Australia (GWA et al 1996).   Most office equipment suppliers have products that qualify for the label. However, the greatest force for compliance was the decision of the US Government, the single largest corporate purchaser of office equipment in the world, to give tender preference to qualifying products, so establishing a form of “Government MEPS”. This is clearly only feasible for products where government represents a large proportion of the market. This is not the case with motors.

As Table 13 indicates, all motors MEPS programs already in place are mandatory. There is no working example of a voluntary MEPS program for motors anywhere in the world, and there is no reason to believe that voluntary MEPS would be effective in Australia. On the contrary, it is likely that compliance would be low.

While energy cost savings under a voluntary MEPS scenario would be lower than in a mandatory one, average product costs should also be lower, so long as consumers were still free to prefer less efficient and less costly products. However, the product range and the extent of competition in the market may ultimately be no different under a mandatory or a (successful) voluntary regime. If a high level of voluntary compliance were achieved, suppliers may rationalise their product ranges and reduce inventory costs by withdrawing non-compliant sub-MEPS models in any case. This occurred with the quasi-voluntary WaterMark labelling program for electric water heaters in NZ (Energetics and GWA, 1994).

In short, it appears that:

- The chances of a successful voluntary implementation of MEPS appears remote; but
- if a voluntary MEPS program could be implemented successfully, the ultimate outcome for competition and consumer choice may be similar, but obtained at a higher program cost due to educating consumer preference and promoting the program for market acceptance.

Under voluntary implementation, the outcome would be uncertain for several years, so the risk that the program would fail to contribute sufficiently to national greenhouse gas reduction objectives would be high.

5. Consultation

COAG Guidelines:

- ***Consultation:*** *a RIS must outline who has been or will be consulted, and who will be affected by the proposed action. On a case by case basis, this may involve consultation between departments, with interest groups, with other levels of government and with the community generally.*

5.1 Consultations

The issues related to energy efficiency programs for electric motors generally, and MEPS in particular, have received considerable exposure over the last 6 years.

Chronology of Previous Reports and Consultations

April 1994	Motors identified as one of the products potentially suitable for MEPS and/or labelling, in Energetics and GWA 1994
May 1994	Bureau of Industry Economics publishes *Energy labelling and standards: implications for economic efficiency and greenhouse gas emissions: a case study of motors and drives*
March 1995	DPIE holds meeting in Sydney to discuss issues related to motors. Attended by representatives of AEEMA, suppliers, electricity utilities, professional and standards associations and governments.
January 1996	Energetics contacts participants in March 1995 meeting and other stakeholders (26 in all) to get their views on specific issues
January 1996	Energetics reports to DPIE on changes affecting the motors market since 1994, and on feedback from stakeholders
August 1997	Energetics consults key stakeholders, and seeks responses to recommended MEPS levels: 12 motor suppliers, some original equipment manufacturers and some special interest groups
October 1997	Energetics reports to DPIE on energy efficiency program for motors, including recommended MEPS levels and “High Efficiency” requirements
April 1999	Consultation Paper on proposed MEPS prepared for AGO by SRCI
April 2000	Standards Australia issues drafts of proposed revised AS/NZS 1359.5 – comment period to closed 7 May 2000
May 2000	Before preparing the draft RIS, GWA presents issues paper (GWA 2000) to a steering group comprising members of AREMA.

Proposed consultations

The following further consultations are planned between early October and mid November.

- AGO will send out copies of this draft RIS to known interested parties, advertise its availability, and in mid October hold public meetings in Sydney and Melbourne (and possibly Perth and/or Adelaide, if there is demand), at which the consultant will make presentations.

- Written comments will be received up to the end of October.

- The consultant will review and address written comments received, propose responses, discuss them with the AGO and revise the final RIS as agreed.

5.2 Comments

Comments received prior to publication of draft RIS

Energetics (1997) formally interviewed representatives of all 12 major motor suppliers, as well as a range of OEMs, the Australian Chamber of Manufactures (ACM), the Business Council of Australia and the Electrical Apparatus Servicing Association (EASA). It found that:

- 9 of the 12 suppliers "were happy to support the recommendations and methodologies, albeit with minor comments..."
- 3 suppliers had some concerns
- all of the OEMs surveyed "conceptually supported the program" and most indicated that it would have minimal impact on their business.

The majority of stakeholders interviewed felt that removing the "least efficient 40%" of motors from the market was a reasonable starting point for achieving the objectives of improving energy efficiency and reducing greenhouse gas emissions. It was generally considered neither too stringent nor too lenient.

In addition, it was felt that even with the introduction of MEPS at the efficiency ratings corresponding to the 40% cut–off level that end-users would still have a good range of choice across all motor size ranges. A number of respondents suggested that if the MEPS cut–off level were significantly higher, non-compliance would increase.

Suggestions for an alternate MEPS level ranged from eliminating only the "bottom 20%" of motors – from a minority of stakeholders – up to removing as high as 80%. The suppliers who took the view that the proposed level were too stringent tended to have more models in the sub-MEPS categories.

One OEM was concerned that it may be required to import a non–standard motor range into Australia from its overseas supplier which, in turn, would raise the cost of its products. The choice of motors in the standard range was influenced by "world–wide" economics and sales – not Australian requirements. (The scope of the regulation as currently proposed would cover only new motors supplied *within* Australia, not direct imports by OEMs that are then incorporated into OEs – proved that the motor is then "integral with, and not separable from, a driven unit"). Support for a more stringent MEPS level was primarily driven by a concern that higher standards were in place elsewhere - notably, Canada and USA - and the sentiment that Australia should harmonise with these. Some of the parties consulted suggested tamping the MEPS levels up over time.

Comments on draft RIS

[This section will address comments received on the draft RIS]

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6. Evaluation and Recommendations

COAG Guidelines:

- ***Evaluation:*** *there should be an evaluation of the relative impacts of the proposal and any alternatives, to show that the desired policy objective cannot be achieved at a lower cost to business and the community at large.*

6.1 Assessment

A summary assessment of the six alternatives considered in this RIS against the objectives of the mandatory MEPS option is given in Table 14.

Reduce greenhouse emissions below business as usual

The mandatory MEPS option is the only one for which the extent of likely reduction can be quantified, and the one where reductions have the highest probability of occurring.

Address market failures

The mandatory MEPS option would address the market's lack of concern with operating costs by enforcing investment in more efficient products so that the total life cycle cost of motors to users would be lower than otherwise, irrespective of whether they changed their purchase behaviour.

An efficiency-related levy on appliances could address the market failure by making the more efficient products cheaper than the less efficient, and so encourage their purchase by all buyers, including those concerned exclusively with capital cost. If such an option could be implemented – and there is no obvious legal or taxation mechanism - the cost to suppliers would be no lower, and the administrative costs higher than under the proposed regulations.

An emissions-related levy on electricity prices would be less effective than the efficiency-related levy on appliances, since it addresses running costs rather than capital costs. It would have economy-wide implications that are beyond the scope of the present analysis. Given that any decision to implement such a levy would need to be taken at the highest levels of Government, it is not considered a direct alternative to the proposed regulation.

Address information failures

One consequence of the mandatory MEPS option would be to address two modes of information failure:

- It would introduce consistency in the designation of models as "High Efficiency"
- It would put reliable data on the energy efficiency of every motor in the public domain for the first time.

Buyers could access this data via the State government registers of products (assuming these are made public, as is now the case of household appliances) and via the Australian Motor Systems Challenge, which would have complete market data (rather than data on about one third of the market, as at present). Some of the other options could also achieve this objective, though not necessarily as effectively.

Minimise negative impact on product quality

None of the options are expected to have any significant effect on product quality or function (ie apart from energy-efficiency).

Minimise negative impacts on suppliers

The mandatory MEPS option would clearly require suppliers to withdraw, replace or improve non-complying products. The other options would have lower costs for suppliers to the extent that they were less effective in bringing about these outcomes. At the extreme, the voluntary MEPS option would have least impact on suppliers because it is unlikely that any would take it up.

Conclusions [Draft]

After consideration of the mandatory MEPS option and the provisions of the Standard in this RIS, it is concluded that:

1. The mandatory MEPS option is likely to be effective in meeting its stated objectives

2. None of the alternatives examined appear as effective in meeting all objectives, some would be completely ineffective with regard to some objectives, and some appear to be far more difficult or costly to implement.

3. The projected monetary benefits of the mandatory MEPS option appear to exceed the projected costs by a ratio of about 1.8 to 1, without assigning monetary value to the reductions in CO_2 emissions that are likely to occur.

4. Given that the proposed MEPS levels have been in the public domain since June 1997, and issued in a draft standard in April 2000, the program could be implemented as early as 1 July 2001. Implementation in December 2001 would reduce the projected energy and CO_2 savings in the period to 2015 by about 5%.

Table 14 Assessment of alternatives against objectives

Objective and assessment criteria	A. Status quo	B. Mandatory MEPS	C. Targeted Regulatory MEPS[(a)]	D. Voluntary MEPS	E. Levy on Inefficient Appliances	F. Levy on electricity
Objective: Reduce emissions below BAU	No	Significant reduction projected	Retention of supporting features in standard contributes to this objective	Extent of reduction uncertain – most likely far less than under proposed regulation	Extent of reduction uncertain – if funds raised go to other programs, they are not likely to be as effective as MEPS	Extent of any reduction uncertain
Address market failures	No	Yes – projected to reduce lifetime costs of motors	Retention of supporting features in standard contributes to this objective	Fails to address market failure; relies on raising consumer and supplier concern with energy	May address market failure, but large price differentials would be necessary to affect purchase decisions	Large price increase necessary to affect purchase decisions
Address information failures	No	Potentially – makes comparable data available, relies on regulators to disseminate	Retention of HE and registration requirements contribute to this objective	Introduction of 3 market segments (HE, MEPS, sub-MEPS) could confuse	Potentially – makes comparable data available, relies on regulators to disseminate	Would help draw attention to running costs
Minimise negative impact on product quality	No effect	No effect	No effect	No effect	No effect	No effect
Minimise negative impacts on suppliers	No effect	Most suppliers will have some non-complying models, so costs are fairly widely distributed. Costs of improving products likely to be moderate. Range of supplier responses possible.	Retention of check test procedures and option of (lower-cost) simulation contributes to this objective	Would minimise supplier costs, since few suppliers likely to opt in	Supplier costs no less than for mandatory MEPS. Administrative costs likely to be higher	Would minimise supplier costs
Other issues		Need to clarify whether MEPS to apply to motors intended for export of for incorporation into exported equipment	Targeting scope of regulation to maximum 50 kW cooling recommended	True voluntary MEPS has not been successfully introduced anywhere in the world	No readily apparent legal means of raising the levy. At best, would be a form of non-mandatory MEPS with higher costs	Not a true alternative – decision does not rest with ANZMEC

(a) “Targeting” implies omission from regulation of the following elements: High Efficiency Motor criteria, consistency in claims of efficiency, registration of product information with regulatory authority.

6.2 Recommendations [Draft]

It is recommended that:

1. States and Territories implement the proposed mandatory minimum energy performance standards.

2. The mode of implementation be through amendment of the existing regulations governing appliance energy labelling and MEPS in each State and Territory.

3. The amendments should:
   – add electric motors to the schedule of products for which minimum energy performance standards are required, and refer to the MEPS levels in Section 2 of the proposed AS/NZS 1359.5;
   – add electric motors to the schedule of products requiring energy labelling, so that any supplied motor for which the claim of "high efficiency" or "energy efficient" are made must meet the energy efficiency criteria Section 3 of the proposed AS/NZS 1359 Section 3 (but without requiring physical energy labelling of the products themselves);
   – require registration of models, so invoking Part 4.1 of the proposed Standard.
   – require compliance with the scope and general provisions of Section 1 of the proposed AS/NZS 1359.

4. Governments make the register of electric motor model characteristics publicly accessible, so prospective purchasers can compare their energy efficiencies.

7. Review

COAG Guidelines:

- ***Review:*** *there should be consideration of how the regulation will be monitored for amendment or removal. Increasingly, sunset provisions are regarded as an appropriate way of ensuring regulatory action remains justified in changing circumstances.*

Electric motor MEPS would be implemented under the same State and Territory regulations as household appliance labelling and MEPS, and so subject to the same sunset provisions, if any. Victoria and SA have general sunset provisions applying to their labelling/MEPS regulations as a whole, while NSW has sunset provisions applying to the inclusion of some (but not all) items scheduled.

Once the States and Territories agree to mandatory requirements, their removal in any one jurisdictions would undermine the effect in all other jurisdictions, because of the Mutual Recognition agreements between the States and Territories (GWA 1999a). Under the cooperative arrangements for the management of the National Appliance and Equipment Energy Efficiency Program, States advise and consult when the sunset of any of the provisions is impending. This gives the opportunity for fresh cost-benefit analyses to be undertaken and consultation.

The Australian Standards called up in State and Territory labelling MEPS regulations are also subject to regular review. The arrangements between the Commonwealth, State and Territory governments and Standards Australia provide that the revision of any Standards called up in energy labelling and MEPS regulations are subject to the approval of the governments.

Therefore any proposal to make the MEPS in AS/NZS 1359.5 either more or less stringent would need the cooperation of both the Standards bodies and of the regulators.

NAEEEC has foreshadowed consideration of raising the MEPS levels for motors to the HE levels in 2005 (NAEEEC 2000). These levels would be comparable to those introduced in the USA and Canada in 1997. NAEEC has adopted the principles that there should be a MEPS “stability period” of at least 4 years, and that a cost-benefit analysis would be undertaken before any revisions are proposed (NAEEEC 1999). The earliest possible timing of any change to the MEPS regulations discussed in this RIS would therefore depend on date of their implementation. If they are implemented in July 2001, the earliest possible revision would be July 2005.

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References

ABARE (1999) *Australian energy: Market developments and projections to 2014-15* Australian Bureau of Agricultural and Resource Economics, April 1999

AGO (2000) *National Greenhouse Gas Inventory 1998* Australian Greenhouse Office, Canberra

AGO (2000a) *National Greenhouse Gas Inventory: Analysis of trends and greenhouse indicators, 1990-1998* Australian Greenhouse Office, Canberra

Almeida et al. (Eds) (1997) *Energy Efficiency Improvements in Electric Motors and Drives,* Anibal de Almeida, Paolo Bertoldi and Werner Leonhard (Eds.), Springer 1997

APEC (1998) *Overview of Trade Flows of Energy-Using Products Between APEC Member Economies,* APEC Energy Working Group, Export Council for Energy Efficiency, November 1998

APEC (1999) *Review of Energy Efficiency Test Standards and Regulations in APEC Member Economies,* APEC Energy Working Group, Asia-Pacific Economic Cooperation, November 1999

BIE (1994) *Energy labelling and standards: implications for economic efficiency and greenhouse gas emissions: a case study of motors and drives* Bureau of Industry Economics

Energetics (1996) *Energy Labelling and Energy Performance Standards: Motors – Stage 1,* Energetics for Department of Primary Industries and Energy, January 1996

Energetics (1997) *Energy Labelling and Energy Performance Standards: Motors – Stage 3. Book 1 – Report,* Energetics in conjunction with George Wilkenfeld & Associates and Energy Efficient Strategies, for Department of Primary Industries and Energy, October 1997

Energetics (1997b) *Energy Labelling and Energy Performance Standards: Motors – Stage 3. Book 2 – Appendices,* Energetics in conjunction with George Wilkenfeld & Associates and Energy Efficient Strategies, for Department of Primary Industries and Energy, September 1997

Energetics (1997c) *Energy Labelling and Energy Performance Standards: Motors – Stage 3. Book 3 – Shareholder Feedback Forms,* Energetics in conjunction with George Wilkenfeld & Associates and Energy Efficient Strategies, for Department of Primary Industries and Energy, August 1997

Energetics and GWA (1994) *Energy Performance Standards and Energy Labelling for Industrial and Commercial Equipment.* Energetics Pty Ltd and George Wilkenfeld and Associates, for Department of Primary Industries and Energy, April 1994.

GWA (1999) *Regulatory Impact Statement: Energy Labelling and Minimum Energy Performance Standards for Household electrical appliances in Australia*. George Wilkenfeld and Associates, with assistance from Energy Efficient Strategies, February 1999.

GWA (2000) *Regulatory Impact Statement: Minimum Energy Performance Standards and alternative strategies for electric motors. Discussion Paper* George Wilkenfeld and Associates, May 2000

GWA (2000a) *Greenhouse Gas Coefficients for Electricity, Australia 1997/98,* George Wilkenfeld and Associates Pty Ltd for the Greenhouse Challenge Office, April 2000

NAEEEC (1999) *National Appliance and Equipment Energy Efficiency Program* National Appliance and Equipment Energy Efficiency Committee, Canberra.

NGS (1998) *The National Greenhouse Strategy*, Commonwealth of Australia, Canberra.

SRCI (1999) *Consultation Paper: Draft Standard for MEPS for Electric Motors,* Prepared for Australian Greenhouse Office by SRC International Pty Ltd, April 1999

Appendix 1 Extract from Typical State Regulations

NSW Electricity Safety Act (1945)
Electricity Safety (Equipment Efficiency) Regulation 1999

Part 2 Standards

5 Minimum standards

(1) An electrical article listed in Schedule 2 must comply with the performance criteria set out in Part 2 of the relevant standard when tested, in accordance with Part 1 of that standard, by an accredited laboratory.

(2) An electrical article listed in Schedule 3 must comply with the energy efficiency requirements set out in the relevant standard.

(3) In this clause, accredited laboratory means a laboratory:

(a) accredited by the National Association of Testing Authorities, or

(b) approved by the Corporation.

Part 4 Labelling of electrical articles

15 Electrical articles to be appropriately labelled when sold

(1) A person must not sell an electrical article listed in Schedule 2 unless an approved energy efficiency label is displayed on the article in accordance with Part 2 of the relevant standard. Maximum penalty: 20 penalty units.

(2) In the case of an air conditioner that is sold in a package, the approved energy efficiency label may instead be displayed on the package.

(3) This clause applies in respect of the sale of new articles, whether by wholesale or retail, but does not apply to the sale of second-hand articles.

SCHEDULE

(Clauses 7 and 19)

Item	Fee
For registration of an electrical article	$150
For transfer of registration of an electrical article	$50
For provision of an extract from the Register	$50

Schedule 2 Standards for electrical articles that require registration and labelling

Article: (Clause 5 (1))

Relevant standard:

Clothes washing machine Australian/New Zealand Standard, "Performance of household electrical appliances Clothes washing machines Part 1: Energy consumption and performance", AS/NZS 2040.1:1998, and Australian/New Zealand Standard, "Performance of household electrical appliances Clothes washing machines Part 2: Energy labelling requirements", AS/NZS 2040.2:1998.

Dishwasher Australian/New Zealand Standard, "Performance of household electrical appliances Dishwashers Part 1: Energy consumption and performance", AS/NZS 2007.1:1998, and Australian/New Zealand Standard, "Performance of household electrical appliances Dishwashers Part 2: Energy labelling requirements", AS/NZS 2007.2:1998.

Refrigerating appliance Australian/New Zealand Standard, "Performance of household electrical appliances Refrigerating appliances Part 1: Energy consumption and performance", AS/NZS 4474.1:1997, and Australian/New Zealand Standard, "Performance of household electrical appliances Refrigerating appliances Part 2: Energy labelling and minimum energy performance standard requirements", AS/NZS 4474.2:1997.

Room airconditioner Australian/New Zealand Standard, "Performance of household electrical appliances Room airconditioners Part 1.1: Non-ducted airconditioners and heat pumps Testing and rating for performance", AS/NZS 3823.1.1:1998, and Australian/New Zealand Standard, "Performance of household electrical appliances Room airconditioners Part 2: Energy labelling requirements", AS/NZS 3823.2:1998.

Rotary clothes dryers Australian/New Zealand Standard, "Performance of household electrical appliances Rotary clothes dryers Part 1: Energy consumption and performance", AS/NZS 2442.1:1996, and Australian/New Zealand Standard, "Performance of household electrical appliances Rotary clothes dryers Part 2: Energy labelling requirements", AS/NZS 2442.2:1996.

Schedule 3 Standards for electrical articles that require registration only

Article: (Clause 5 (2))

Relevant standard:

Storage water heater unvented without an attached feed tank Australian Standard, "Storage water heaters Part 1: General requirements", AS 1056.1:1991, Clause 2.4 "Thermal Insulation".

Appendix 2 Proposed MEPS and HEM levels

The following sections are taken from Standards Australia Combined Postal Ballot/ Draft for Public Comment DR 00092 CP, issued 1 April 2000. This is a draft of the standard proposed to be published as AS/NZS 1359.5 *Rotating electrical machines – General requirements Part 5: Three-phase cage induction motors – High efficiency and minimum energy performance standards requirements.* Publication is expected in October or November 2000. However, it should be noted that drafts are liable to alteration and should not be used as Standards.

SECTION 2 MINIMUM EFFICIENCIES— ALL MOTORS (METHODS A AND B)

2.1 MINIMUM EFFICIENCY—TEST METHOD A

Where measured in accordance with AS/NZS 1359.102.3 or with a standard method technically equivalent thereto, the efficiency of a motor, at either rated load or at 75% rated load, shall not be less than that specified in Table 2.1.

NOTE: IEEE 112–1996 Method B is considered to be technically equivalent to AS/NZS 1359.102.3.

TABLE 2.1 MINIMUM EFFICIENCY—TEST METHOD A

Rated output kW	Minimum efficiency %			
	2 pole	4 pole	6 pole	8 pole
0.73	72.3	72.7	70.7	66.7
0.75	72.3	72.7	70.7	66.7
1.1	74.6	74.6	73.6	69.9
1.5	76.9	76.9	75.7	73.0
2.2	79.5	79.5	78.1	76.1
3	81.2	81.2	79.9	78.2
4	82.8	82.8	81.6	80.1
5.5	84.4	84.4	83.3	82.0
7.5	85.8	85.8	84.7	83.7
11	87.2	87.2	86.4	85.6
15	88.3	88.3	87.7	87.1
18.5	89.0	89.0	88.6	88.0
22	89.5	89.5	89.1	88.7
30	90.5	90.5	90.2	89.9
37	91.1	91.1	90.8	90.6
45	91.7	91.7	91.5	91.2
55	92.2	92.2	92.0	91.8
75	92.9	92.9	92.8	92.7
90	93.4	93.2	93.2	93.0
110	93.8	93.8	93.7	93.5
132	94.2	94.1	94.1	93.8
150	94.5	94.5	94.4	94.1
<185	94.5	94.5	94.4	94.1

Note: For intermediate values of rated output, the efficiency shall be determined by linear interpolation.

2.2 MINIMUM EFFICIENCY—TEST METHOD B

Where measured in accordance with AS 1359.102.1 or with a standard method technically equivalent thereto, the efficiency of a motor, at either rated load or at 75% rated load, shall not be less than that specified in Table 2.2.

IEC 60034-2 and BS 4999.102 are considered to be technically equivalent methods to AS 1359.102.1.

TABLE 2.2 MINIMUM EFFICIENCY—TEST METHOD B

Rated output kW	Minimum efficiency %			
	2 pole	4 pole	6 pole	8 pole
0.73	74.0	74.4	72.4	68.4
0.75	74.0	74.4	72.4	68.4
1.1	76.2	76.2	75.2	71.5
1.5	78.5	78.5	77.3	74.6
2.2	81.0	81.0	79.6	77.6
3	82.6	82.6	81.4	79.7
4	84.2	84.2	83.0	81.5
5.5	85.7	85.7	84.6	83.3
7.5	87.0	87.0	86.0	85.0
11	88.4	88.4	87.6	86.8
15	89.4	89.4	88.8	88.2
18.5	90.0	90.0	89.6	89.0
22	90.5	90.5	90.1	89.7
30	91.4	91.4	91.1	90.8
37	92.0	92.0	91.7	91.5
45	92.5	92.5	92.3	92.0
55	93.0	93.0	92.8	92.6
75	93.6	93.6	93.5	93.4
90	94.1	93.9	93.9	93.7
110	94.4	94.4	94.3	94.1
132	94.8	94.7	94.7	94.4
150	95.0	95.0	94.9	94.7
<185	95.0	95.0	94.9	94.7

For intermediate values of rated output, the efficiency shall be determined by linear interpolation.

SECTION 3 MINIMUM EFFICIENCIES — HIGH EFFICIENCY MOTORS (METHODS A AND B)

3.1 HIGH EFFICIENCY—TEST METHOD A

A motor may be designated 'high efficiency' only if its efficiency, measured in accordance with AS/NZS 1359.102.3 or with a standard method technically equivalent thereto, at either rated load or at 75% rated load, is not less than that specified in Table 3.1.

TABLE 3.1 MINIMUM 'HIGH' EFFICIENCY—TEST METHOD A

Rated output kW	Minimum efficiency %			
	2 pole	4 pole	6 pole	8 pole
0.73	78.8	80.5	76.0	71.8
0.75	78.8	80.5	76.0	71.8
1.1	80.6	82.2	78.3	74.7
1.5	82.6	83.5	79.9	76.8
2.2	84.1	84.9	81.9	79.4
3	85.3	86.0	83.5	81.3
4	86.3	87.0	84.7	82.8
5.5	87.2	87.9	86.1	84.5
7.5	88.3	88.9	87.3	86.0
11	89.5	89.9	88.7	87.7
15	90.3	90.8	89.6	88.9
18.5	90.8	91.2	90.3	89.7
22	91.2	91.6	90.8	90.2
30	92.0	92.3	91.6	91.2
37	92.5	92.8	92.2	91.8
45	92.9	93.1	92.7	92.4
55	93.2	93.5	93.1	92.9
75	93.9	94.0	93.7	93.7
90	94.2	94.4	94.2	94.1
110	94.5	94.7	94.5	94.5
132	94.8	94.9	94.8	94.8
150	95.0	95.2	95.1	95.2
<185	95.0	95.2	95.1	95.2

For intermediate values of rated output, the efficiency shall be determined by linear interpolation.

3.2 HIGH EFFICIENCY—TEST METHOD B

A motor may be designated 'high efficiency' only if its efficiency, measured in accordance with AS 1359.102.1 or with a standard method technically equivalent thereto, at either rated load or at 75% rated load, is not less than that specified in Table 3.2.

TABLE 3.2 MINIMUM 'HIGH' EFFICIENCY – TEST METHOD B

Rated output kW	Minimum efficiency %			
	2 pole	4 pole	6 pole	8 pole
0.73	80.5	82.2	77.7	73.5
0.75	80.5	82.2	77.7	73.5
1.1	82.2	83.8	79.9	76.3
1.5	84.1	85.0	81.5	78.4
2.2	85.6	86.4	83.4	80.9
3	86.7	87.4	84.9	82.7
4	87.6	88.3	86.1	84.2
5.5	88.5	89.2	87.4	85.8
7.5	89.5	90.1	88.5	87.2
11	90.6	91.0	89.8	88.8
15	91.3	91.8	90.7	90.0
18.5	91.8	92.2	91.3	90.7
22	92.2	92.6	91.8	91.2
30	92.9	93.2	92.5	92.1
37	93.3	93.6	93.0	92.7
45	93.7	93.9	93.5	93.2
55	94.0	94.2	93.9	93.7
75	94.6	94.7	94.4	94.4
90	94.8	95.0	94.8	94.7
110	95.1	95.3	95.1	95.1
132	95.4	95.5	95.4	95.4
150	95.5	95.7	95.6	95.7
<185	95.5	95.7	95.6	95.7

For intermediate values of rated output, the efficiency shall be determined by linear interpolation.

Appendix 3 Key Modelling Assumptions and Outcomes

Price and Efficiency Relationships

The Energetics (1997) survey compiled data on kW output, type, poles and efficiency for some 1,344 individual motors. About 400 of these had sales numbers, representing sales of around 52,300 units or about 40% of the total market (34% if the OEs are included). While parts of the survey were completed by all 12 suppliers, only 6 provided a breakdown of unit sales by motor model and size. Around 470 models had list price data associated with them.

The motor models where efficiency was available were examined in detail. Very little data for open drip proof design (ODPD) motors was provided, so these were included with the totally enclosed design (TEFC) motors for analysis. It is clear that average efficiency varies with both motor size and the number of poles. Generally 4 poles variants are the most efficient while 8 pole variants are the least efficient, although this depends on the size. A summary of the (unweighted[14]) average motor efficiency of those models surveyed is shown Table 15.

Table 15 Average Motor Efficiency (%) by Pole and Size - Australia 1995

kW	2 Pole	4 Pole	6 Pole	8 Pole
0.75	75.05	75.18	72.34	68.35
1.1	77.55	77.50	75.25	71.50
1.5	79.98	79.24	77.59	74.59
2.2	82.06	81.99	80.77	78.82
3	83.61	82.41	82.50	81.22
4	85.58	84.65	84.54	82.53
5.5	86.21	86.89	85.39	84.32
7.5	87.15	88.03	86.90	85.66
11	88.39	89.30	88.15	87.77
15	89.32	90.19	89.68	88.86
18.5	90.40	90.71	90.53	90.23
22	90.99	91.31	91.25	91.13
30	91.71	92.02	91.51	91.67
37	92.33	92.69	92.10	92.48
45	92.82	93.07	92.74	92.82
55	93.08	93.50	93.11	93.21
75	93.79	93.79	93.70	93.56
90	93.77	93.92	93.92	93.74
110	94.03	94.24	94.45	94.10
132	94.52	94.83	94.82	94.37
150	94.95	95.05	94.76	94.67

This table has been used as the basis for data analysis for this study. The number of motor models used to determine average efficiency was not weighted by sales volume

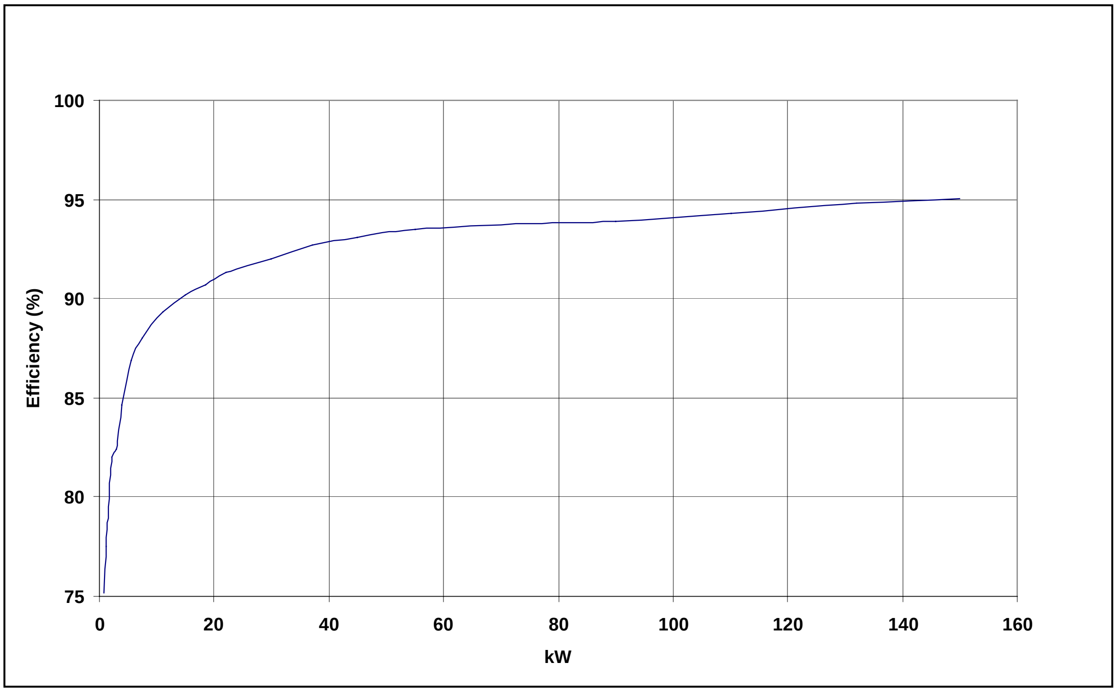
[14] Unweighted average in this context is the raw average for those models where efficiency was reported in the survey (not weighted by estimated sales).

and the number of motors in some larger pole/size categories was limited. Due to lack of data it was not possible to examine drip proof motors separately. The relationship between size and efficiency for 4 pole motors is shown in Figure 9.

Table 16: Number of Models used to Determine Average Motor Efficiency

kW	2 Pole	4 Pole	6 Pole	8 Pole
0.75	14	16	16	14
1.1	15	17	17	13
1.5	15	17	17	14
2.2	16	17	17	14
3	14	14	14	12
4	17	17	17	14
5.5	17	17	17	14
7.5	17	17	17	13
11	19	19	19	14
15	19	19	19	13
18.5	19	19	19	13
22	19	19	19	11
30	18	19	17	10
37	19	20	18	12
45	19	20	18	12
55	19	19	18	11
75	19	19	17	11
90	19	19	17	11
110	18	19	14	10
132	17	18	13	9
150	15	17	10	7

Figure 9 Motor size versus average efficiency - 4 pole motors



Models where list price data was available were examined to determine the relationship between size (kW) and price (if any). A cross tabulation of average price by pole and motor size was prepared, to establish price trends fir the 84 possible combinations of size and pole numbers. For any given motor size, average price tends to increase with the number of poles. A line of best fit was fitted to 4 pole motors, as this was the smoothest curve. The equation used was a third order polynomial:

$$\text{Price} = 0.001\,(\text{kW})^3 - 0.2969\,(\text{kW})^2 + 89.538\,(\text{kW}) + 143.59$$

Due to the limited number of price data points for some combinations of poles and kW, the data points varied from the line of best fit in places, although the average fit was very good. It was found that the average ratio of list price to number of poles was constant with size, so a scaling factor was used to produce a curve for each pole combination. Relative to a scaling factor of 1.0 for 2 pole units, 4 pole prices were 1.08, 6 pole prices were 1.43 and 8 pole prices were 2.21.

Figure 10 shows that data available (as points) and the lines of best fit for each of the pole combinations. Note that no price data for 8 pole motors larger then 45 kW was provided, so this estimated curve needs to be treated with some caution.

The next step was to determine the relationship of motor efficiency to list price for those models where price data was available. As efficiency varies with both poles and size, it was necessary to normalise data (as far as possible) back to non-dimensional units where the influence of poles and size is removed. For each model where both list price and efficiency values were available, there were compared with the average price and average efficiency for that particular size and pole combination. Where the actual efficiency was higher than the average efficiency for that group, the "normalised efficiency" (the ratio of actual efficiency to average efficiency) was greater than 1. Similarly, where the actual efficiency was less than the average efficiency for that combination, the "normalised efficiency" was less than 1. Similar calculations were made for price.

The use of "normalised" efficiency and price values allows all motors to be plotted on the same graph, since the influence of capacity and pole type is already taken into account by the process of normalisation.

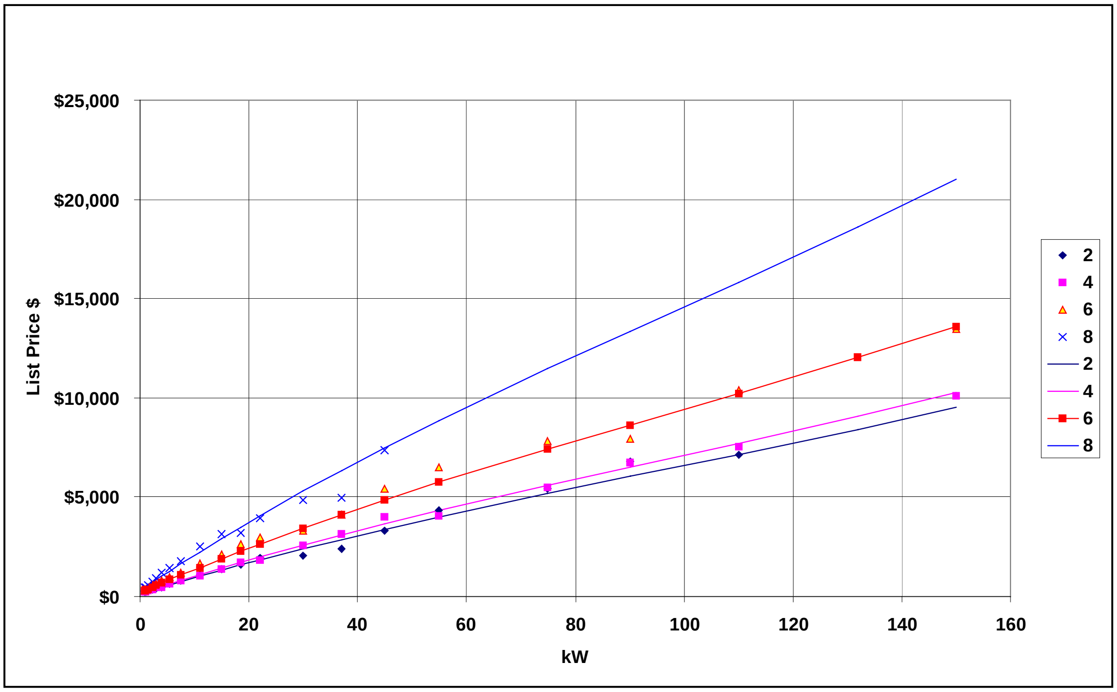
A linear regression was obtained as follows:

$$\text{Normalised Average Price} = 1.1877 \times \text{Normalised Efficiency} - 0.289$$

For all motor models where efficiency data was collected, an estimated list price was used where this was available, or a calculated list price was used based on the above regression. Thus all 1,344 models were assigned a list price (either actual or estimated).

The survey of manufacturers resulted in the collection of detailed sales data by model for 6 of the 12 manufacturers. This constituted some 52,300 motor sales. According to Energetics research, this left nearly 78,000 motor sales to allocate to the remaining 6 manufacturers (as well as a further 26,000 OE motors). Energetics provided an estimate of the total sales by manufacturer and total sales by size. The manufacturers without model sales data each had around 70 models into which to allocate sales, so sales were allocated in the same proportions of kW size and pole combinations for models where sales were known.

Figure 10 Motor List Price versus kW for Various Pole Combinations



Efficiency Trends

The model develops two sets of projections for each of 5 motor capacity ranges:

- The sales-weighted average in the absence of MEPS (the BAU case); and
- The sales-weighted average with MEPS.

Figure 11 to Figure 15 illustrate the trends for each of the capacity ranges, using a common scale on each of the axes. The with-MEPS average diverges from the BAU line in the lead-up to the implementation of MEPS, since suppliers change their model range before the implementation date. The area between the two lines represents the energy saved through the implementation of MEPS. It is assumed that after implementation, motor efficiencies increase rather more slowly in the MEPS scenario than in the BAU case, because efficiency increases that would have occurred in the future are pulled forward rather than augmented, but if information programs such as the Australian Motor Systems Challenge are successful, then there may be additional savings over the MEPS case.

The diagrams also illustrate the model average efficiency increases for the 4 brands where data are available (using linear interpolation between the 1995 and 2000 data). There conform reasonably well to the "with-MEPS" projections, suggesting that these motor suppliers are already anticipating implementation.

Figure 11 Energy efficiency projections, 0.75 to 2.2 kW motors

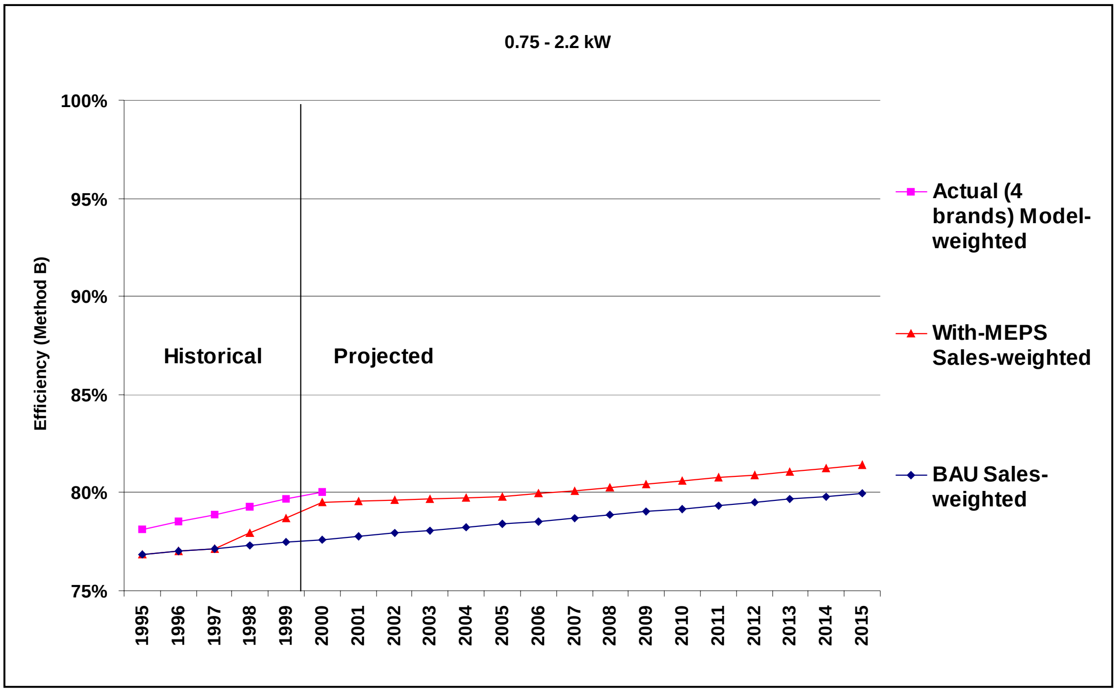


Figure 12 Energy efficiency projections, 3 to 7.5 kW motors

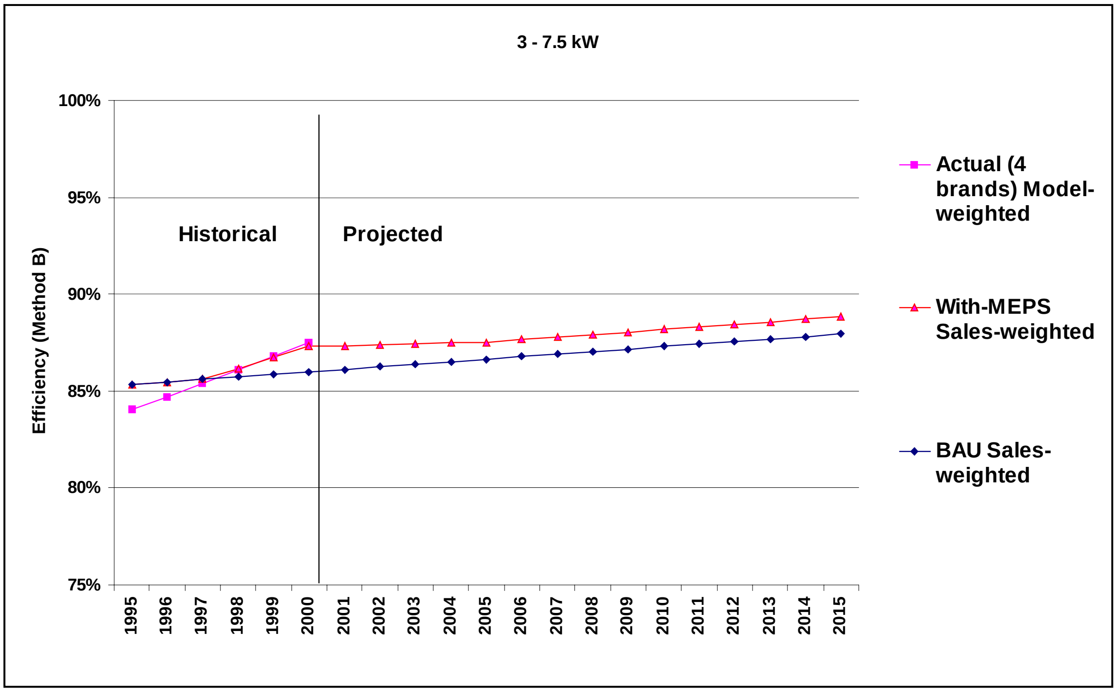


Figure 13 Energy efficiency projections, 11 to 37 kW motors

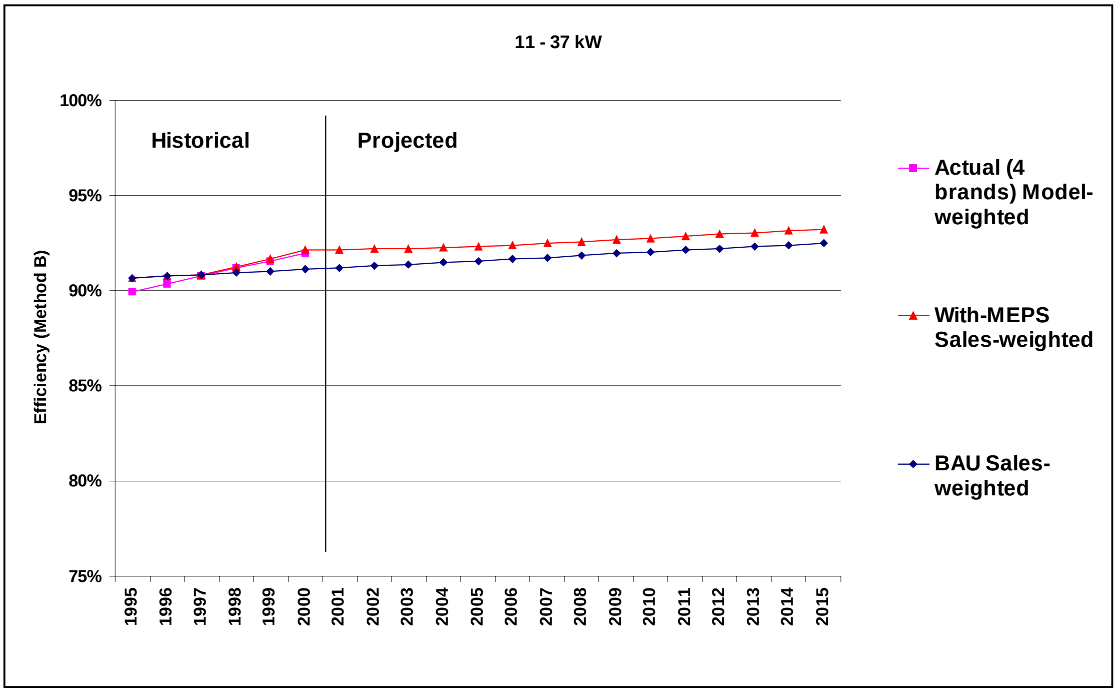


Figure 14 Energy efficiency projections, 45 to 90 kW motors

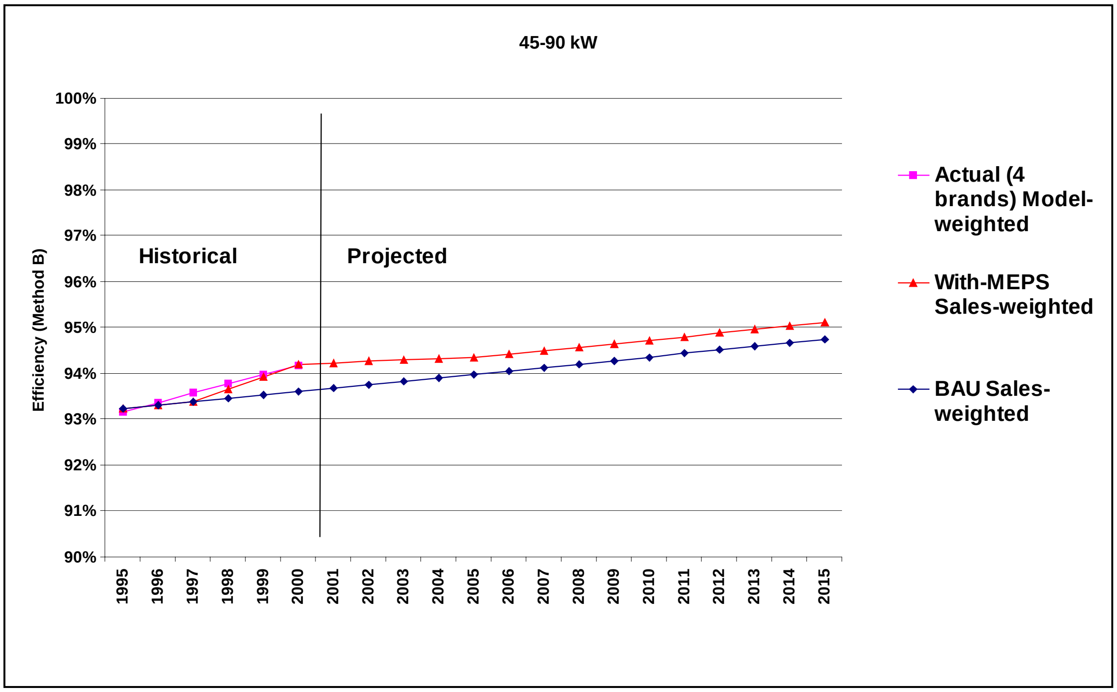
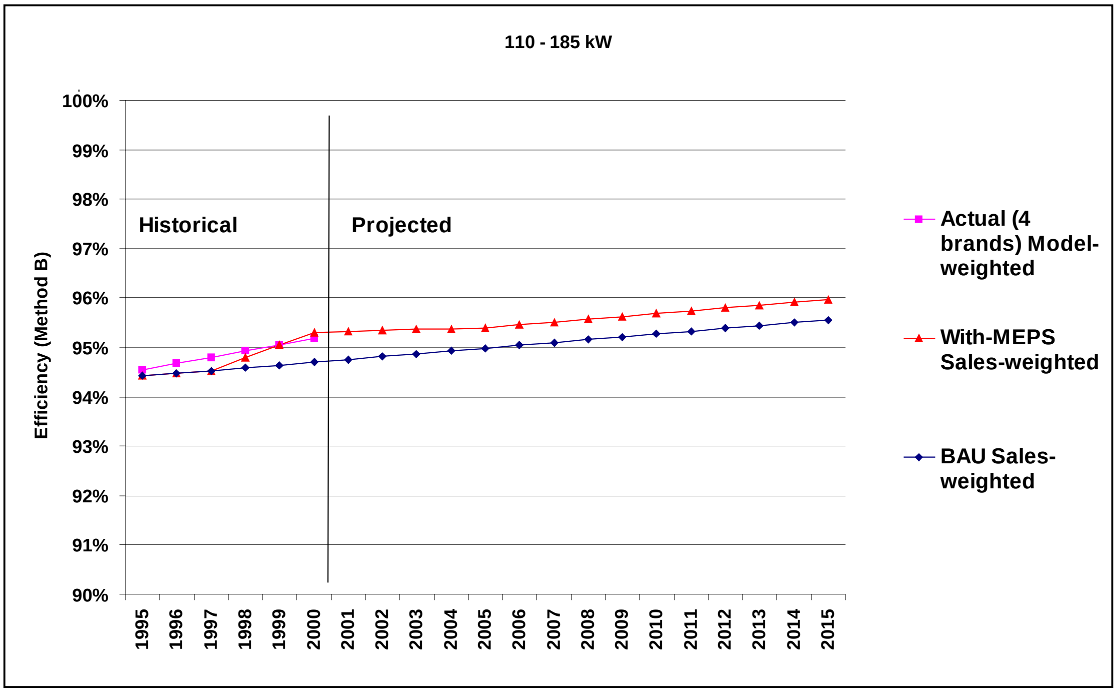


Figure 15 Energy efficiency projections, 110 to 150kW motors



Greenhouse Gas Emissions

The projection of electricity system CO_2 intensities used in the RIS, illustrated in Figure 16, are taken from GWA (2000a). The intensities are projected to decline due to an eventual preference for natural gas, and the impacts of two Commonwealth initiatives, the "2% renewables" measure and power station efficiency standards.

Figure 16 Projected emissions-intensity of electricity supply by State, 1990-2020