Equipment Energy Efficiency

Product Profile – Small Fan Units

Australia and New Zealand

May 2012

A joint initiative of Australian, State and Territory and New Zealand Governments.

Contents

CONTENTS III

EXECUTIVE SUMMARY 1
- The issue 1
- Possible policy options 2
- Consultation on this Product Profile 2
- After Consultation on this Product Profile 2
- Questions for readers 2

1. INTRODUCTION 5
- Background to this report 5
- Scope of this Product Profile 6
- Policy context 7

2. SMALL FAN UNIT TECHNOLOGY 9
- Types of small fan unit motors 9
  - Shaded-pole single-phase fan motors 9
  - External rotor fan assembly: single and three-phase fan motors 9
  - Permanent split capacitor motor 9
  - Electronically commutated motors 9
  - Universal motors 10
- Fan power and efficiency 10

3. MARKET PROFILE 12
- Market characteristics and trends 12
  - Fan motors in non-domestic refrigeration 14
- Barriers to energy efficiency improvement 16

4. ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS 17
- Opportunities for energy efficiency improvement 19
  - Improving energy efficiency of fan motors used in non-domestic refrigeration 20

5. POSSIBLE POLICY OPTIONS 22

6. STANDARDS 24
- Test method 24
- Efficiency Levels 24

7. REGULATORY CONSIDERATIONS 25

8. CONCLUSIONS 27

9. REFERENCES 28

10. APPENDICES 29
- Appendix A1. Comparison of regulating the fan alone against regulating the fan+motor combination 29
- Appendix A2. Benefits of regulating the fan alone 29
- Appendix A3. Benefits of regulating the fan+motor combination 30

LIST OF TABLES

Table 1: Typical shaft efficiency ranges for fan motor types, single phase power 11
Table 2: Estimated annual sales for selected appliances containing small fan units, 2009 13
Table 3: Estimated stock of fan motors used in non-domestic refrigeration, Australia 2008 14
Table 4: Value of motor imports for non-domestic refrigeration, Australia 1999-2008 14
Table 5: Country of origin of fan motor imports, Australia 1999-2008 15

Table 6: Estimated electrical energy usage for selected small fan units, 2009 18
Table 7: Estimated electricity consumption by fan motors in non-domestic refrigeration, Australia 2009 19
Table 8: Potential for improving energy efficiency by switching to a more efficient fan motor type 21
Table 9: Comparison of regulating the fan alone against regulating the fan+motor combination 29

LIST OF FIGURES

Figure 1: European Union Energy Efficiency Regulations for Fans 5
Figure 2: How this Product Profile compliments other current E3 motor and fan work streams 6
Figure 3: Designs for optimising fan+motor efficiencies: Axial fans used in non-domestic refrigeration 20
Figure 4: Designs for optimising fan+motor efficiencies: Centrifugal fans 20

Executive summary

This report provides a Product Profile for small fan units sold in Australia and New Zealand, where the input power to the fan motor is in the range 5 Watts (W) up to 125 W. It presents an outline of the context for considering policy approaches to improve energy efficiency and reduce greenhouse gas emissions associated with these products.

It is acknowledged that there are significant gaps in the information needed for effective decision-making regarding small fan units, including:

1) data on the market e.g. stock and sales of small fan units and appliances and equipment which potentially contain fan units within the scope of the profile, and

2) technical knowledge such as typical power consumption, annual operating time, and average efficiency of small fan units within scope.

Ultimately, to advance this work we will need assistance from industry stakeholders to address these gaps. Feedback from readers on the key questions presented in this Product Profile will be greatly appreciated.

The issue

Small fan units are found in many household appliances and some commercial and industrial equipment. Although each consumes low amounts of energy individually, the cumulative electrical consumption of the total stock of small fans in use could be substantial.

The Australian and New Zealand Governments acknowledge the potential for energy efficiency to deliver substantial and comparably low-cost reductions in energy consumption. In turn, this minimises greenhouse gas emissions, honouring international commitments and targets under the United Nations Framework Convention on Climate Change and the Kyoto Protocol.

In from the Cold, the ten-year strategy for non-domestic refrigeration launched in July 2011 (not yet published), recommends that initial consideration be given to possible measures to encourage improvements in the energy efficiency of small fan units used in refrigeration applications. This action is supported by the Fan Manufacturers Association of Australian and New Zealand (FMAANZ), the main industry association representing fan manufacturers and suppliers in Australia and New Zealand.

This Product Profile identifies two major barriers that mean the market for more efficient small fan units is not as strong as it could be:

‘Split incentives’ are associated with small fan units being selected by the appliance designers or manufacturers for incorporation into appliances according to design specifications or availability, while the electricity bills are paid by end users.

‘Information failures’ are likely to occur, especially where small fans are integrated into a larger item of equipment, as it will be very difficult for the end-use customer to obtain information on the efficiency of the small fan unit and to understand the benefits of a higher efficiency unit.

‘Bounded rationality’ occurs where consumers have limited information and limited time to make a decision and therefore lifecycle costs are not considered in decisions about selecting small fan units.

The large numbers of stock of appliances where small fan units are installed mean that the potential energy savings could be substantial if all of these issues are addressed. See section 1.2 for a list of common appliances with small fan units installed.

Possible policy options

A range of policy approaches might be effective at shifting the market for small fan units toward increased energy efficiency (in new equipment sold and new replacement components), in Australia and New Zealand. Options include Minimum Energy Performance Standards (MEPS) and High Efficiency Performance Standards (HEPS). Assessing the feasibility of regulating small fan units needs further discussion and better data provision - readers are asked for their feedback.

Consultation on this Product Profile

This is an initial consultation document for industry stakeholders. Comments are invited on the information, assumptions, and data gaps in this document. Feedback will be important in formulating the most appropriate policy approach, which could possibly be mandatory regulation or a voluntary measure. See the Questions for Readers below, and at the end of each section throughout the Product Profile. Please indicate the country of origin for any data supplied.

<u>Comments should be sent by email, and should be received by 6 July, 2012.</u>

Comments should be clearly titled 'Small Fan Units Product Profile' and sent to energyrating@climatechange.gov.au.

Consultation meetings with stakeholders will be held in Australia and New Zealand in June 2012.

After Consultation on this Product Profile

The evidence in the Product Profile will be reviewed and supplemented in light of any written submissions made by readers and/or issues raised at consultation meetings.

Decisions will be made by the Equipment Energy Efficiency (E3) Committee on whether to proceed with a proposal to improve the efficiency of small fan units sold into the Australian and New Zealand markets, and what the preferred option should be. If the preferred options involve regulation, a Regulatory Impact Statement (RIS) will be prepared to analyse the costs, benefits and other impacts of the proposal. Consultation will be undertaken with stakeholders prior to any final decision being made.

Final decisions on policy will be made by the Select Council on Climate Change (SCCC), formerly the Ministerial Council on Energy (MCE), in Australia, and by the New Zealand Cabinet.

Questions for readers

Readers are invited to comment on any aspect of this Product Profile. Key items are listed in the box below, and also repeated throughout the paper. Responses to these would be of particular assistance. Where the specific data asked for is not available, any indication of the relative split between identified categories would be very useful.

	Scope of Product Profile
1	*Is the size range of 5 to <125W appropriate for considering policies to increase the efficiency of small fan units?*
2	*Is input power of the fan unit a more appropriate metric than output power for defining the range of the scope for small fan units?*
3	*Is it more appropriate to approach efficiency improvements in the given size range by looking at the efficiency of the fan-motor assembly (fan unit), or at the fan as a stand-alone item?*
4	*Should this scope cover all types of fan units within this input power range?*
5	*What are other key applications for small fan units?*
6	*What would a market breakdown by application look like – either in terms of the installed stock or in terms of annual sales?*
7	*Feedback is sought on the appropriateness of the terminology and, if necessary, suggestions of alternative terms.*

Types of small fan unit motors

8 *What proportion of small fan units would be driven by each different type of motor?*

9 *How could the market for small fan unit motors be broken down by application?*

10 *What are the average cost differences between types of small fan unit motors?*

Fan power and efficiency

11 *What is the expected/typical energy efficiency and life-time length of small fan units driven by particular motors?*

Market Profile

12 *Readers are invited to address the knowledge gaps around market characteristics and trends for small fan units in Australia and New Zealand, including existing stock numbers, annual sales and industry sector breakdowns for small fan units.*

13 *Estimated sales and stock numbers are requested for:*

- Small fan units imported as separate items, to be integrated into products or used as replacement parts

- Small fan units imported as a component that is already integrated into an appliance

- Small fan units manufactured within Australia or New Zealand

14 *Which countries are the majority of small fan units imported from?*

Barriers to energy efficiency improvement

15 *Readers are invited to comment on the nature of split incentives and other market failures that are hindering uptake of higher efficiency small fan units.*

Energy consumption and greenhouse gas emissions

16 *Readers are asked to estimate the energy use and GHG emissions from the existing stock of small fan units, including:*

- total number of stock broken down by main end-use applications and size, and

- typical average power consumption and annual operating hours of small fan units in the main applications.

Opportunities for energy efficiency improvement

17 *What opportunities currently exist for improving the energy efficiency of small fan units?*

Possible policy options

18 *Would the greatest improvements in energy efficiency come from increasing the energy efficiency of the motor (e.g. EC motor technology), or the fan, or both?*

19 *Readers are invited to comment on the suitability of policy measures to achieve improvements in energy efficiency of small fan units. Comments are invited on the potential for savings in terms of economic costs, energy, and greenhouse gas emissions.*

Standards

20 *What kinds of efficiency levels would be appropriate if governments decided to pursue a regulatory approach to increasing the energy efficiency of small fan units?*

21 *Are testing facilities with the capacity to perform testing to AS ISO 5801 'Industrial fans performance testing using standardised airways' readily accessible? Is this test standard appropriate for small fans?*

22 *Are there other issues with regard to standards that have not been considered in this Product Profile?*

	Regulatory considerations
23	*What kinds of outcomes could be expected from regulations targeting the fan only? What would be the outcomes of regulating the fan and motor combination? See Appendix A for a detailed outline of the key issues.*
24	*What voluntary approaches could deliver an effective improvement in small fan unit efficiency, either complimentary to, or in absence of, MEPS/HEPS?*
25	*If small fan units were regulated with MEPS, what issues might arise with using them inside larger appliances such as fridges that also have MEPS?*
26	*Readers are asked to comment on the potential implications of taking a regulatory approach to the energy efficiency of small fan units. See pages 24-25 for more questions.*

1. Introduction

Although the energy consumption of an individual small fan unit (fan and motor combination) is minimal, the cumulative consumption of electrical energy by this product type across the equipment stock could be substantial because there are so many units in operation. Energy efficiency improvements in small fan unit technology could provide significant energy savings and associated greenhouse gas emissions reduction.

Background to this report

This Product Profile was developed with the recognition that we currently have very limited data to prompt discussion on the feasibility and practicality of potentially regulating small fan units. The aim is to use this document as the basis for collecting more in-depth data before proceeding with further investigations to determine the size of the potential costs, benefits and risks associated with various regulatory actions. It coincides with the release of the Product Profiles on non-domestic fans for Australia and New Zealand, covering fans driven by motors with an input power of 125W to 500kW. Figure 1.

Figure 1 below shows how this Product Profile compliments other current E3 motor and fan work streams.

The E3 non-domestic refrigeration strategy In from the Cold (launched in July 2011, not yet published) recommended that efficiency performance policy measures should be investigated for combined fan-motor assemblies supplied as complete units with input ratings of 15 W and above which are used in refrigeration applications.

Selected industry stakeholder support for policy action in this area has been indicated by Fan Manufacturers Association of Australian and New Zealand (FMAANZ, the main industry association representing fan manufacturers and suppliers) urging the Equipment Energy Efficiency Committee (E3) to expand the consideration of possible MEPS for fans[1] to include products driven by motors with an input power consumption of less than 125 Watts (E3 2012a). However, feedback is sought from other sectors such as importers of small fan units.

The energy efficiency regulations to be introduced for fans in the European Union are outlined in Figure 1.

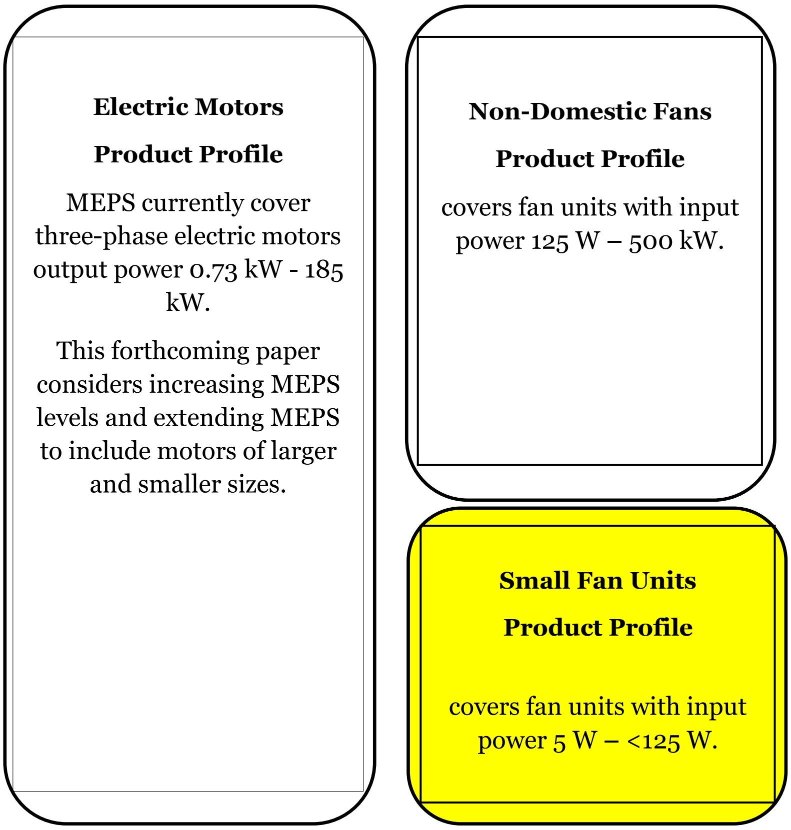
Figure 1: European Union Energy Efficiency Regulations for Fans

> The European Union has decided to introduce regulations which will place energy efficiency requirements on fans driven by motors with an electric input power between 125 W and 500 kW. These regulations will remove the least efficient ventilation fans used in non-residential buildings from the market. They will be introduced in two stages:
>
> First tier: effective from 1 January 2013 is intended to target the bottom 10% of the market in terms of efficiency;
>
> Second tier: effective from 1 January 2015 is intended to target the bottom 30% of the market in terms of efficiency.
>
> For more information on the European Eco-design Directive, refer to the Non-domestic Fans Product Profiles (E3 2012a, E3 2012b).

Many small fan units are incorporated into appliances that are already required to comply with MEPS in Australia and New Zealand. There is a need to determine the size of the market for small fan units and the practicalities of regulatory options and the interactions with appliances already covered by MEPS.

[1] Approaches to driving improvements to the energy efficiency of larger, non-domestic fans are being considered in a separate Product Profile. It recommends that the feasibility of implementing MEPS consistent with the approach being taken in the European Union from 2013 be investigated via a RIS.

Figure 2: How this Product Profile compliments other current E3 motor and fan work streams



Scope of this Product Profile

The scope of this Product Profile is motor-driven fan units with input power in the range of 5 to <125 W. The term 'fan units' refers to the fan and motor combination. This scope includes integral fan-motor assemblies which are constructed in such a way that it is not possible to separate the fan blade from the motor without losing the function of the fan.

Fan units within this size range are used in many different domestic, commercial, and industrial applications. In some cases the small fan units are largely a stand-alone product, including:

- fans for human comfort cooling (i.e. stand and tower fans, ceiling fans, table fans and wall mounted fans), and
- extractor and extractor/heater combination fans (e.g. inside bathrooms).

Fan units within this size range also include those embedded in many types of household equipment and appliances, such as in:

- computers,
- refrigerators,
- freezers,
- room heaters (various types) with a fan
- clothes dryers,
- hair dryers,
- dishwashers,
- room air conditioners,
- ovens,
- microwaves, and
- rangehoods.

Depending on the application, the range of fan types varies. Each fan type has different efficiency characteristics and differing potential for improved energy efficiency performance.

Readers are invited to comment on the scope of this Product Profile.

- Is the size range of 5 to <125 W appropriate for considering policies to increase the efficiency of small fan units?
- Is input power of the fan unit a more appropriate metric than output power for defining the range of the scope for small fan units?
- Is it more appropriate to approach efficiency improvements in the given size range by looking at the efficiency of the fan-motor assembly (fan-unit), or at the fan as a stand-alone item?
- Should this scope cover all types of fan units within this input power range?
- What are other key applications of small fan units (e.g. other appliances not listed)?
- What would a market breakdown of numbers by application look like – either in terms of the installed stock or in terms of annual sales?
- Feedback is sought on the appropriateness of the terminology and, if necessary, suggestions of alternative terms.

Policy context

To be included in the Equipment Energy Efficiency (E3) regulatory program, appliances and equipment must satisfy certain criteria relating to the feasibility and cost effectiveness of government intervention. These include:

- the potential for energy and greenhouse gas emissions savings,
- environmental impact of the fuel type,
- opportunity to influence purchase,
- the existence of market barriers,
- access to testing facilities, and
- considerations of administrative complexity.

If MEPS were to be implemented for small fan units, all eligible units would be required to show proof of passing a specified efficiency test. The suppliers would be required to register makes and models through the Energyrating website. Until the GEMS Australian national legislation comes into force, each State or Territory may require fees to be paid in order to certify that the fan units comply with sale requirements. Listing is free in New Zealand but sales data is required to be submitted annually post-MEPS, to track the energy savings that have been made against a business as usual scenario.

Any energy efficiency requirements for small fan units would aim to complement policy measures, both existing and proposed, for larger fan units and for electric motors.

Two new Product Profiles for Australia and New Zealand, covering non-domestic centrifugal and axial fan units with an 125 W – 500 kW input power range, have been completed for E3 (2012a and 2012b). They focus on policies to drive improvements in the efficiency of fans within this size range – most of which are used in non-domestic applications[2]. Integral small fan-motor assemblies were outside the scope of that work.

While the key focus of those Product Profiles was the 'fan only', the major international initiative in this area is the forthcoming MEPS regulations in the European Union (EU). In 2013, the EU regulations will implement minimum energy efficiency requirements for fan units (i.e. the fan and motor combination) with input power ratings from 125 W – 500 kW. If Australia and New Zealand decide to pursue a regulations based on the EU approach, it is likely that these would also target improvements to the efficiency of the fan unit (rather than the 'fan only') in order to maintain consistency.

While fan units with input power less than 125 W are outside of the scope of the forthcoming EU regulations, the EU is considering the possibility of regulating these. Australia and New Zealand will be interested in the practicalities such as compliance and enforcement that the EU may be faced with solving.

The majority of non-domestic fans are driven by three-phase AC induction motors. Three-phase induction motors with an output power in the range of 0.73 kW to 185 kW have been regulated in Australia and New Zealand since MEPS were introduced in 2001. MEPS stringency was increased in 2006. Motors that are an integral part of the

[2] Some fans within this size range are used in domestic applications, including fans used in gas ducted heaters, evaporative coolers and ducted refrigerative air conditioners.

fan-motor assembly (i.e. if it is not possible to separate the fan blade from the motor without losing the function of the fan) are currently excluded from MEPS. Where the motor has to be physically bolted on to the fan and can be separately identified as a motor, these would be covered by MEPS.

A review of MEPS for electric motors, currently underway for E3, may propose further increases in stringency and expansions to the product range covered by MEPS. Possible policy directions to be tested in a stakeholder consultation process could include proposals that MEPS be extended to integrated fan-motor assemblies and also to smaller single-phase motors.

Small fan unit motors with input power of 5 to <125 W are single-phase motors and are currently excluded from the electric motors MEPS program. If the decision is made to extend MEPS to include these smaller products, this would increase the energy efficiency of small fan units that are offered for sale in Australia and New Zealand. Figure 2 illustrates how this Product Profile fits into the other work in this area currently underway as part of the E3 Program.

For a detailed description of the policy context, refer to the two Product Profiles for Non-Domestic Fans, for Australia and New Zealand (E3 2012a, E3 2012b). These profiles contain information about the policies and drivers for improving the energy efficiency of products and equipment including the trans-Tasman response to climate change and the Equipment Energy Efficiency Program.

2. Small Fan Unit Technology

A fan unit comprises a motor drive and fan. The motor drive converts electrical energy into mechanical energy and generates movement by rotating a shaft. The motor can either drive the fan directly, or via a belt and pulley arrangement. Most small fan units would be direct drive. This means that the fan (sometimes called the blade, impellor, fan wheel, or bladed rotor) is directly connected to the shaft. The fan converts the mechanical input energy into a flow of air or gas in the direction required, often against a pressure, which is largely due to the resistance to flow offered by the system in which the fan unit is located (E3 2012a).

Some fans are integrated into their motor drive, as shown in the following list of common small fan units. If efficiency requirements such as MEPS were introduced for the fan blade only, these types would need to be excluded because the fan blade cannot be removed for testing.

Types of small fan unit motors

The first four of the following descriptions of the different types of motors that drive small fan units are heavily based on *In from the Cold, Technical Report Vol 2* (MEA 2009:48-52):

Shaded-pole single-phase fan motors

Common motors used in small fan unit systems are of the single-phase, shaded-pole (SP) type. The shaded-pole motor is a type of AC single-phase induction motor. As in other induction motors, the rotating part is a squirrel-cage rotor. All single-phase motors require a means of producing a rotating magnetic field for starting. In the shaded-pole type, a part of the face of each field pole carries a copper ring called a shading coil. Currents in this coil delay the phase of magnetic flux in that part of the pole sufficiently to provide a rotating field. The effect produces a low starting torque compared to other classes of single-phase motors.

These motors have one winding and no capacitor or starting switch, making them cheap to purchase and run, and reliable. Since their starting torque is low, they are best suited to driving fans or other loads that are easily started. They are also compatible with triac-based variable-speed controls, which are often used with fans. They are built in power sizes of about 5 to 70 W output. While these motors have been the most prolific in use they are now considered very inefficient compared to other new types, like electronically commutated (EC) motors of similar capacities.

External rotor fan assembly: single and three-phase fan motors

Another type of motor used in small fan units is the external rotor (ER) motor, another version of AC induction motor. In this type of induction motor the wound stator is fixed and the rotor assembly rotates externally around the stator. When combined with a fan blade the rotor is integrated into the fan blade forming the hub, resulting in better cooling of the motor by the airflow passing over it and improved motor efficiency.

Permanent split capacitor motor

Permanent split capacitor (PSC) motors are mostly used in residential air conditioners and other household appliances. Also known as a capacitor start and run motors, PSC motors have the start windings permanently connected to the power source through a capacitor along with the run windings.

These motors are typically more efficient than the same size shaded-pole motors due to the continuous capacitor assistance but in most cases operate at less than full load, which reduces the efficiency of the motor installed.

Electronically commutated motors

A brushless electronically commutated (EC) motor is a synchronous electric motor which is powered by direct-current electricity which has an electronically controlled commutation system, instead of a mechanical commutation system based on brushes. In such motors, current and torque, voltage and rotational speed (e.g. revolutions per minute) are linearly related.

In EC motors, the electromagnets do not move; instead, the permanent magnets rotate and the armature remains static. In order to do this, the brush-system/commutator assembly is replaced by an electronic controller. The controller performs the same power distribution found in a brushed DC motor, but using a solid-state circuit rather than a commutator/brush system.

EC motors offer several advantages, including higher efficiency and reliability, reduced noise, longer lifetime (no brush erosion), elimination of ionizing sparks from the commutator, more power, and overall reduction of electromagnetic interference (EMI). With no windings on the rotor, they are not subjected to centrifugal forces, and because the electromagnets are attached to the casing, the electromagnets can be cooled by conduction, requiring no airflow inside the motor for cooling. This in turn means that the motor's internals can be entirely enclosed and protected from dirt or other foreign matter.

EC motors require electronic speed controllers to run. In small single-phase sizes up to 70 W they are most often built into the motors electronics. For larger sizes, both single and three-phase, speed controllers are often separate units and can control more than one EC motor.

Universal motors

A number of hand tools such as heat guns, hair dryers, and vacuum cleaners have universal motors. The universal motor has the stator coil windings in series with the rotor windings with brushes used to connect the two sets of coils. Universal motors can run on either AC electricity or DC electricity. The motor output is generally quite small with few motors, apart from vacuum cleaner motors, exceeding 1kW.

They have a high starting torque, and compact size, with a good power to weight ratio. They generally run at high speed and may be quite noisy, although high fan speed is usually the cause. The speed of rotation is determined by the resistance load rather than the AC supply frequency. This means that the motors can often run over 10000rpm in a number of common applications.

Because they tend to have short life spans due to the brushed commutation, they are best suited to intermittent use. Sparking that occurs at the commutator brushes can cause electromagnetic interference and prevents them from being used in flammable atmospheres.

The efficiency of universal motors is low (See Table 1).

Questions for readers:

- What proportion of small fan units would be driven by each type of motor?
- How could the number of small fan unit motors in the market be broken down by application?
- What are the average cost differences between different types of small fan unit motors?

Fan power and efficiency

See the Product Profiles for non-domestic fans (E3 2012a and 2012b) for detailed explanations of fan power, performance, and efficiency.

The efficiency of motors commonly incorporated into small fan units is indicated in Table 1. Shaded-pole (SP) type motors, which are commonly used to drive small fan units, have very low efficiency. It is worth noting that the figures in the table represent the motor efficiency, and because the efficiency of the fan unit is a product of the motor and the fan efficiency, the efficiency of the fan unit driven by these motors will be somewhat lower.

Table 1: Typical shaft efficiency ranges for fan motor types, single phase power

Fan Motor Type	Output Capacity Range (Watts)	Efficiency (%)*
Shaded-pole (SP)	5 to 70	20% to 30%
Electronically commutated (EC): small	5 to 70	60% to 70%
Permanent split capacitor (PSC)	3 to 100	40% to 60%
Electronically commutated (EC): medium	70 to 770	90% to 95%
External rotor (ER)	70 to 770	40% to 60%
Universal motor	5 to 2000	60% to 70%

*Shaft power efficiency rating without blade
Sources: MEA 2009, adapted from Table 16, Page 53, and EECA

The efficiency of the fan alone, as distinct from the motor efficiency, has been derived based on a study in the EU for larger fans driven by motors with an input power of 125W to 500kW. More detailed explanations of fan power, performance, and efficiency, as well as the modelling of efficiency has been derived from EU data and presented in the Product Profiles for non-domestic fans (E3 2012a, E3 2012b).

While this is informative, it is worth recognising that small fan units would typically be expected to be comparably less efficient because a greater proportion of the input power will be lost in friction and aerodynamic losses.

An important consideration in calculating whole-of-life costs, energy consumption and efficiency is the product lifespan. For small fan units however, this largely depends on the lifespan of the appliance or equipment within which it is embedded because the small fan unit would be generally expected to last as long as the appliance.

Readers are invited to comment on the expected/typical energy efficiency and life-time length of small fan units driven by particular motors.

3. Market Profile

Market characteristics and trends

Significant information gaps exist around the import, sales, and installed stock of small fan units in Australia and New Zealand, so where it is available, stakeholders are invited to provide market data in their submission on this Product Profile. Table 2 provides initial estimates of annual sales of small fan units within the scope of this Product Profile, for selected appliances. Reader's feedback would be appreciated, especially on the cells marked "nd" to indicate data gaps.

Some small fans and fan units are imported as separate components and integrated into products in Australia and New Zealand, or used as replacement parts. However, many small fan units are imported as part of an appliance.

Table 2: Estimated annual sales for selected appliances containing small fan units, 2009

Appliance	Estimated annual sales			Small Fan Units					Small Fan Unit Sales 2009
	NZ	Australia	Total	Type	Purpose	Motor output power (Watts)	Motor input power (Watts)	No. of fan units	(NZ & Aust, 5 - <125 W input power)
Clothes Dryer	51,640	294,866	346,506	Split Phase induction	Drum and Fan	250	313	1	Likely to be out of scope (average input power >125W)
Household Fan Heater	85,000	340,000	425,000	Shaded Pole	Air Circulation	10	30	1	425,000
Household refrigerator-freezer	184,075	1,098,644	1,282,719	Shaded Pole	Air Movement	2	6	1	1,282,719
Commercial Refrigerated Display Cabinet	10,540	97,000	107,540	Shaded Pole/PSC	Air Movement	10	30	2	215,080
Room refrigerative air conditioner	5,000	1,209,629	1,214,629	Split Phase/ PSC/EC	Air Movement (condenser)	50	84	1	1,214,629
					Air Movement (evaporator)	30	40	1	1,214,629
Cooling Fans*	100,412	401,648	502,060		Air Movement	65	197	1	Likely to be out of scope (average input power >125W)
Dishwasher	75,235	360,090	435,325	nd	Drying fan	nd	nd	nd	nd
Room heater	nd	nd	nd	nd	Air Movement	nd	nd	nd	nd
Extractor fan	nd	nd	nd	nd	Ventilation	nd	nd	nd	nd
Domestic rangehood	nd	nd	nd	nd	Ventilation	nd	nd	nd	nd
Oven	nd	nd	nd	nd	Air Circulation	nd	nd	nd	nd
Microwave	nd	nd	nd	nd	Air Circulation	nd	nd	nd	nd
Computer	500,000	nd	nd	nd	Air Circulation	nd	nd	nd	nd
Hair dryer	nd	nd	nd	nd	Air Movement	nd	nd	nd	nd
Estimated total annual sales of small fan units incorporated into selected appliances^									4,352,057

Sources:	EECA	Greening Whitegoods, 2010	GFK	Pro rata estimate, using data for the other country	Decision RIS Refrigerators and Freezers, Oct 2008
ABS 2009	Decision RIS Air Conditioning, 2011 and 2009	Estimate from stock data in 'Proposed MEPS and labelling for computers and monitors, Consultation draft September 2011'			

*Includes stand and tower fans (upright), ceiling fans, table fans, and wall mounted fans. Larger ceiling fans are likely to be out of scope (due to input power requirement of > 125 W). Smaller ceiling fans, and desk and floor fans, are likely to have a power consumption of less than 125 W. Stakeholders are invited to provide information.
nd = no data. Stakeholders are invited to assist in filling these information gaps.
^ This is a minimum estimate, as sales data is not included for many appliances which also incorporate small fan units.

Fan motors in non-domestic refrigeration

Data on the total installed stock of small fan units for Australia and New Zealand is not currently available. Neither is there any comprehensive detail about imports of small fan units. The stock and import data modelling done for *In from the Cold: Strategies to increase the energy efficiency of non-domestic refrigeration in Australia and New Zealand: Background Technical Report Volume 2* gives an indication of the numbers in a market segment that overlaps with small fan units.

We do not have a similar analysis on non-domestic refrigeration for New Zealand. Readers are asked to assist in filling these data gaps.

For fan motors applied in non-domestic refrigeration, the installed base in Australia was estimated by MEA (2009) to be 6.6 million. Industry consultation suggested the installed base was smaller. A response from AREMA in January 2009 estimated an installed base of 3.05 million fan systems in refrigeration (See Table 3).

Table 3: Estimated stock of fan motors used in non-domestic refrigeration, Australia 2008

Fan motor type	Estimate from MEA, 2009		Estimate from AREMA, 2009	
	Number in installed base	Proportion of Total	Number in installed base	Proportion of Total
Shaded-pole single-phase	2,446,200	37%	2,500,000	82%
External rotor single-phase	2,002,300	30%	350,000	11%
External rotor three-phase	2,190,880	33%	200,000	7%
Total	6,639,380	100%	3,050,000	100%

Source: MEA 2009 (page 56) and AREMA submission 2009

The ER three-phase types in the table above would be out of scope for this Product Profile due to their large power input requirement, however some of the smaller fan motors (67% of non-domestic refrigeration fan motors) would be sized under 125 W. This does not account for the significant numbers of small fan units used in other applications besides non-domestic refrigeration.

Annual sales value data for motors imported into Australia for use in non-domestic refrigeration can also provide indications about the value of the broader market for small fan units within the scope of this Product Profile. Table 4 shows that of the range of sizes of fan motors imported for non-domestic refrigeration, around three-quarters of sales value is attributable to single phase AC motors less than 380 W, and around 52-68% of sales value comes from single phase fan motors up to 37.5 W (MEA 2009:57). These figures are only indicative, as there will be fan units imported inside of a range of different appliances.

Table 4: Value of motor imports for non-domestic refrigeration, Australia 1999-2008

Type	1999	2003	2008
	AUD ($ million)	AUD ($ million)	AUD ($ million)
AC Motors single-phase < 37.5 W output power	38	75	70
AC Motors, single-phase ≥ 37.5 W & < 380 W output power	10	15	32
AC Motors, multi-phase ≥ 380 W & < 746 W output power	7	10	17
AC Motors, multi-phase ≥ 746 W & < 3,000 W output power	9	11	16
Total	64	111	135

Source: MEA 2009, Table 21, Page 57, data from ABS 2009

All fan motors used in non-domestic refrigeration in Australia are imported (MEA 2009). The situation for small fan units used in other applications is likely to be similar.

This suggests that if a decision was made to introduce MEPS for small fan units, then the part of the supply chain most impacted would be import companies, including those that import the individual fan and fan unit components, and also those that import the appliances that contain small fan units.

The countries from which small fan units are imported are relevant to this Product Profile because market characteristics and regulatory requirements in these countries will influence heavily the types of fan motors imported into Australia and New Zealand.

Table 5 shows the main countries from which fan motors (of all sizes and types) were imported into Australia between 1999 and 2008. Note that this information is not limited to the products sized within the scope of this Product Profile.

Table 5: Country of origin of fan motor imports, Australia 1999-2008

1999		2003		2008	
Country of origin	**Import value (AUD$ million)**	**Country of origin**	**Import value (AUD$ million)**	**Country of origin**	**Import value (AUD$ million)**
Germany	11.53	USA	18.30	USA	29.60
USA	10.48	Japan	10.5	China	22.66
Vietnam	6.84	Vietnam	10.50	Thailand	17.90
France	3.10	Italy	6.40	Germany	10.14
Italy	2.93	France	4.05	France	8.96
UK	2.63	Germany	2.31	Italy	1.87
		Thailand	1.98		
		China	1.54		
		UK	1.10		
Total	37.51	Total	56.68	Total	91.13
% of Total Imports	59%	% of Total Imports	51%	% of Total Imports	68%

Source: MEA 2009, Table 21, Page 57, data from ABS 2009

A significant proportion of small fan units incorporate single-phase electric induction motors of the shaded-pole type. For these types, it is common for the motor and fan to be purchased separately. Small fan units driven by an external rotor motor (ERM) are usually sold to OEMs (Original Equipment Manufacturers) as an assembly with motor, specifically selected fan blades, and fan guard. For small fan units driven by EC motors (5 to 20 W), some importers select motors with matched fan blades that optimise performance (MEA 2009). Such integral fan-motor assemblies are units which are constructed so that it is not possible to separate the fan blade from the motor.

Readers are invited to address the knowledge gaps around market characteristics and trends for small fan units in Australia and New Zealand, including existing stock numbers, annual sales and industry sector breakdowns for small fan units.

Estimated sales and stock numbers are requested for:

- Small fan units imported as separate items, to be integrated into products or used as replacement parts
- Small fan units imported as a component that is already integrated into an appliance
- Small fan units manufactured within Australia or New Zealand

Which countries are the majority of small fan units imported from?

Barriers to energy efficiency improvement

A range of obstacles restrict the market from selecting and using more efficient small fan units.

A split incentive exists because the fan unit is often chosen by the appliance designer/manufacturer yet the energy bill is paid by the end-user. A small fan unit that is embedded inside an appliance uses only a small proportion of the appliance's overall energy consumption, so the designer/manufacturer may not maximise the fan's efficiency.

There are a range of information failures and barriers which mean that the end-consumer is unlikely to take account of the energy efficiency of small fan units. Where the small fan unit is embedded in a larger appliance, the fan unit is likely to remain hidden from view and is therefore not given much consideration by the appliance user, and the consumer is unlikely to be given any information about the power consumption and efficiency of the fan. Even where the fan unit is a more explicit part of an appliance (e.g. cooling fan, exhaust fan or range hood) consumers are unlikely to be given the information (motor input power and fan output power) which would allow a meaningful comparison of energy performance to be undertaken.

Other reasons why less efficient fans predominate are described by the 'bounded rationality' concept where there is incomplete awareness (or consideration) of the costs and benefits of efficient small fan unit technologies, including lifecycle costs. Bounded rationality issues:

- Appliance designers and manufacturers may not use available information to select the fan unit with the lowest lifecycle cost. They may simply use the fan which has always been used because it has a proven performance record, and use of a different, more efficient fan unit may be perceived as an unnecessary risk.
- The relatively low energy consumption of small fan units provides little incentive to optimise its efficiency.
- Purchase cost, ability to meet the functional requirements for the application (e.g. move enough air at the required flow rate), and reliability, would be the key considerations, and efficiency may only be a secondary consideration or may not be considered at all.
- There may also be perceived risks associated with advocating a more efficient solution.
- Even where efficiency regulations exist for the appliances – e.g. refrigerators and freezers –the use of a more efficient small fan is unlikely to make much difference to the overall level of appliance energy performance, so there will be less effort applied to optimising its efficiency performance.

Further barriers to the adoption of more efficient small fan units include:

- A significant gap may exist between prices for old and new technologies; a gap that is considerably smaller in more mature markets.
- Retrofitting or replacing any motor or fan embedded in an appliance is a large risk unless it is one that has been approved by the manufacturer. For new products however, more efficient small fan units can be incorporated into the design.

Readers are invited to comment on the nature of split incentives and other market failures that are hindering uptake of higher efficiency small fan units.

4. Energy Consumption and Greenhouse Gas Emissions

Small fan units with an input power in the range of 5 to <125 W do not individually consume large amounts of energy. However, they are embedded in large numbers of appliances and equipment and inefficiencies in individual small fan units could aggregate to unnecessary energy consumption and greenhouse gas emissions across the stock of all appliances in which they are installed. For example, fan motors of between 5 W and 2,000 W consume an estimated 33% of all energy used in non-domestic refrigeration (ES 2007). Table 6 presents annual energy use estimates for small motors in selected appliances.

Table 6: Estimated electrical energy usage for selected small fan units, 2009

Appliance	Estimated annual sales			Purpose	Duty			Energy Usage		Energy usage, selected small fan units
	NZ	Australia	Total		hrs/day	days/wk	wks/yr	Annual per appliance	Total Energy	(NZ & Aust, 5 - <125 W input power)
								kWh	MWh/annum	MWh/annum
Clothes Dryer	51,640	294,866	346,506	Split Phase induction	2	3	26	48.8	Likely to be out of scope (average input power >125W)	Likely to be out of scope (average input power >125W)
Household Fan Heater	85,000	340,000	425,000	Air Circulation	8	7	20	33.6	14,280	14,280
Household refrigerator-freezer	184,075	1,098,644	1,282,719	Air Movement	24	7	52	52.9	67,914	67,914
Commercial Display Cabinet	10,540	97,000	107,540	Air Movement	24	7	52	529.5	56,938	56,938
Room refrigerative air conditioner	5,000	1,209,629	1,214,629	Compressor fan - external	10	7	20	117.6	142,840	142,840
				Air handling fan - internal	10	7	20	56.0	68,019	68,019
Cooling Fans*	100,412	401,648	502,060	Air Movement	10	7	20	275.8	Likely to be out of scope (average input power >125W)	Likely to be out of scope (average input power >125W)
Dishwasher	75,235	360,090	435,325	Fan	nd	nd	nd	nd	nd	nd
Room heater	nd	nd	nd	Air Movement	nd	nd	nd	nd	nd	nd
Extractor fan	nd	nd	nd	Ventilation	nd	nd	nd	nd	nd	nd
Domestic rangehood	nd	nd	nd	Ventilation	nd	nd	nd	nd	nd	nd
Oven	nd	nd	nd	Air Circulation	nd	nd	nd	nd	nd	nd
Microwave	nd	nd	nd	Air Circulation	nd	nd	nd	nd	nd	nd
Computer	500,000	nd	nd	Air Circulation	nd	nd	nd	nd	nd	nd
Hair dryer	nd	nd	nd	Air Movement	nd	nd	nd	nd	nd	nd
Estimated total electrical energy usage for selected small fan units^										349,991

Sources				
Sources	EECA	Greening Whitegoods, 2010	GFK	Pro rata estimate, using data for the other country	Decision RIS Refrigerators and Freezers, Oct 2008
ABS 2009	Decision RIS Air Conditioning, 2011 and 2009	Estimate from stock data in 'Proposed MEPS and labelling for computers and monitors, Consultation draft September 2011'		

*Includes stand and tower fans (upright), ceiling fans, table fans, and wall mounted fans. Larger ceiling fans are likely to be out of scope (due to input power requirement of > 125 W). Smaller ceiling fans, and desk and floor fans, are likely to have a power consumption of less than 125 W. Stakeholders are invited to provide information.

nd = no data. Stakeholders are invited to assist in filling these information gaps.

^ This is a minimum estimate, as sales data is not included for many appliances which also incorporate small fan units.

The estimated electricity consumption by fan motors used in non-domestic refrigeration is shown in Table 7. External rotor 3-phase fan motor types are out of scope for this Product Profile, however some of the shaded-pole single-phase and external rotor single phase types would be within the size range under 125 W. Combined annual energy usage for SP and ER types is approximately 2,570 GWh per annum, totalling 59% of the total fan motor energy usage in non-domestic refrigeration (MEA 2009). This is only an indicative guide as this table excludes the many domestic and non-refrigeration applications of small fan unit motors. The table also includes a range of products exceeding the maximum size of <125 W input power for fans within the scope of this Product Profile.

Table 7: Estimated electricity consumption by fan motors in non-domestic refrigeration, Australia 2009

Fan Motor Type	No. Installed	GWh per annum	% of GWh
Shaded-pole single-phase	2,446,200	385	9%
External rotor single-phase	2,002,300	2,185	50%
External rotor three-phase	2,190,880	1,790	41%
Totals	6,639,380	4,360	100%

Source: MEA 2009, Table 23, Page 61, based on modelling by ES 2007

Modelling of business-as-usual (BAU) energy consumption and greenhouse gas emissions for small fan units and small integral fan-motor assemblies would be incorporated into a Regulatory Impact Statement (RIS) as part of the consultation process for developing any appropriate regulatory measures.

Readers are asked to estimate the energy use and GHG emissions from the existing stock of small fan units, including:

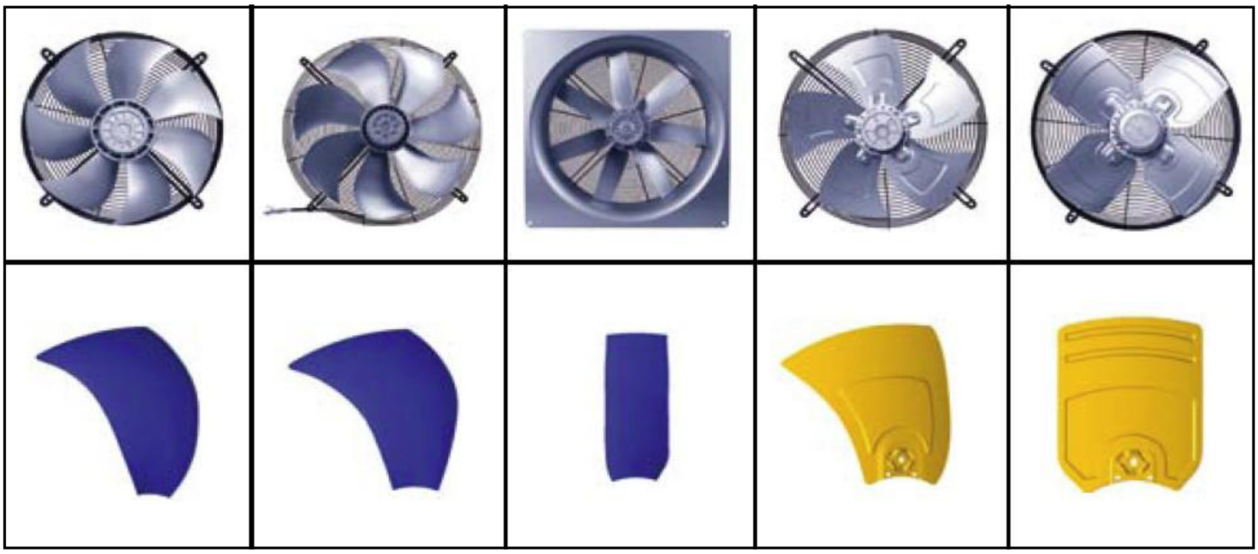
- total number of stock broken down by main end-use applications and size, and
- typical average power consumption and annual operating hours of small fan units in the main applications.

Opportunities for energy efficiency improvement

Improvements to the energy efficiency of small fan units can be the result of increased efficiency of the motor, or of the fan, or a combination of both.

Fan unit efficiencies can be improved by selecting the fan design with the correct application. Manufacturers provide detailed application curves for accurate selection criteria (MEA 2009). Figure 3 and Figure 4 show several options for fan blade designs to optimise fan+motor efficiencies.

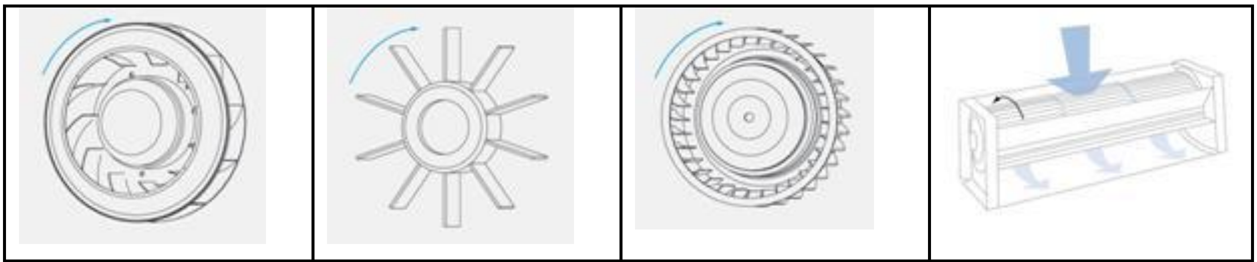
Figure 3: Designs for optimising fan+motor efficiencies: Axial fans used in non-domestic refrigeration



Sickle blade high efficiency fan and low noise	Sickle blade high air volume capability	Axial fan, high efficiency and high air volume	Sickle blade axial fan	Economical flat axial blade

Source: Ziehl-Abegg in MEA 2009

Figure 4: Designs for optimising fan+motor efficiencies: Centrifugal fans



Backward-Curved	Straight –Radial	Forward-Curved	Cross-Flow Fan
High pressure, high efficiency (79% to 85%)	Low to medium volumes, high pressure, durable, medium efficiency 69-75%	Low air volumes, low pressure, low noise, low efficiency 55-65%	Uniform broad airflow pattern, low noise, high air volume, low pressure, low efficiency ~40%

Note: Rotation direction shown on diagrams
Image source: Systemair.
Information source: DOE EERE "Improving Fan System Performance – A sourcebook for Industry"

Improving energy efficiency of fan motors used in non-domestic refrigeration

In the absence of calculations specific to small fan units, the data on non-domestic refrigeration sector can provide an indicative example of a valuable opportunity to move the market away from less energy efficient SP fan motors toward more efficient EC type fan motors.

Switching to more energy efficient fan motors could incrementally and independently reduce energy consumption in non-domestic refrigeration applications, according to MEA (2009).

Table 8 shows the potential energy savings provided by switching fan motor types in non-domestic refrigeration, away from SP fan motors toward more efficient EC type fan motors.

Table 8: Potential for improving energy efficiency by switching to a more efficient fan motor type

Capacity (Output)	Existing fan motor type, single phase power	Efficiency level	New fan motor type, single phase power	Efficiency level	Average reduction in energy usage
5-70 W	Shaded-pole	20-30%	Electronically commutated	60-70%	58%
70-770 W	External rotor	40-60%	Electronically commutated	90-95%	44%

Source: MEA 2009, adapted from Table 24, Page 62

Technological advances over the last two decades have meant that the energy performance of AC induction motors has improved through better design, more precise production and use of more conductive material. Fan blade technology has also improved due to the air conditioning industry's pursuit of better motor/fan efficiency and lower air noise levels (MEA 2009:48). Such improvements could be built upon by introducing regulatory requirements for product energy efficiency.

Readers are asked to suggest what opportunities currently exist for improving the energy efficiency of small fan units.

5. Possible Policy Options

The Fan Manufacturers Association of Australian and New Zealand (FMAANZ) is considering adopting, with some modifications, the EU ISO 12759 as a voluntary industry standard. Set to be used as the basis of fan regulations in Europe from 2013, this standard covers fan units with input power of 125 W – 500 kW. FMAANZ will develop an industry code which specifies MEPS and HEPS levels and lists any exclusions.

For products with input power less than 125 W, further development work will be required and it is likely that the approach would follow protocols being written in Europe for low power and ventilation products. It is the policy of the E3 program to align standards with international standards, such as those adopted by the EU, where appropriate.

Across all Australian and New Zealand jurisdictions, the only program currently seeking to promote improvements to fan energy efficiency is the Victorian Energy Efficient Target (VEET) scheme. As part of the expansion of the scheme to cover the business sector from 1 January 2012, consideration is being given to allowing the replacement of a fan unit in a commercial refrigerator or cool room with a fan unit driven by an EC motor to be included as an eligible energy efficiency measure.

The Equipment Energy Efficiency Program (E3) develops specific measures to improve the energy efficiency of equipment and appliances used in the residential, commercial and

industrial sectors in Australia and New Zealand. The primary tools used to improve efficiency of products in the program are regulatory: minimum energy performance standards (MEPS) and energy labelling.

Regulatory measures with potential to improve the energy efficiency of small fan units include:

- Mandatory minimum energy performance standards (MEPS): can be an effective tool for improving the efficiency level of the lowest performing units. MEPS specify a minimum energy efficiency benchmark for certain product types so models that do not meet this benchmark cannot be legally sold. MEPS help to address split incentives and bounded rationality and can, to some extent, also address the information failures.
- High efficiency performance standards (HEPS): create a legal definition of “high efficiency” that can be advertised to consumers to show which models are the most efficient types on the market. They have been used in conjunction with a number of products which have been regulated for MEPS, including electric motors and commercial refrigerated display cabinets. They can also be used to support incentive programs for high efficiency products such as government procurement policies which favour high efficiency products, white certificate schemes and rebates.
- Restricting the sales of the least efficient types of motors that drive small fan units: could be one way to phase out older technologies so they cannot be used as replacements or as retrofits except where it can be demonstrated that no alternative exists. The choice to ban rather than impose MEPS removes the need to register and test for efficiency. This approach is rarely used by the E3 program, as performance based benchmarks are generally favoured because they are technology neutral.

Several alternative regulatory approaches for these types of products could include:

- Mandatory or voluntary energy efficiency labelling or certification programs: Energy labelling is most effective where the product being labelled is on display in retail outlets. This would likely be inappropriate for small fan units as they are not purchased in this way by end-use consumers using visual inspection to compare options.
- Training and education programs, codes of practice, bench-marking and voluntary best practice agreements: It could be suggested that education about best practice design, installation and maintenance of products that contain small fan units would be an appropriate means to achieve energy efficiency improvements. However, this would be difficult as the target of any such programs would need to be the designers and OEMs which are responsible for putting the fans into appliances and many of these will be based overseas. In addition, these approaches would likely be unsuitable for small fan units because they are not ‘maintained’, instead they are ‘replaced’, unless specific incentives were offered for replacement.

- Business as usual (BAU) could mean that no regulatory action is taken. Or this could mean the market for small fan units and small integral fan-motor assemblies would be monitored and regulatory measures may be considered in the future.
- Raising public awareness about the benefits of maintaining fans. This is particularly related to air conditioning/heat pump fans where the performance of the whole device is affected by the cleanliness of the fan, ducts, and filters.

Questions for readers:

- Would the greatest improvements in energy efficiency come from increasing the energy efficiency of the motor (e.g. EC motor technology), or the fan, or both?
- Readers are invited to comment on the suitability of policy measures to achieve improvements in energy efficiency of small fan units. Comments are invited on the potential for savings in terms of economic costs, energy, and greenhouse gas emissions.

6. Standards

Development of a regulatory approach for small fan units will need to consider the measures that are applied to larger size fans and electric motors.

Test method

The Australian Standard *AS ISO 5801-2004: Industrial fans - Performance testing using standardized airways*, a well-established testing standard, sets out methods for the determination of the performance of industrial fans of all sizes and types, including the determination of fan power and efficiency, except those designed solely for air circulation, such as ceiling and table fans. It is identical to the international standard that will underpin the proposed EU regulations (E3 2012a).

As a test method for industrial fans, *AS ISO 5801* does not include small fan units, however DCCEE consultants advise that the method could be applied to products in the 5 to <125 W size range, except for those designed solely for air circulation, such as ceiling and table fans. An issue here will be identifying a widely accepted test method for measuring energy efficiency of small fan-units or the small, single-phase motors which drive them. Given that there is an Energy Star specification for ceiling fans, this suggests that a test method exists for these particular products.

Efficiency Levels

If a decision was made to implement MEPS for small fan units then efficiency levels would be developed by stakeholder working groups including Government and industry representatives. Relevant domestic and international standards for test methods and means of setting efficiency levels would be reviewed and consideration given to the appropriate measurement method(s), including an examination of:

- IEC 60034.-30 Rotating electrical machines – Draft Part 30: Efficiency classes of motor
- IEC 60034-2-3 Rotating electrical machines - Part 2-3: Specific test methods for determining losses and efficiency of converter-fed AC motors (draft),
- AS/NZS 1359 Rotating electrical machines,
- ISO 12759 Fans – Efficiency classification for fans AS ISO 5801-2004: Industrial fans - Performance testing using standardized airways,
- US test methods, developed mainly by AMCA (Air Movement and Control Association).

While *AS ISO 5801* could be modified to enable testing of small fan unit efficiency, it does not provide a methodology for setting energy efficiency performance levels. A new international standard, *ISO 12759:2010 Fans – Efficiency classification for fans*, sets out Fan Motor Efficiency Grade (FMEG) curves, which specify minimum required efficiency at "best efficiency point" (BEP), and can be used as the basis for setting MEPS levels for fan units with an input power range from 125 W to 500 kW. Therefore, introducing MEPS for small fan units in Australia and New Zealand would require development of efficiency level classifications for products below 125 W input power. Where possible it would be desirable to align with internationally agreed levels.

Questions for readers:

- What kinds of efficiency levels would be appropriate if governments decided to pursue a regulatory approach to increasing the energy efficiency of small fan units?
- Are testing facilities with the capacity to perform testing to AS ISO 5801 readily accessible? Is this test standard appropriate for small fans?
- Are there other issues with regard to standards for small fan units that have not been considered in this Product Profile?

7. Regulatory Considerations

If regulatory action is deemed appropriate, a consultation Regulatory Impact Statement (RIS) for small fan units would be developed and released for consultation. It would provide detailed cost-benefit analysis and would outline specific policy options. However, at this stage there are significant gaps in our knowledge of the market for small fan units in Australia and New Zealand, and these knowledge gaps would need to be addressed before a RIS could proceed.

Regulatory decisions concerning small fan units must weigh up the costs and benefits of business-as-usual versus regulatory options, and must also compare the approach of targeting the fan alone against measures that focus on the whole fan-motor assembly. The information presented in this Product Profile for non-domestic refrigeration fans suggests that the largest gains could come from addressing the efficiency of the motor drive.

The *Product Profile for Non-Domestic Fans – Australia* provides a comparison of the benefits of regulating the fan alone and the benefits of regulating the fan and motor combination (E3 2012a:48, C2-C4). Refer to Appendix A of this Product Profile for Small Fan Units, for a full transcript.

Introducing MEPS for these products based on the approach being pursued in the EU, where MEPS regulations will be applied to the fan unit (fan and motor combination) has some drawbacks. However this approach would allow Australia and New Zealand to align with international regulations being adopted by a jurisdiction which represents a major source of fan imports.

The EU has not yet agreed to regulate small fans. However, if European regulators did decide to go down this path, this would strengthen the case for doing so in Australia and New Zealand.

E3 needs to explore the validity of possibly regulating small fan units in line with EU efficiency regulations, or regulating only in certain applications. It may be possible and practical to adopt the EU regulations for certain sectors such as fans used in non-domestic refrigeration, where it is feasible that these fans will already need to comply with the EU regulations in 2013.

A key challenge with small fan units is that most will enter Australia and New Zealand as a part integrated into another product. This will make it potentially quite difficult to identify the products which are subjected to regulation and also to enforce compliance. It is possible that Australia and New Zealand may need to wait until other major economies (e.g. the EU) have regulated in this area to reduce any cost-burden on local suppliers and consumers, and also to improve compliance capability.

Another key issue for consideration is how to address small fan units which are components within a product that is already regulated for energy efficiency e.g. air conditioners, refrigerators, clothes dryers. Regulatory options include regulating the small fan unit separately, or possibly increasing the MEPS levels for the whole appliance in an effort to drive improvements in fan efficiency.

The issues associated with regulation of small fan units require further industry discussion.

Readers are asked to comment on the following questions:

- What kinds of outcomes could be expected from regulations targeting the fan only? What would be the outcomes of regulating the fan and motor combination? See Appendix A for a detailed outline of the key issues.
- What voluntary approaches could deliver an effective improvement in small fan unit efficiency, either complimentary to, or in absence of, MEPS/HEPS?
- If small fan units were regulated with MEPS, what issues might arise with using them inside larger appliances such as fridges that also have MEPS?
- Are there other ways that the efficiency of small fan units can be improved, other than by regulation?
- Are the small fan units used in products covered by MEPS already the most suitable for their application (e.g. those used in refrigeration condensers)?

- For fans where the lower efficiency produces a useful by-product such as heat, should these be excluded from a potential MEPS consideration? E.g. in a domestic fridge the heat from the fan motor can be used to an advantage, such as during defrost. Are there any products where potential regulations would not be effective at improving the fan efficiency or their function? E.g. vacuum cleaners have sophisticated fan and motor designs and a low duty cycle.
- Is it practical to consider the efficiency of domestic and industrial small fan units separately? (e.g. fan blades in household appliances are often used for dispersing air quietly and in efficient patterns whereas industrial fan blades are rapidly moving vast quantities of air.
- What additional costs would measuring the efficiencies of small fan blades and small fan motors impose on manufacturers and users of these components?
- What impact would potential regulations have on different sectors or suppliers eg appliance manufacturer, fan blade manufacturer?
- What impact would there be on the appliance cost, of requiring more energy efficient small fan motors and fan blades? What affect would this have on product and or company competition?
- What compliance and enforcement issues could arise if MEPS were imposed on small fan units?
- Are there any separate categories in small fan unit applications that would offer more potential than others, for MEPS regulation? (e.g. fans used in refrigeration equipment not otherwise covered by MEPS)

8. Conclusions

There is significant potential to reduce energy consumption and life-cycle costs (purchase cost plus lifetime energy costs) through increasing the energy efficiency of small motor-driven fan units.

This Product Profile commences a process of considering regulatory measures to shift the market toward more efficient products. Possible policy options available include MEPS, HEPS, and banning the purchase of the least efficient class of product.

Selected industry support for MEPS as a regulatory approach is indicated by the Fan Manufacturers Association of Australian and New Zealand (FMAANZ) urging E3 to expand MEPS for fans to include products with a power consumption of less than 125 W (E3 2012a).

Further data collection and analysis for both the Australian and New Zealand markets is required to enable the E3 Committee to develop more specific policy proposals.

Readers are asked to provide what data they can for sales, imports and exports of small fan units, and make comments about all other aspects of this product profile.

If a preliminary cost-benefit analysis shows that there may be some benefit to a regulatory approach, then a thorough cost-benefit analysis and modelling of policy options will be prepared. This Regulatory Impact Statement (RIS) process would assess potential impacts on market players, energy usage and reduced greenhouse gas emissions from potential regulatory options such as MEPS and HEPS. Further industry consultation will occur if a proposal needs to be re-worked into the RIS.

9. References

ES (Energy Strategies) 2007, *Cold Hard Facts*, prepared in association with Expert Group for the Equipment Energy Efficiency Committee.

MEA (Mark Ellis and Associates) Not yet published (Launched July 2011), *In from the Cold: Strategies to increase the energy efficiency of non-domestic refrigeration in Australia and New Zealand*, draft prepared for the Equipment Energy Efficiency Committee.

MEA 2009, *In from the Cold: Strategies to increase the energy efficiency of non-domestic refrigeration in Australia and New Zealand*, Background Technical Report Volume 2, prepared for the Equipment Energy Efficiency Committee.

E3 2012a, *Product Profile for Non-Domestic Fans - Australia*, prepared for the Equipment Energy Efficiency Committee.

E3 2012b, *Product Profile for Non-Domestic Fans – New Zealand*, prepared for the Equipment Energy Efficiency Committee.

10. Appendices

Appendix A1. Comparison of regulating the fan alone against regulating the fan+motor combination

Table 9: Comparison of regulating the fan alone against regulating the fan+motor combination

Issue	Regulating the fan unit (fan+motor)	Regulating the fan only
Alignment with Australian legislation	Would be possible.	Current legislation relates to energy using products only, and regulation of the fan only may not be possible. The forthcoming Commonwealth GEMS legislation in Australia would allow regulation of the fan only.
International alignment	Aligned with the EU approach, which would minimise testing costs for European importers and companies manufacturing for the European market.	Not aligned directly with the EU approach, and likely to require additional testing costs to demonstrate compliance with MEPS levels.
Impact on fan efficiency	Would not directly address the efficiency of the fan, and may not result in improved fan (blade) efficiency. However, due to the larger scope of coverage of the MEPS there is the potential to drive greater efficiency improvements in the overall fan unit.	Would directly address the efficiency of the fan, and drive improvements to only the fan (blade).
Establishing MEPS levels	More complicated, as need to take into account the efficiency of the fan, coupling, motor and possibly also VSD. Would need to account for any increases in motor MEPS in Australia, and these may not be aligned with the EU.	More straight forward as only need to consider the fan.
Alignment with market trends	This is how the majority of fans are sold (except for large fans), and there is an increased trend towards integrating the fan unit with a VSD. Also, testing would include all fan-unit components, including outer casing and motor which would give a more realistic indication of performance in practice.	Most fans are sold to end-users with the fan attached to a motor, so could make it more difficult to verify compliance with MEPS levels.

Note: Taken from E3 2012a, Product Profile for Non-Domestic Fans, page 49 and C2-C4

Appendix A2. Benefits of regulating the fan alone

Clarity of responsibility. Some fans are sold as just the fan only, and are attached to a motor by the end user, although it is more usual for fans to be placed onto the market by the fan producer with a motor attached. Some fan suppliers will produce their own motors, others will purchase motors. Because of the variation in the market, regulating the fan by itself makes the responsibility for compliance clear. Equipment and appliance manufacturers design and produce fan blades to suit the product and source motors to fit.

Improvements focussed on the fan. Regulating the fan means that any energy efficiency

improvements must be aimed at the fan, not the fan+motor combination. Otherwise it is quite

possible that fan manufacturers will simply specify a more efficient motor to achieve any required efficiency improvements. As motor regulations may specify ever more efficient motors anyway, possible savings from fan regulations may be reduced if regulation includes the motor.

Ignore the complication of ancillary components. Many fan units are more than just a fan and a motor. For example they may come with a transmission belt, or be fitted with a built in VSD. By looking only at the fan, these complicating factors can simply be ignored.

Testing is easier. Tests for the efficiency of variable speed motors are still being developed. Until this is agreed, it is unclear how to assess the efficiency of variable speed fan+motor combinations.

Labelling. An efficient fan could have a label attached, although the EU is not proposing to do this. Its performance may then be reduced by the poor choice and design of system components, but the label is still valid. Labelling a fan+motor combination could lead to confusion in a number of areas:

- There could be separate and maybe different labels for the motor and fan.
- It would be the responsibility of the seller of the fan+motor combination to fit the motor, and these "system integrators" may not always be well equipped to cope with this responsibility.

Setting levels of MEPS for the fan alone is easier. Deciding on MEPS for any product is a difficult and time-consuming exercise, as they need to be based on a wide sample of products in order to be robust. If regulating a combined product, such as a fan+motor, this task is more complicated, because as well as the fan, the motor, transmission and possibly also VSD need to be taken into account. This is a complicated exercise to get right, and the MEPS will need regular revision to reflect changes in any of these components.

Appendix A3. Benefits of regulating the fan+motor combination

It is how fans are sold. Most fans are sold to the end user with a motor attached. It is therefore useful to regulate on this basis.

It is about the real efficiency. (Almost) all fans need a motor to drive them, and so it makes sense to include this.

It follows market trends. The market for small fan units with integral variable speed control is growing. These may be amongst the most efficient of their size, but because of their construction it may not be possible to separate the fan from the motor.

Separate MEPS regulations for these products could be developed, but it would be counterproductive to exclude less efficient fans with integral variable speed control if they are actually better than conventional fans.

If they are excluded from the MEPS regulations they could still be sold, but would not benefit from the kudos of having their energy performance rated, and this may also exclude them from any type of future "high efficiency" list. They would be actively disadvantaged if the best performing fans were actively promoted, perhaps through a financial incentive scheme, but fan-units with integrated VSD's were not.

Drive belts are an integral part of the fan efficiency. When selecting a fan, it needs to be run at the correct speed for optimum performance. In many cases this will mean that a drive belt needs to be fitted. Ignoring this will over-state the efficiency that a fan can possibly give.

It includes the casing. Most fans are sold with some sort of outer casing, the detailed design of which is critical to the fan performance. The motor itself, when it is fitted in-line with axial fans, also represents an obstruction and so will alter the airflow and hence performance.

Incentivises advances in motor technology. There are many new types of motor appearing with higher efficiencies than the induction motors assumed in the setting of the MEPS. Including the motor within the regulations will encourage the development of these new high efficiency motors.

It includes more of the total fan system. The energy savings from the system are many times that of the component, such as the fan. Finding a way to regulate the system would be a great achievement, but the inability to specify what is "good" means that this has so far been elusive for other than some very specific applications. The idea of regulating a bit more of the system than just the fan wheel is seen as a positive move in this direction.

Product Profile – Small Fan Units

www.energyrating.gov.au

A joint initiative of Australian, State and Territory and New Zealand Governments