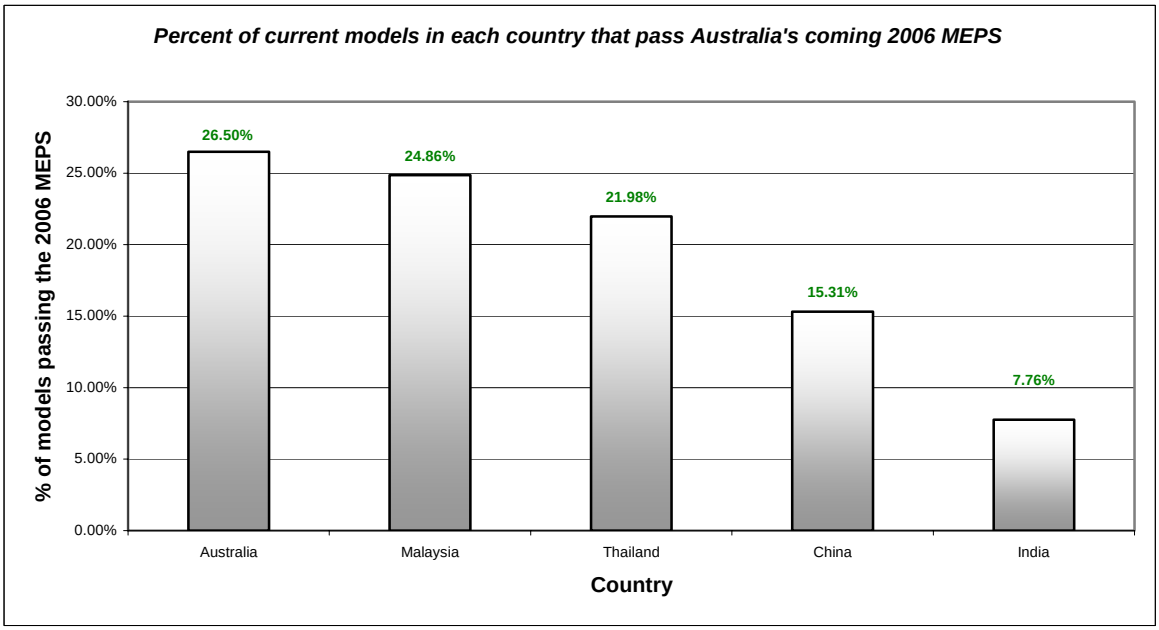
FINAL REPORT

BENCHMARKING OF ELECTRIC MOTOR EFFICIENCY LEVELS IN FIVE ASIAN COUNTRIES



9 September 2005

Prepared for

Australian Government
Australian Greenhouse Office

Danish Energy Management

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ACKNOWLEDGMENTS

We would like to thank the Australian Greenhouse Office for sponsoring the present benchmarking study, and state our acknowledgement for the valuable assistance and comments provided by the reviewers of this Report.

DISCLAIMER

The primary data used in this report are based on catalogue data collected from individual manufacturers and distributors in each country. Therefore, neither the authors nor the Australian Greenhouse Office can be held responsible for errors that may occur in the data. However, we encourage any interested parties to contact the authors if they feel that any of the data points are in error, and they will be revised for the final report.

EXECUTIVE SUMMARY

Overview of the Project

Project Objective. Under contract to the Australian Greenhouse Office, Danish Energy Management A/S (DEM) carried out this study to benchmark the efficiency of three phase electric motors in five Asian countries: Thailand, Malaysia, China, India, and Australia. The data for India are not included in this draft report, but will be included in the final report.

The Study Team. DEM assembled a team of local consultants in the five countries. The country consultants were responsible for collecting and gathering available data in their country and supplying it to DEM. DEM carried out the data analyses presented in this report and integrated the data and conclusions across the five countries.

Data Collection. The DEM team carried out market surveys and characterized the market for three-phase electric motors in each of the countries. Teams also reviewed manufacturers' catalogues of models available on the market; collected available laboratory test data on motor performance; and collected data on trade between the countries. The data collection and analysis focused on motors with up to 100 kW rated power. A large amount of data was collected – ranging from 11 to 35 brands per country; and from 210 up to 2995 models per country.

Main Findings

Price Comparisons. On average electric motors sold in Australia are twice as expensive or more, compared to electric motors of the same size sold in China. The prices of electric motors sold in Malaysia and Thailand are comparable, and lie approximately halfway between the prices for Australia and China.

Trade Flow Analysis. Overall, China and India are net exporters of electric motors; and Australia, Malaysia, and Thailand are net importers. The report displays charts and table showing the net direction and magnitude of imports and exports.

Efficiency Comparison. Australia has the best average motor efficiency over the range of motor sizes analyzed. Thailand and Malaysia have comparable efficiency ranges, at a lower level than Australia. China has the lowest average efficiency levels of the countries studied.

Take-Home Message for Australian Industry. Based on this benchmarking study, it appears that Australia's electric motors are, on average, the most efficient of the countries studied. Australian is also leading the way in MEPS for electric motors in the region. Nearly half of electric motors sold in Australia meet the 2006 MEPS

LIST OF ACRONYMS

ABS	Australian Bureau of Statistics
AC	Air Conditioners
AGO	Australian Greenhouse Office
ANSI	American National Standards Institute
APEC	Asia Pacific Economic Cooperation
APEC-ESIS	APEC Energy Standards Information System (www.apec-esis.org)
AS	Australian Standards
BS	British Standards
DEDE	Department of Alternative Energy Development and Efficiency (DEDE)
DEM	Danish Energy Management A/S
EFF	European rating system for motors (e.g., EFF1, EFEF2, EFF3)
EPPO	Energy Policy and Planning Office (Thailand, formerly called NEPO)
ESIS	Energy Standards Information System (www.apec-esis.org)
FOB	Freight On Board
IEC	International Electrotechnical Commission
MEA	Metropolitan Electricity Authority (Thailand)
MEPS	Minimum Energy Performance Standards
MIEEIP	Malaysian Industrial Energy Efficiency Improvement Project
MTC	Industrial Metrology and Testing Center (Thailand)
NEMA	National Electrical Manufacturers Association (United States)
NEPO	National Energy Policy Office (Thailand, recently renamed EPPO)
OEM	Original Equipment Manufacturers
RM	Malaysian Ringgit
SIRIM	Standards and Industrial Research Institute of Malaysia
TISI	Thailand Industrial Standards Institute
TISTR	Thailand Institute for Scientific and Technological Research
ToR	Terms of Reference

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1. INTRODUCTION

Background

Since the mid- to late 1990s, an increasing number of international meetings on energy policy have identified that energy-efficiency standards and labeling programs can deliver cost effective environmental benefits and conserve energy, while also calling for the acceleration and expansion of such programs. Even though appliances and equipment are internationally traded, policymakers rarely look at international benchmarks when developing thresholds for minimum energy performance standards (MEPS) and labeling. For example, it is extremely rare to find direct, cross-country comparisons of MEPS and labeling tiers.

The Australian government is beginning to take the lead in the area of benchmarking, in line with the country's stated policy of examining "international best regulatory practice" when develop new MEPS and labeling requirements. The Australian approach is that its MEPS levels should not be lower than any other economy – or stated another way, if a product is made in Australia, it should meet the energy and environmental criteria and be able to be sold in any market in the world. AGO's interest in benchmarking energy performance of appliances and equipment is a direct outgrowth of its focus on "best regulatory practice."

Under contract to the Australian Greenhouse Office, Danish Energy Management A/S (DEM) has carried out this study to benchmark the efficiency of three phase electric motors in five Asian countries: Thailand, Malaysia, China, India, and Australia. The results of our data collection and analyses are provided in this report, and will be posted on the web site of the APEC Energy Standards Information System (APEC-ESIS, www.apec-esis.org). The results will also be presented at an international conference in Heidelberg, Germany 5-8 September 2005.

Objectives

The primary objectives of this consultancy are, for three phase electric motors, to:

1. Assess and analyze trade flows between Australia and Thailand, Malaysia, China & India
2. Benchmark efficiencies in these five markets against each other

Organization of the Report

The report is arranged in six main sections, describing key aspects of the work and the findings. At the end a number of appendices containing collected information and motor data, as well as details of calculation methods used and other materials of relevance.

The rationale for this is to allow the reader to first present the overall picture and subsequently more detailed results, analysis and discussion. This is emphasized by

putting most of the details of the calculation methods employed into appendices so that the flow of the text is not thereby unnecessarily interrupted.

2. BRIEF REVIEW OF PROJECT IMPLEMENTATION

Project team

Danish Energy Management (DEM) assembled a team of local consultants in the five countries. Table 1 provides an overview of the research team.

Table 1. Overview of the Study Team

Country	Role	Consultant
All	Overall coordination and analysis	Danish Energy Management A/S
Australia	Market and trade data collection	Paul Ryan, Energy Consult Pty.
China	Market and trade data collection	Dr. Liu Caifeng, China Certification Center for Energy Conservation Products (CECP)
India	Market and trade data collection	Mahesh Patankar, IIEC India
Malaysia	Market and trade data collection	Benjamin Sipaun, Spire Research Sdn. Bhd.
Thailand	Market and trade data collection	Monthon Kumpengsath, Saangsan Consultants Co., Ltd.

The country consultants were responsible for collecting and gathering available data in their country and supplying it to DEM. DEM carried out the data analyses presented in this report and integrated the data and conclusions across the five countries.

Data collection

Subcontracted national consultants in each of the five countries gathered the motor data according to terms of reference describing the details and format of the assignment.

The national consultants collected data relating to trade flow, market structure and motor efficiencies as well as laboratory test data to the extent available with the above objectives in view. The APEC Energy Standards Information System was used to supplement the collected primary and secondary data.

The standard terms of reference (ToR) for the data collection can be found in Appendix A of this report.

Brief review of data analysis

Using the data collected by the local consultants, analysis and comparison of trade flows, market make-ups and motor efficiencies have been conducted.

The trade flow analysis concentrated on establishing the trade volume, the net direction of trade and whether a country is net exporter of importer of motors in the regional as well as in the global context. Originally it was the intention to extend this analysis to the composition of traded motors in terms of major brands and motor sizes, but the trade data available form official sources is not sufficiently detailed to allow estimation of such breakdowns – at least not without significant uncertainties. It was therefore decided that such estimates would not seem to yield information of sufficient accuracy to justify the effort.

The analysis and comparison of motor efficiencies between the five countries is founded on collected catalogue and test data for motor models in each of the countries, as well as on the market composition in each country. Based on this information market average efficiencies were calculated and benchmarked against each other. Additionally the data allowed an analysis of the annual relative energy consumption contributed by the motors sold.

The results of the analysis are presented in Section 5 of this report.

3. COLLECTED DATA

Overview of the Data

An overview of what data has been collected is given in Table 2. Table 3 provides detail on the data collected, based on type of motor unit, number of brands, and number of models for each country.

Table 2. Overview of Data Collected

	Australia	India	China	Thailand	Malaysia
Catalogue data	Y[b]	Y[c]	Y[c]	Y	Y
Test data	Y	N[a]	Y[c]	N[a]	N[a]
Trade data	Y	Y	Y	Y	Y
Market data	Y	Y	Y	Y	Y

Key: Y= Yes, N = No

Notes:

Notes: a) For Thailand, Malaysia and India, test data were not available. b) Since in Australia MEPS are enforced, the MEPS registration dataset that have been used contains all models on the market. c) In China and India only relatively small samples were collected.

Table 3. Overview of Data Collected on Motor Brands and Models

	Australia	India	China	Thailand	Malaysia	Total
DATA ON MOTOR BRANDS						
Catalogue data	NA[1]	4	5	14	11	NA
Test data	35	NA[2]	9	NA[2]	NA[2]	NA
Total number of motor brands	35	4	14	14	11	NA
DATA ON MOTOR MODELS[3]						
Catalogue data	NA[1]	232	78	789	519	NA[4]
Test data	2,995	NA[2]	150	NA[2]	NA[2]	NA[4]
Total number of models	2,995[3]	232[3]	228[3]	789[3]	519[3]	NA[4]

Notes: Notes: NA = not applicable. 1) Model data was sourced directly from the MEPS registration database. Therefore catalogue data as such were not collected. 2) For Thailand, Malaysia and India, test data were not available. 3) Covers 2,4,6 and 8 pole motors for Australia, and 2, 4, and 6 pole motors in Thailand, Malaysia, India and China. 4) The model numbers do not match in the different economies. It is therefore not possible to determine the total number of different models in the dataset across all economies.

In order to compare information across the five economies, a number of adjustments to the raw data have been required. In the present paper motor performance data generally refer to IEEE 112 B, whereas collected data – depending on the manufacturer and economy of origin – are refer to variety of standards. The two main

reference standards en-countered are the IEC 60034-2A and the IEEE 112B. To compare all the data on an equal footing, conversions of the performance data has been made, so that e.g. values quoted according to IEC 60034-2A has been converted to an equivalent figure within the IEEE 112 B frame of reference.

The distribution of model data over different power ranges is generally quite balanced as can be seen in Figure 1 below. The Chinese data exhibit certain unevenness in this respect, but the data collection by the local consultant, although not as comprehensive as for the other countries, was done so as to provide a representative sample of the model efficiencies on the market.

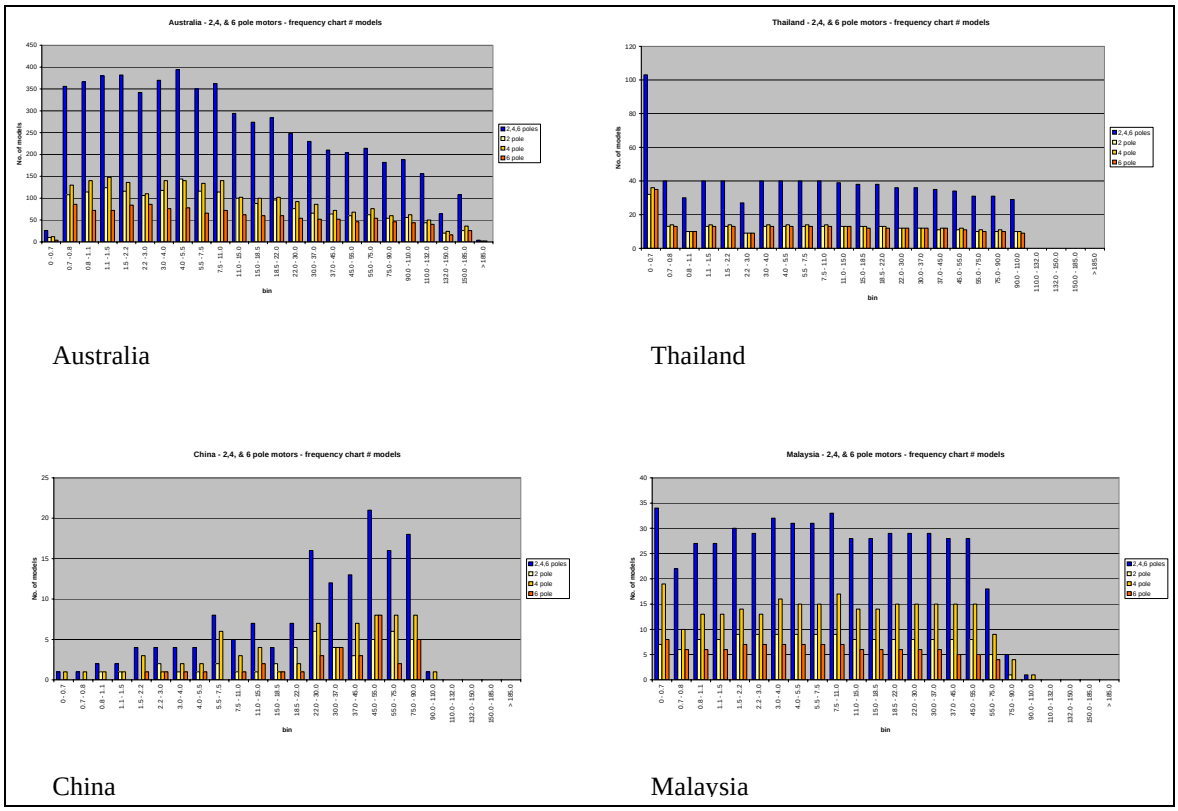

Figure 1. Distributions of collected model data. Power ranges are from 0 to 185 kW.

Finally it was necessary to adjust some of the trade data provided. Firstly some data were provided only in monetary value[1], and those have been recalculated to get the number of units corresponding to the value given[2]. The calculation is based on local purchase prices for motors of different sizes. The details can be found in section 5 where the findings of the trade flow analysis is given along with details of the methodology used, and considerations on uncertainties involved.

[1] This was the case in Thailand
[2] Approximately of course since the price to size relationship is an average for a whole range of efficiencies.

Overview of MEPS, Labeling and Testing

The following section is a summary based mainly on the market overviews prepared by each of the country consultants (cf. appendices C-G) as well as on supplementary sources such as www.apec-esis.org.

Of the five economies surveyed Australia and China have had MEPS in effect from 2001, whereas Thailand, Malaysia and India do not have MEPS. Australia will implement new, more stringent MEPS by 2006, and China is considering increasing its MEPS levels as well. Thailand and India are considering MEPS but the final decisions are still pending. Malaysia has just introduced a voluntary labeling scheme for three-phase electric motors based on the European EFF scheme (identical in terms of efficiency levels), while considerations for MEPS are still undecided.

Figure No.2 shows current and planned MEPS levels in the five economies.

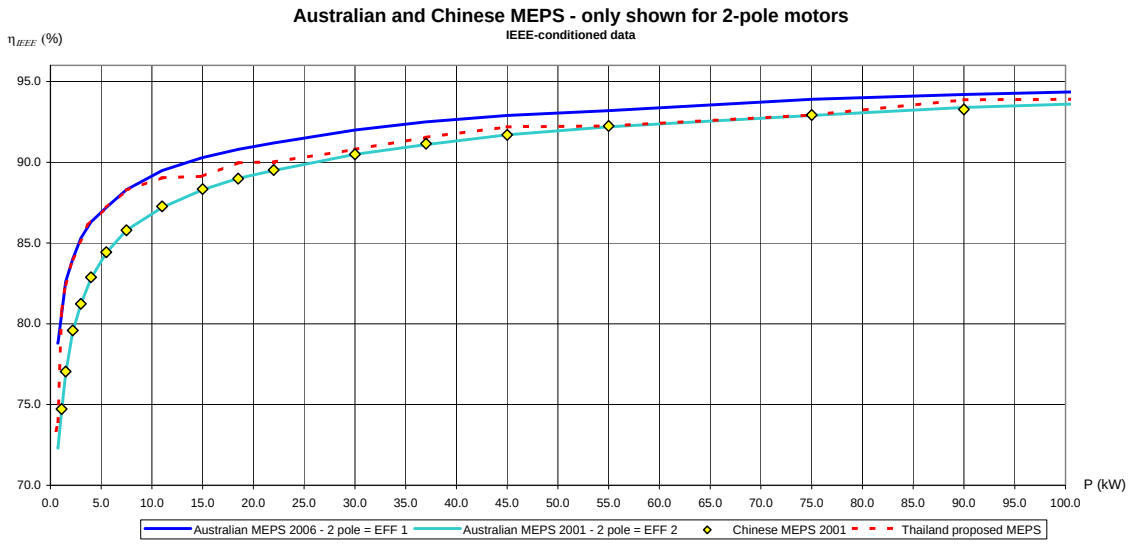

Figure 2. Current and proposed MEPS levels in the Five Countries.
The MEPS stringency level will be raised in Australia in 2006 (2001: light blue, 2006: dark blue). The Chinese MEPS (yellow diamonds) are equivalent to the Australian 2001 MEPS. The proposed Thai MEPS are shown as a dotted red line. The Malaysian (voluntary) EFF 2 and 1 levels are identical to the Australian 2001 and 2006 MEPS respectively.

More comparisons referring to 4 and 6 pole motors can be found in the appendices. A comprehensive review[3] of MEPS in APEC economies has been conducted for APEC-ESIS. This study discusses various factors that can influence the comparison of MEPS (and motor efficiencies) when the performance has been determined using different standards[4].

[3] A survey of efficiency levels specified for three-phase cage induction motors; APEC-ESIS; January 2003
[4] Mainly IEEE 112-Band IEC60034-2.

Australia

In Australia MEPS applies to three phase electric motors, manufactured in or imported into Australia with a rated output in the range 0.73 kW to <185kW and with 2, 4, 6 or 8 poles. State and territory laws requires that all such electric motors be registered by the manufacturer or importer, their sale being illegal unless they are registered and comply with the MEPS.

Since 1 October 2001, three phase electric motors must comply [5] with MEPS requirements, which are set out in AS/NZS 1359.5-2000. The Australian MEPS levels are essentially harmonized with the European Efficiency Level 2 (EFF2). High efficiency motors in Australia approximately correspond to European High Efficiency Level 1 (EFF1) and US MEPS levels for electric motors.

Motors may be tested to either of the following testing methods:

- AS1359: Rotating electrical machines - General Requirements Part 102.1: Methods for determining losses and efficiency – General. This test is also termed as "Test Method B" and is equivalent to IEC 60034-2A; or
- AS/NZS1359: Rotating electrical machines - General Requirements Part 102.3: Methods for determining losses and efficiency - Three phase cage induction motors. This test is also termed as "Test Method A" and is equivalent to the forthcoming IEC 61972 standard and US ANSI/IEEE 112 method B.

From 1 April 2006, MEPS levels for three phase electric motors will become more stringent in that the "High Efficiency" level from 2001 will become the new MEPS. Additionally from 1 April 2005 a revised "High Efficiency" level will come into force. These new MEPS and high efficiency requirements together with transition arrangements are set out in detail in AS/NZS 1359.5-2004, published in September 2004, which supersedes AS/NZS 1359.5-2000.

Tests can be conducted by any motor testing laboratory that has been accredited by National Association of Testing Authorities (NATA) of Australia, and currently there is only one such laboratory[6] operating in Australia.

Thailand

In 1998 the Energy Policy and Planning Office (EPPO)[7] commissioned a study to develop energy efficiency standard for several electrical appliances, including motors for Thailand. The study recommended that a MEPS should initially be set at a "standard efficiency level" (IEEE B) for 4-pole TEFC motors, and take effect two years after finalization of the standard, set a second-tier standard at a "medium efficiency" level to take effect five years after finalization of the standard, and finally set a third-tier standard at a "high efficiency" level to take effect three years after the second-tier standard. The study pointed out that the proposed standards would be cost-effective to consumers and suggested the government to establish a comprehensive program

[5] There are a number of motor types that are exempt from MEPS including:
- submersible motors;
- integral motor-gear systems (non separable);
- variable or multi-speed speed motors;
- motors rated only for short duty cycles (IEC60034-2 duty rating S2); and,
- rewound motors or motors sold as second hand.

[6] This laboratory is owned and operated by the only motor manufacturer in Australia i.e. CMG Pty Ltd.

[7] Previously known as the National Energy Planning Office (NEPO)

to support Thai manufacturers in producing high efficiency motors. Alas, this proposed program has not yet been implemented.

In 2003, however, the Department of Alternative Energy Development and Efficiency (DEDE) issued a standard (shown in figure 2 above) to be used as a draft Ministerial Order. This standard will be effective when the Thai Industrial Standard Institute (TISI) publishes in the government gazette.

Today most motor performance data in Thailand refer to the European Standard, IEC 34-2 although some use US Standard, IEEE 112- Method B, and the Japanese Standard, JEC-37. Thailand has two testing centers. One is the Industrial Metrology and Testing Service Centre (MTC), located at Bangpoo Industrial Estate, established under Thailand Institute of Scientific and Technological Research (TISTR) and the other is the Metropolitan Electricity Authority (MEA)[8] at Samsen Branch.

MTC can test motors up to 37 kW using IEC or IEEE standards. So far, however, they have not yet tested any motors commercially. MEA can test motors up to 30 kW and have tested several motors from local manufacturers using mainly IEEE 112 – method B.

Malaysia

There are currently no minimum efficiency level requirements for industrial motors in Malaysia. Furthermore there is no national standard for determining motor performance in Malaysia. The introduction of a Minimum Efficiency Performance Standards (MEPS) for electric motors is not expected in the immediate term but possibly in the longer term (5 to 10 years). From motor manufacturers' catalogues available in Malaysia it is found that the most common standard used is the International Electrotechnical Commission (IEC) 34-2. Other standards, such as The Institute of Electrical and Electronics Engineers (IEEE) Standard, British Standard (BS) and Australian Standard (AS), are also used but to a lesser extent.

Currently there is no authoritative or independent testing facility to test and assess the energy efficiency levels of motors from various brands. The Standards and Industrial Research Institute of Malaysia (SIRIM) plans to acquire the necessary equipment to carry out independent testing on the energy efficiency of motors in the foreseeable future.

The Government of Malaysia encourages the use of high efficiency motors but current compliance is on a voluntary basis. Through the Malaysian Energy Commission, the government is engaging in a voluntary labeling and promotion campaign in 2005, to encourage purchase and use of EFF1 or EFF2 motors in industries.

China

In China most motors in the market follow IEC design parameters, and a Chinese MEPS for motors[9], was publicized in 2002 and table 6 in appendix D show the values (for 2, 4 and 6 pole motors) for energy-efficient motors specified by this standard. For the moment the motor MEPS in China is equal to the minimum limit of the EU EFF2. These efficiency values correspond closely to the Y2 design series. Therefore, although

[8] In Bangkok.
[9] Based on IEC 34-2, entitled "Limited Values of Energy Efficiency and Evaluating Values of Energy Conservation of Small and Medium Three-phase Asynchronous Motors" (GB 18613-2002).

it is not a very aggressive standard, new motor MEPS promote the overall efficiency level of installed motors by removing from the market the less efficient models[10]. Even so, a revision of the MEPS is currently said to be underway.

Figure 2 above shows the MEPS for 2-pole motors in comparison with other countries.

India

Three phase induction motors manufactured and sold in India have to adhere to the Indian Standard IS 325: 1996 by the Bureau of Indian Standards (BIS). As many of the large manufacturers target the export market, the European IEC design and efficiency standard and the NEMA standards are also widely followed. A revised Indian standard, IS 12615 is currently under circulation and finalization. This standard follows the worldwide practice of categorizing motors as improved efficiency 'Eff2' and high efficiency 'Eff1', with the efficiency values specified in IS 8789:1996 being the frame of reference.

Due to the widespread and varied usage of motors, improving the efficiency of motors has been long identified as a priority. Various initiatives have been promoted and implemented by the public and private sectors. Under the Energy Conservation Act 2001, the Bureau of Energy Efficiency (BEE) has been established to undertaken specific initiatives targeted at energy intensive industries and activities. One of the key activities being undertaken by BEE is the formalization of the motor energy efficiency standards to raise the overall efficiency of electricity use in the country.

[10] The vast majority of motors sold in China today are of a less efficient design - about 5% of all motors sold in China are of the "Y2" design, and another 90% are of the earlier "Y" series design according to the local consultant. The different design series are described in Appendix D, and in the section on market characterization

5. MAIN FINDINGS

Motor Market Characterizations and Trade Flow Analysis

Market Characterizations

The absolute size of the markets in the five countries varies, with China being the largest and Malaysia the smallest national market for electric motors. Table 4 below gives an overview of the sales volumes involved.

Table 4. Motor Sales in the Five Countries.

	Market Size	
	US$	Number of units
Australia	49,081,161	310,442
Thailand	91,245,000	792,374
Malaysia	--	64,030
China	3,061,883,565	--
India	--	993,600

The figure for the Chinese market is the annual income by motor manufacturers[11], while the Australian Figure is the FOB value of imports (imports making up some 92-97 % of the market this figure would be only marginally lower than the actual market size), meaning that sales overheads etc. which would somewhat increase the amount are not included. The estimate of the Thai market value found by the local consultant is significantly larger than the estimate given in Energy efficiency standards regime study from 1999 (which estimated the market at about a third of the figure in table 4).

The numbers of units in the second column are taken directly from the collected data for Australia and Malaysia, whereas the figure for Thailand is a calculated estimate based on the total value, the size composition of the market and the average price relationship as a function of motor size that is derived in the following. The Chinese and the Malaysian data have not been converted into number of units, and sales value respectively due to the uncertainties involved (both price relationship and market distribution according to size are subject to uncertainties that would of course collude to an even larger uncertainty). The Thai data have been converted since only monetary values were provided for market size, imports and exports. Therefore the conversion was necessary in order to establish the trade flows analyzed below. The Malaysian market size appears to be quite small compared to Thailand and Australia. However, in analyzing the trade flows together with the market size and local production it would appear that a significant amount of re-export of motors takes place in Malaysia. Please refer to the trade flow analysis below for details of this possible explanation.

[11] It is difficult to compare this figure accurately with the other countries since the earnings of the manufacturers is not a very accurate measure of the size of the market sales. The market overview also report that the local production annually amounts to 89.2 MW . This figure seems obviously too small and should likely be GW instead of MW.

The markets in the five countries, described in the market overviews prepared by the local consultants, vary in size (as seen above) as well as in composition of motor sizes. In all the countries small motors dominate the sales, although this predominance is most strongly expressed in China and least in Malaysia. The data collected, shown in Figure 3 as accumulated[12] market shares as a function of rated power, are obviously subject to a certain degree of uncertainty and especially the Chinese apparent extreme dominance of small motors seems a little exaggerated. For Thailand and Australia earlier surveys more or less show the same distribution, although the earlier Thai survey[13] suggests slightly larger motors on average. All in all the actual distribution is probably somewhere in-between. Contrary to the Chinese result the Malaysian distribution may slightly exaggerate the average size of motors sold in the market. An earlier survey in Malaysia suggests that this may be the case.

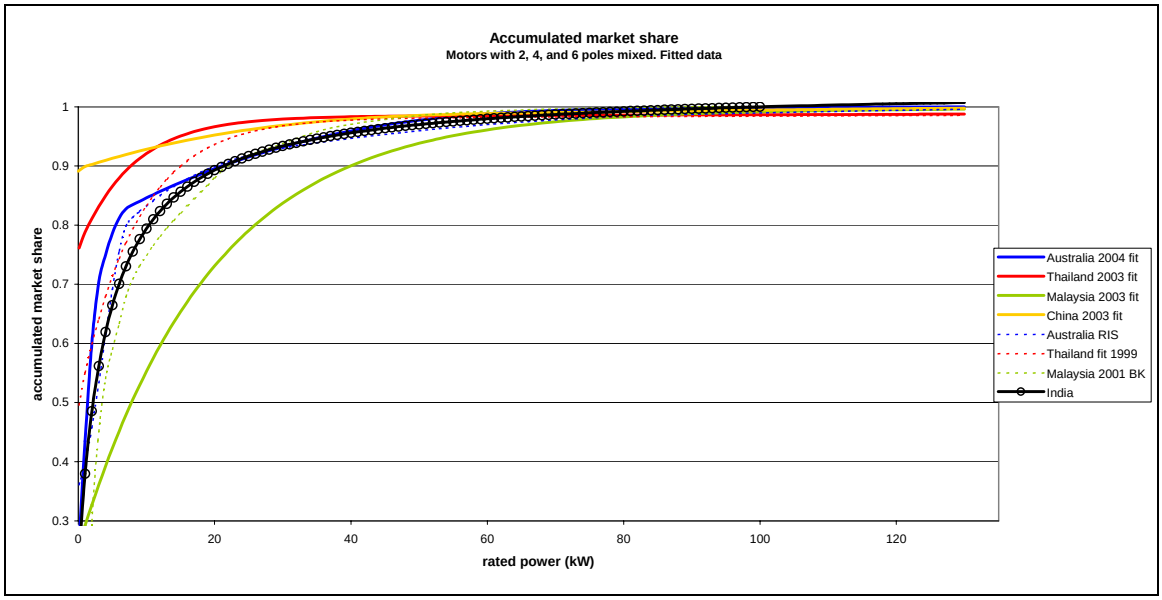

Figure 3. Accumulated Market Shares as a Function of Rated Power.
The full blue curve represents Australia, The dotted blue line an earlier survey done in Australia (ref. 13); the Red curves represent Thailand (full line – present study's data; dotted line: ref. 9); The two green curves for Malaysia similarly represent the present study's data and an earlier survey (ref. 14). The yellow line represents China, and the black India. Details of the fitting process can be found in Appendix B.

Thus taking the variation between surveys done at different times into account the overall picture is that the Australian, Thai and Malaysian markets are very similar in composition. In the following sections calculations using the market composition use the data collected in the present study, but it obviously follows from the considerations above that there is some uncertainty involved in those results.

For purposes of subsequent calculations of relative energy consumption contribution from different sizes of motors the accumulated market distributions in figure 3 above

[12] The primary data give the market share in intervals (in fact different intervals depending on the country) meaning that each data point represents the integrated market share of each interval. The accumulated curve is then easily established by subsequent summation. Finally a best fit curve is determined so that in this way the full distribution is adequately approximated. The Indian market data are estimates using the import size-distribution as proxy. This is not likely to be very accurate, but given the available data it is acceptable.
[13] "Energy Efficiency Regime Study, Final report"; ERM Siam; National Energy Policy Office, Thailand, November 1999

have been used to determine the actual market distributions as a function of size[14]. The result of this is shown in Figure 4 below[15]. The graphs also serve to emphasize the predominance of the small motors in all of the markets.

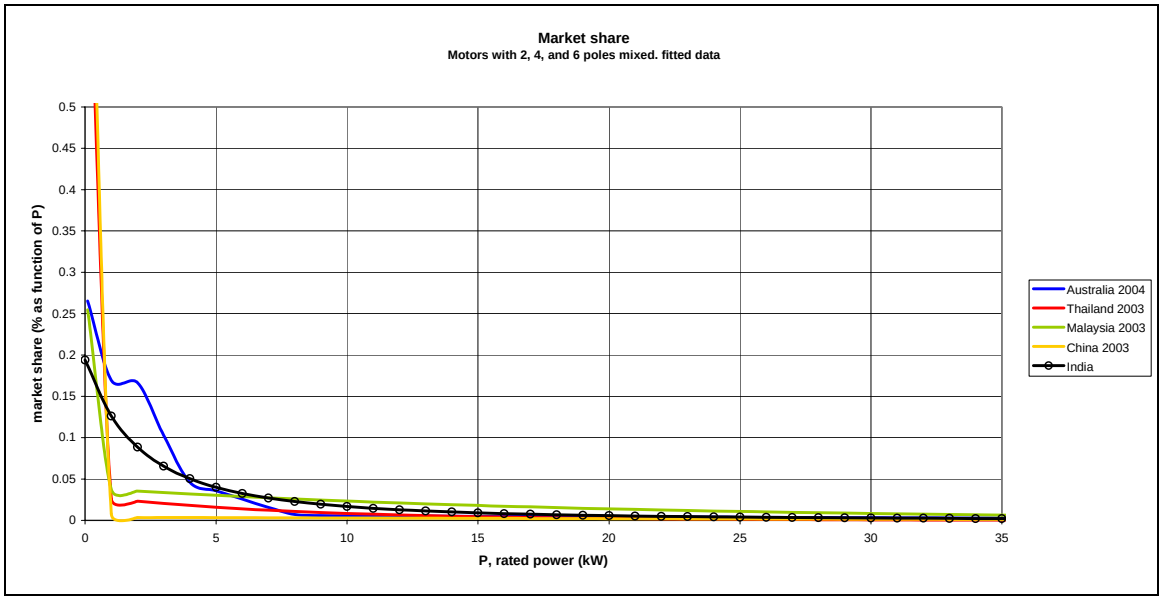

Figure 4. Market share as function of rated power of the motor.
The curves are derived from the accumulated distributions shown in figure 3 above. For the sake of clarity only rated power up to 35 kW is shown.

It is interesting to note that the Chinese, Thai and Malaysian markets appear very similar in structure (although the Chinese as noted above appears to be a little extreme), whereas small-medium size motors (1-5 kW) seem more prevalent in Australia. It is difficult to say with certainty whether the "hump" visible on the Australian graph (which is even stronger in the data from the previous survey, ref. 13) is real or an artifact of the approximation method used for determining the best fitting curve. By choosing a different type of approximating function [16]the hump can be eliminated at the cost of an overall slightly worse approximation. In the final analysis this is likely to be of minor importance though.

Another interesting result is the price relationships that have been derived on the basis of the model data collected. Although the overall relationship is more or less as expected there are some interesting variations between the countries. It should be noted that for Australia the price relationship has been derived on the basis of ref. 13 rather than from primary data since prices were not systematically collected for the Australian market. Overall, the average data given in the Australia market overview correspond well with the data used, however. Furthermore, it should be noted that the data collected in China does not allow a direct relationship to be determined between price and efficiency, but only a relationship between price and rated power[17].

[14] In principle the market shares are found as the derivative of the accumulated graphs.
[15] Again, the Indian market data are estimates using the import size-distribution as proxy.
[16] E.g. an exponential instead of a spline approximation
[17] The Chinese data consists of a test data set, and a catalogue data set. The catalogue data set includes prices, but not efficiencies since those are generally not quoted in the Chinese catalogues, whereas the test data set contain information on efficiencies, but not on price. Since the models in

Figure 5 is a scatter plot of price and efficiency data from Thai and Malaysian model data, and it is interesting to note the sharp increase in price at higher efficiencies (the price is close to exponentially increasing with efficiency).

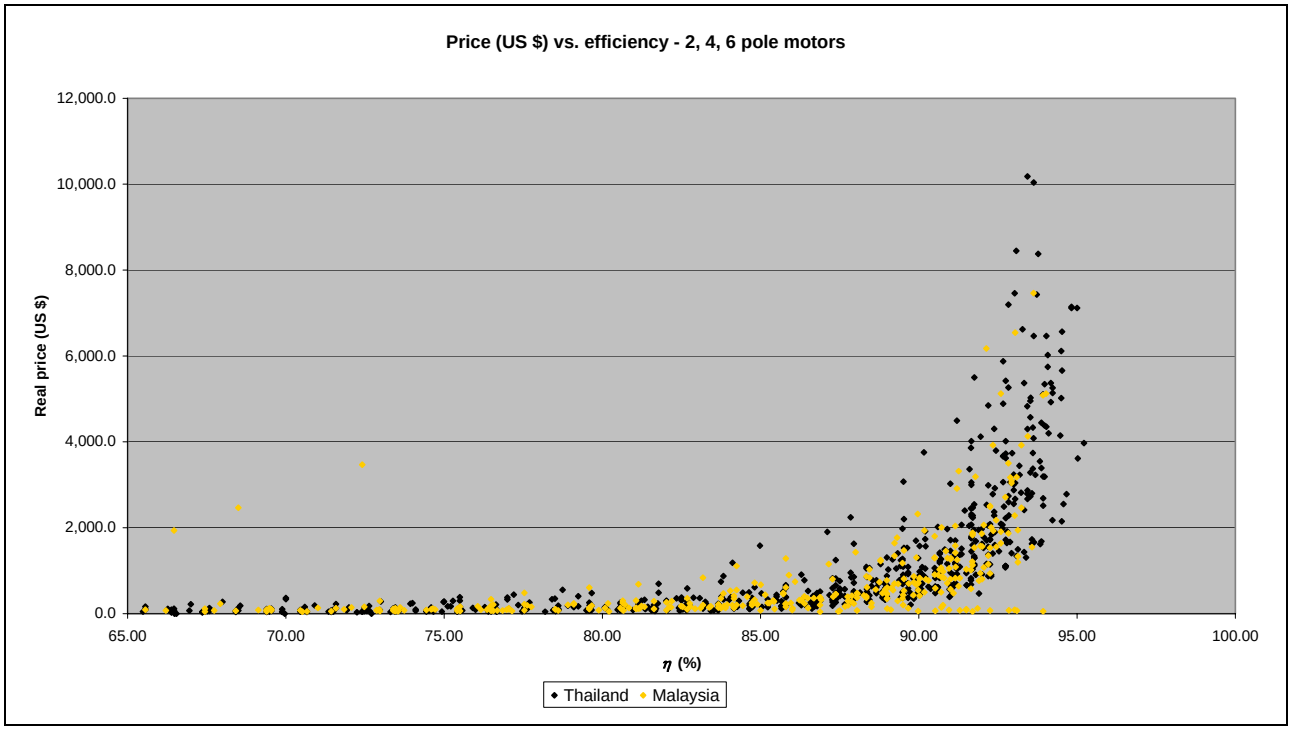

Figure 5. Price vs. Efficiency Scatter Plot Based on Thai and Malaysian Model Data. Yellow dots show Malaysian data, and black Thai data.

each data set are not the same a direct relationship between price and efficiency cannot be established. It may be assumed though that it has the same overall properties as shown in figure 5.

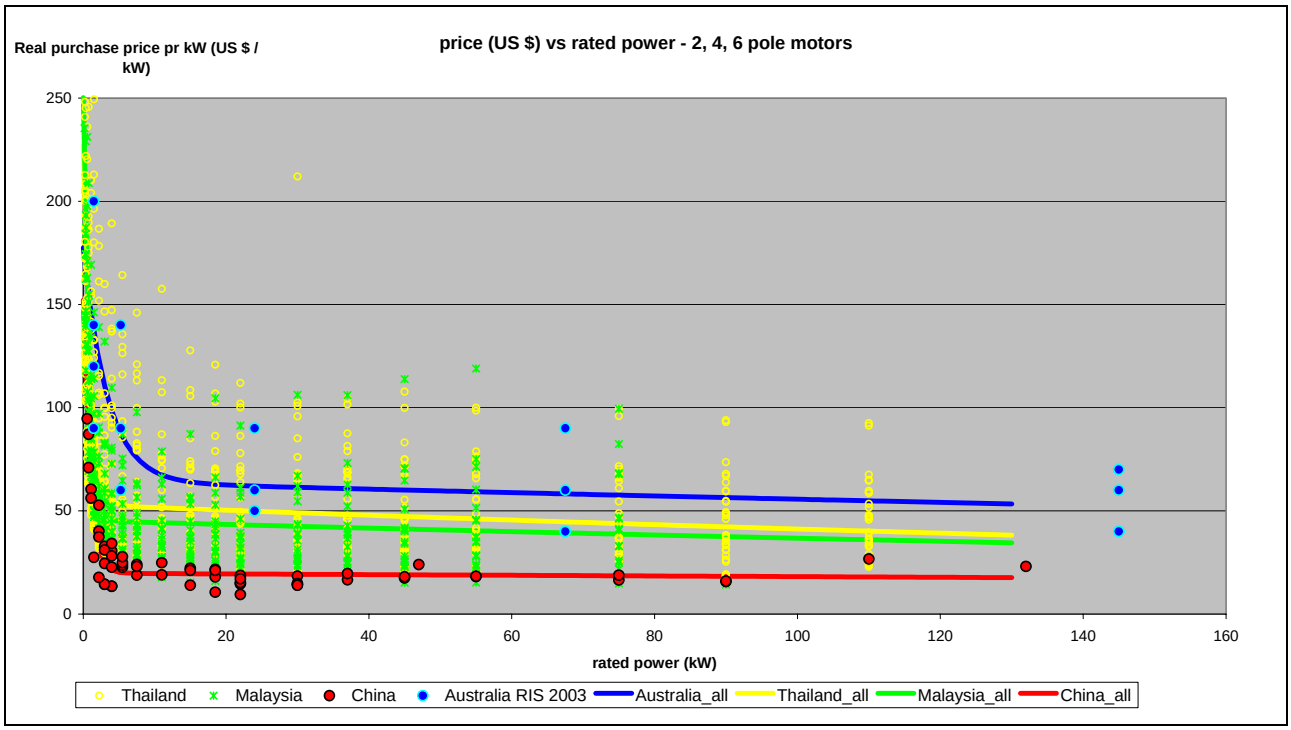

Figure 6. Prices as Function of Rated Power (US $ / kW plotted against kW).
The blue line represents Australia, the Red China, the green Malaysia and the yellow Thailand.

As for the relationship between price and efficiency, the relationship between price and rated power[18] is qualitatively and quantitatively as expected (Figure 6). The variation, from model to model, is generally quite high, which testifies to the fact that the price is a function of many parameters apart from the size of the motor. As might have been expected the Australian average price seems to be higher than in the other economies; the Thai and Malaysian average prices are roughly comparable, whereas the Chinese prices appear to be significantly lower than in the other economies. This may to a certain degree reflect the lower average efficiency found for the Chinese market (cf. below), but perhaps also the fact that most motors sold in China use more or less the same basic design.

An interesting variation of the price as function of motor size is if instead of straight prices the PPP prices are shown instead. The graph then looks as in Figure 6b below.

[18] Price data for India were not collected. As in the other countries the readily available list prices would need to be adjusted to reflect how actual prices are formed, e.g. through rebates, which makes price formation lose transparency. In Thailand, Malaysia and China the list prices were adjusted to reflect normal practices in this regard on the basis of interviews with manufacturers and suppliers.

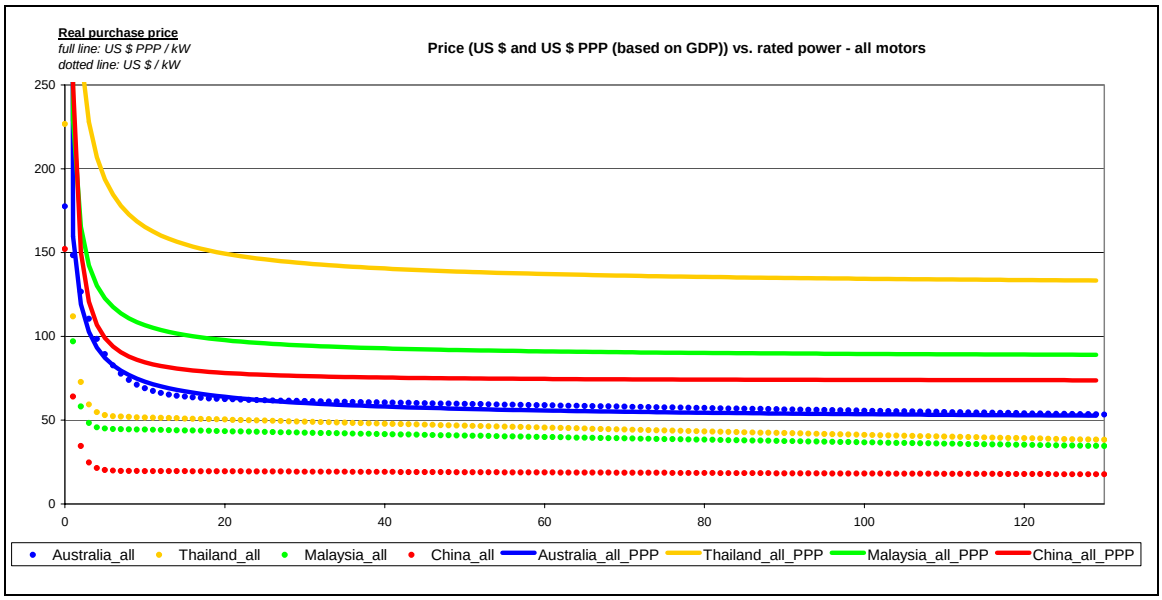

Figure 7b. PPP Prices as Function of Rated Power (US $ PPP / kW plotted against kW).

The blue line represents Australia, the Red China, the green Malaysia and the yellow Thailand. Dotted lines are the curves using conventional currency exchange rates.

Using PPP to compare price levels indicates that relative to local purchasing power motors are most expensive in Thailand and Malaysia. This could mean that incentives would be relatively more effective in promoting higher efficiency motors in Thailand and Malaysia. It is likely that this is also true for India, although as noted above local prices were not collected so that a definite answer cannot be given here.

Trade Flow Analysis

The purpose of the trade flow analysis was to assess the volume of trade (export, import and net trade), the direction of net trade, and the kind of motors traded between the five economies. The collected information presented in the market overviews gives rise to a number of questions when compared to each other. First, one would expect that the ex-port from one economy to another equals the import into the second economy from the first. However, in taking a closer look at the data this turns out not to be the case, meaning that there are discrepancies in the official data sourced[19]. In most cases the net direction of trade coincides, whereas the volume of trade differs (but is of the same order of magnitude). In some instances, however, neither the volume of trade nor the order of magnitude matches up.

There can be many explanations for this including possibly different classifications of products by different countries (e.g. of motors built into integrated applications), varying accuracy of customs records, erroneous or lacking registration of information, erroneous information provided by the importers/exporters which is not generally discovered since only a fraction of goods are actually physically inspected, fraudulent practices by some traders perhaps, etc. the possibilities are legion. Other reasons

[19] The local consultants have generally been sourced the trade data from customs reports.

could be related to the large fluctuations in the trade from year to year that can be observed in the data from all countries.

Whatever the reason, the fact remains that the figures don't match up when compared so in order to get a useful and generally reliable result the data have been modified by, firstly, taking averages of trade over a couple of years. This has the downside of removing trends of increasing or falling trade volumes, but has the virtue of eliminating the fluctuations from year to year that are observed. All in all it is probably fair to take averages over a couple of years as the representative figure since although there may be certain trends the overall trade is not likely to change dramatically over the timescale of a few years. In any event, assessments employing similar approach separated by a few years would establish such trends in any event given that they are persistent.

Secondly, to ensure that the export from A to B equals the import into B from A the two complementary sets of data are averaged. This generally does not result in any net change of trade direction, except in one case where the net direction of trade is reversed[20]. Overall the benefit overshadows the drawbacks since one cannot accept theoretically that the import/export figures are not internally consistent.

It should also be noted that the number of units imported and exported from Thailand has been calculated based on the value of the trade, the distribution of trade according to the rated power of the motors and the average price/size relationship shown above.

It is also necessary to note that the import/export data from China as presented in the economy overview prepared by the local consultant appear to be a factor 1000 too large (three orders of magnitude larger figures from China than from any of the other economies concerned). Therefore, until further details are available the analysis has assumed that the Chinese figures by mistake have been made a factor 1000 too large.

Table 5 below presents the overall results of the trade flow analyses. Note that the numbers are <0 when they are imports, and >0 when exports.

Table 5. Net Average Trade within the Five-Country Group. (Number of units)

Figures >0 denote net export, and < 0 net import**.**

		To				
		Australia	**Thailand**	**Malaysia**	**China**	**India**
From	**Australia**	**0**	**-14,770**	**-8,954**	**-84,953**	**-130**
	Thailand	**14,770**	**0**	**4,841**	**-25,960**	**-1,137**
	Malaysia	**8,954**	**-4,841**	**0**	**-21,363**	**44**
	China	**84,953**	**25,960**	**21,363**	**0**	**456**
	India	**130**	**1,137**	**-44**	**-456**	**0**

[20] Between Thailand and China.

The net direction of trade as well as whether a country is a net importer or exporter is visualized in Figure 8 below. It is interesting to note that the status as net importer or exporter determined through the trade flows internally in the five/country group coincides with the individual countries' net trade balance globally.

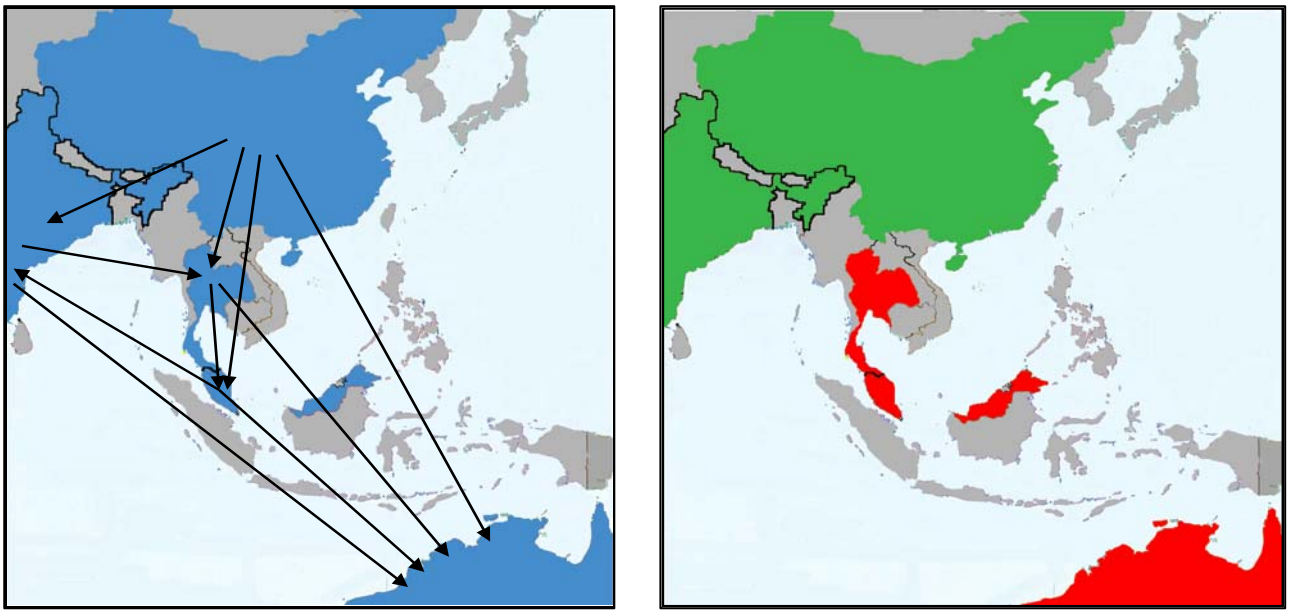

Figure 8. Direction of Trade and Trade Balance for Electric Motors.

Left: Net directions of motor trade between Australia, Thailand, Malaysia, India and China. Right: Net trade balance locally (Red: net importer; Green: net exporter). Overall the local trade is small compared to global trade with among others EU, USA and Japan.

Generally speaking, the results of the trade data analysis are quite uncertain as a result of the fact that both the trade figures and the figures for local production and market size are subject to significant uncertainties.

The possibility that re-export could be significant in some economies contribute to the understanding of the observed discrepancies, although it is not likely to be the full explanation.

Motor Model Efficiencies

Based on the collected data model efficiencies have been compared and a model-weighted average efficiency curve has been determined for each country's motor market. In general the relative number of models is fairly tightly clustered around the model-weighted average efficiency curve. This curve has been determined as a smoothed line fitted to the set of model data[21]. A selection of paired country scatter plots, with rated power and efficiency along the x and y axis respectively, is shown in Figure 9 below. Figure 10 shows the model data for all the countries and the

[21] Alternatively one could calculate an average efficiency in each power-interval and fit a spline to this set of averages. This was done and the result showed that the difference between the two methods is negligible. The method mentioned in the text was preferred since it was faster to generate by using the software package Matlab™.

Australian current and coming MEPS in one and the same graph. Although it has not been possible to calculate a sales-weighted average due to inaccessibility of model specific sales values, it is reasonable to expect that the sales weighted average efficiency is close to the model-weighted average.

In general there is only a slight difference between motors with different number of poles.

The graphs below all show "mixed" model data, i.e. 2, 4 and 6 pole models are plotted on the same graph. In case a MEPS line is graphed together with the model data it is unless otherwise stated the 2-pole MEPS. This could in some cases make a few models appear incompliant whereas they are in fact compliant since the MEPS line for their number of poles is slightly different form the one shown.

It should be noted that all efficiencies shown are according to the IEEE 112 B standard. Since a substantial part of the model data has had their efficiencies determined according to IEC 34-2[22]. To achieve this, the data sets have been adjusted so that all efficiencies are either IEEE 112 or equivalent IEEE 112 efficiencies. Basically this conversion has been done by applying the tables in the Australian/New Zealand MEPS standard which show equivalent values determined according to IEC and IEEE respectively. This approach proposed in ref.12 is likely an improvement over the conversion algorithm suggested by Almeida et. Al (refs. 3, 4). The details of the calculation can be found in appendix B. This conversion, however is not exact and therefore might either somewhat over or underestimate the differences and thus be another minor source for apparent "non-compliant" data points in the scatter plots.

The model-weighted average efficiency curves are shown in Figure 11, and as can be fairly easily seen there is a distinctly higher average efficiency in the Australia compared to the Thai, Malaysian, Indian and Chinese markets.

[22] or another standard such as the Japanese.

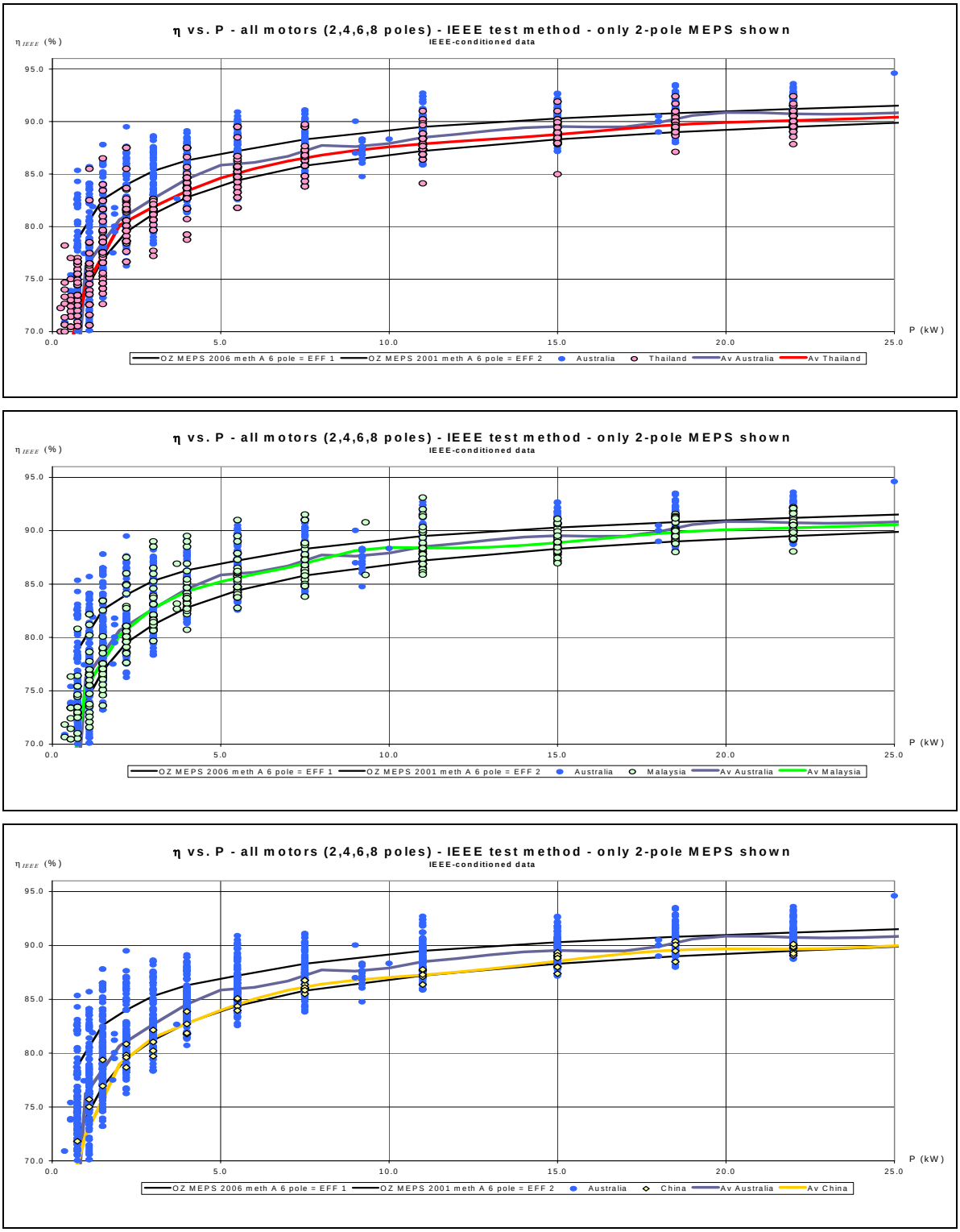

Figure 9. Selected Country-Paired Scatter Plots.
The three scatter plots shown here compare the markets of Australia & Thailand (top), Australia & China (center), and Australia & Malaysia (bottom), respectively. Note that for the sake of clarity the Australian MEPS lines (black) shown are for 2-pole motors only. Colors: Blue: Australia; Red: Thailand; Green: Malaysia; Yellow: China

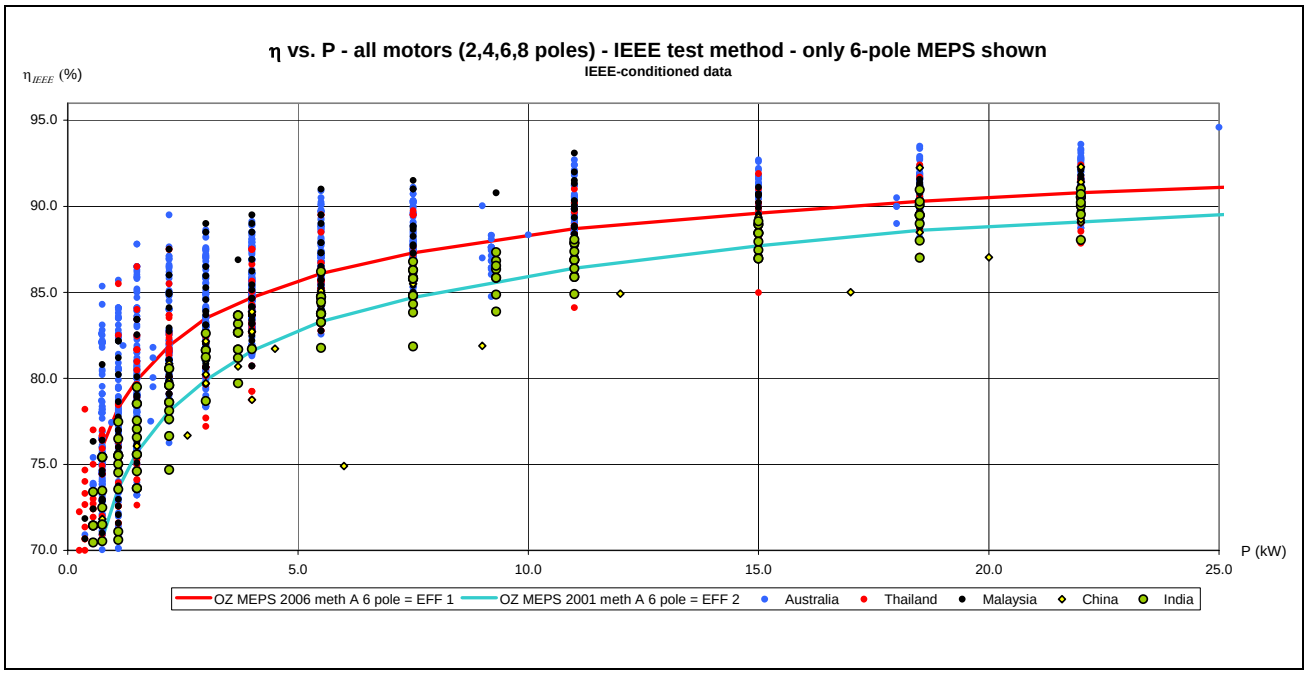

Figure 10. Scatter Plot Showing Data for All Countries vs. Australian 2001 and upcoming 2006 MEPS. 2001 MEPS in blue; 2006 MEPS in red.

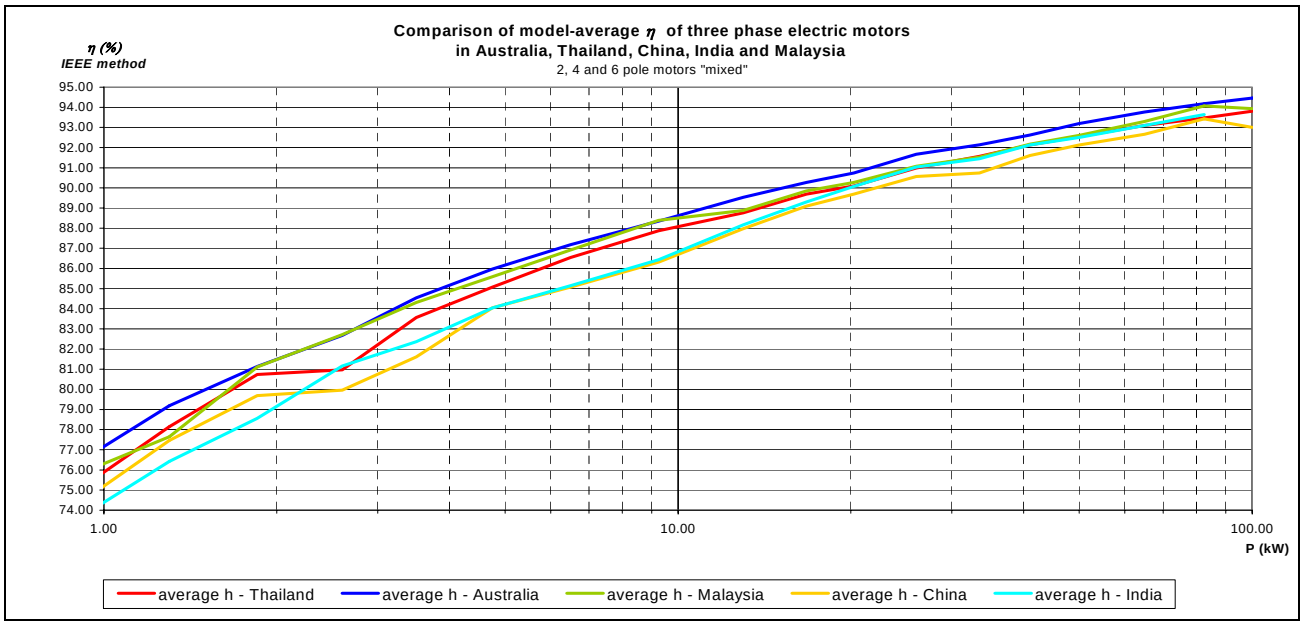

Figure 11. Model-Weighted Average Market Efficiency Curves.
The blue curve representing Australia is distinctly above the Thailand (red) and Malaysia (green) curves. The Chinese and Indian average model averages (yellow and pale blue) are distinctly lowest over most of the range. Note that for the sake of clarity the x-axis is logarithmic.

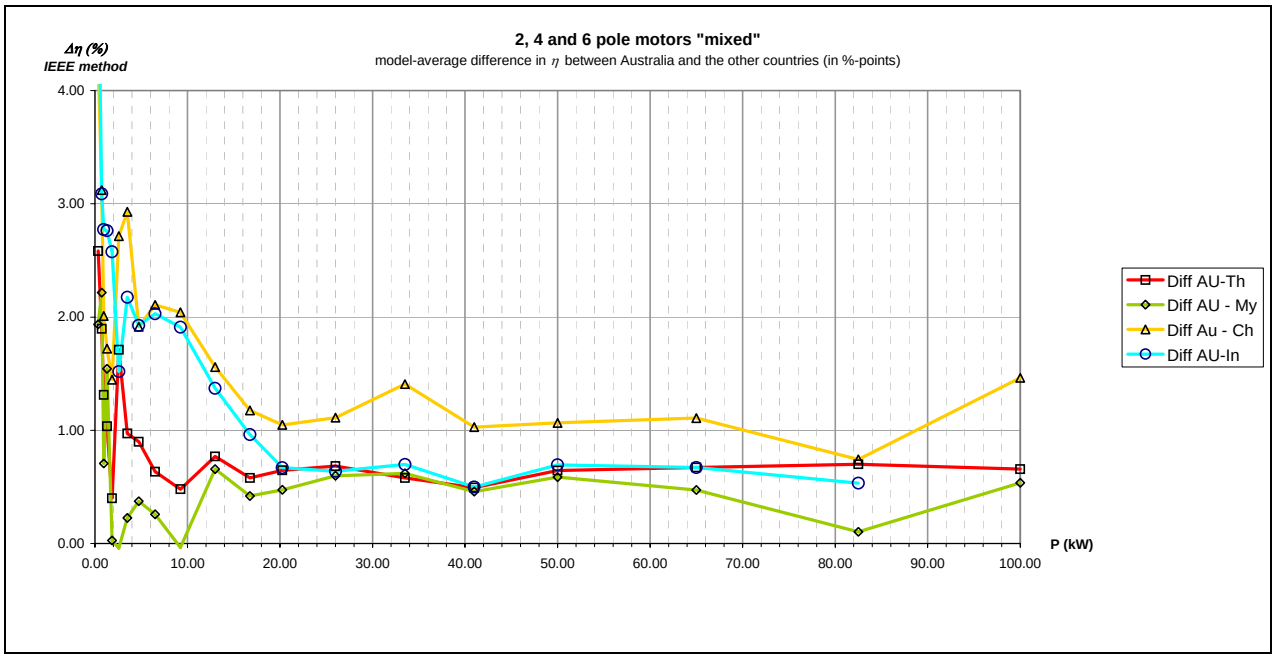

Figure 12. Differences between the Australian Model-Weighted Market Average and Corresponding Curves for Other Countries.
Color key: Thailand in red; Malaysia in green; India in pale blue; and China in yellow. It is seen that the difference is greatest between the Australian and the Chinese market averages over the whole range of motor sizes. The Thai and Malaysian market averages fall in between the Australian and Chinese curves and are roughly equivalent.

The differences are clearly seen in Figure 12, which graphs the differences between the average efficiency curves. The Thai and Malaysian markets are roughly equivalent in terms of efficiency, whereas the Chinese market appears to be characterized by significantly lower efficiency over the entire range of motor sizes.

The difference in model efficiencies is perhaps most clearly demonstrated (Figure 13) by the percentage of currently marketed motors in each market that would comply (at least in theory) with the more strict MEPS levels that will be introduced in Australia in 2006. Roughly a quarter of the current models in the Australian market would be in compliance. The percentages for Thailand and Malaysia at 22% and 25% respectively are similar. However, a mere 15% of the motors on the Chinese market, and roughly 8% in India would pass these more stringent MEPS. The result for China and India are less certain than the Australian, Thai and Malaysian as a result of the smaller samples. In fact the Chinese passing rate calculated from the sample may be too high, as indicated by the local consultant in the country report where it is estimated that only about 5% of the motors sold would pass current Australian MEPS.

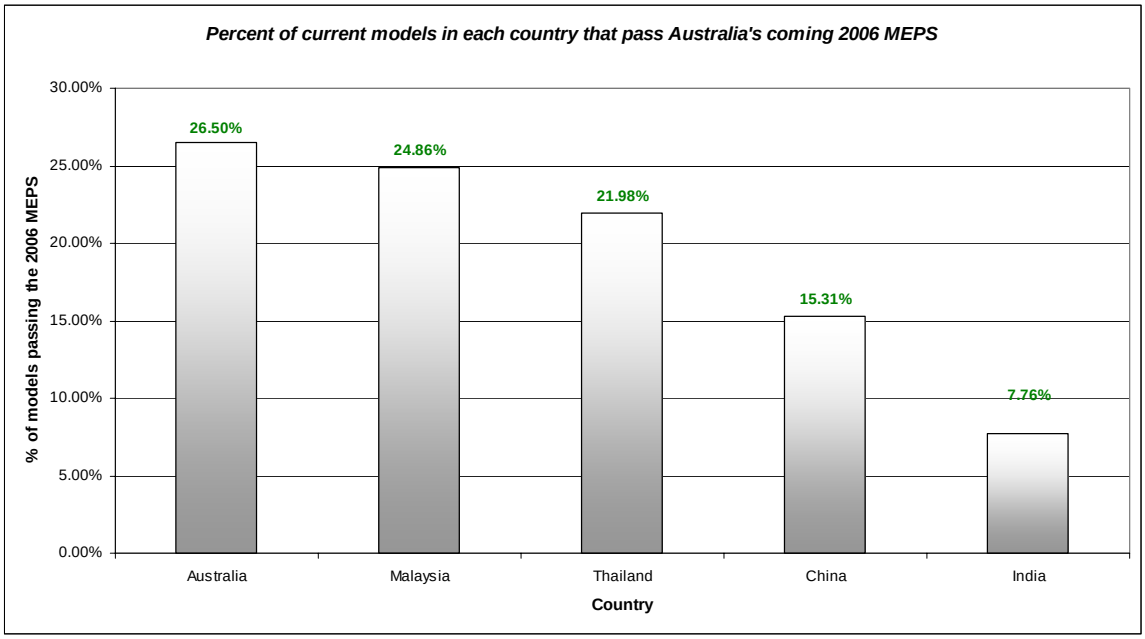

Figure 13. Percentage of Current 2,4 &6 pole models that Would pass the More Stringent, Australian MEPS to be introduced in 2006.

Interestingly the graph in Figure 13 is the same as the percent of models in the samples that are EFF 1, since the AU 2006 MEPS is equivalent to EFF 1. Furthermore all the local consultants' reports state that the % of sales that are EFF 1 is quite low, much lower in fact than the % calculated based on our samples.

Annual Normalized Energy Consumption Contribution from Motor Market

The impact on energy consumption from the different market segments has been assessed by applying the characteristics of market distribution and model-weighted efficiency found in the previous sections. To enable comparisons across countries[23] the energy contribution has been normalized[24] with respect to the total market size. The results are that in general the largest energy consumption contribution comes from small and medium size motors. However, it is worth pointing out that the result is sensitive to the assumptions on annual operation hours as function of motor size, as well as the precise shape of the fitted curves for market share and model-weighted efficiencies. Therefore the result is more likely to be qualitatively correct than accurate in quantitative terms.

The result of the analysis is shown below in Figure 14, and it appears that the overall distribution of energy input from the market is similar in the five countries. Since the precise shape of the distributions are sensitive to the precise shape of the market distribution etc as mentioned above, and since these are in themselves estimates with some uncertainty, it is fair to say that the main conclusion to be drawn from the energy contribution analysis is that the relative contribution from small and medium

[23] As noted earlier the Indian market distribution is quite uncertain. Since the calculations in this section are very sensitive to this distribution it was decided that the uncertainties would be too great and that therefore the calculation was not carried out for the Indian data.

[24] Normalization has been done with respect to the total market size and also so as to show the relative contribution as a function of motor size - i.e. the energy input from the market normalized relative to total market size has itself been normalized to "1 unit of energy" input so that the resulting distribution show the relative contribution from different size motors.

size motors is the most significant. This result is consistent[25] with similar results from earlier studies such as the MIEEP project in Malaysia, shown in Figure 15 (ref.14).

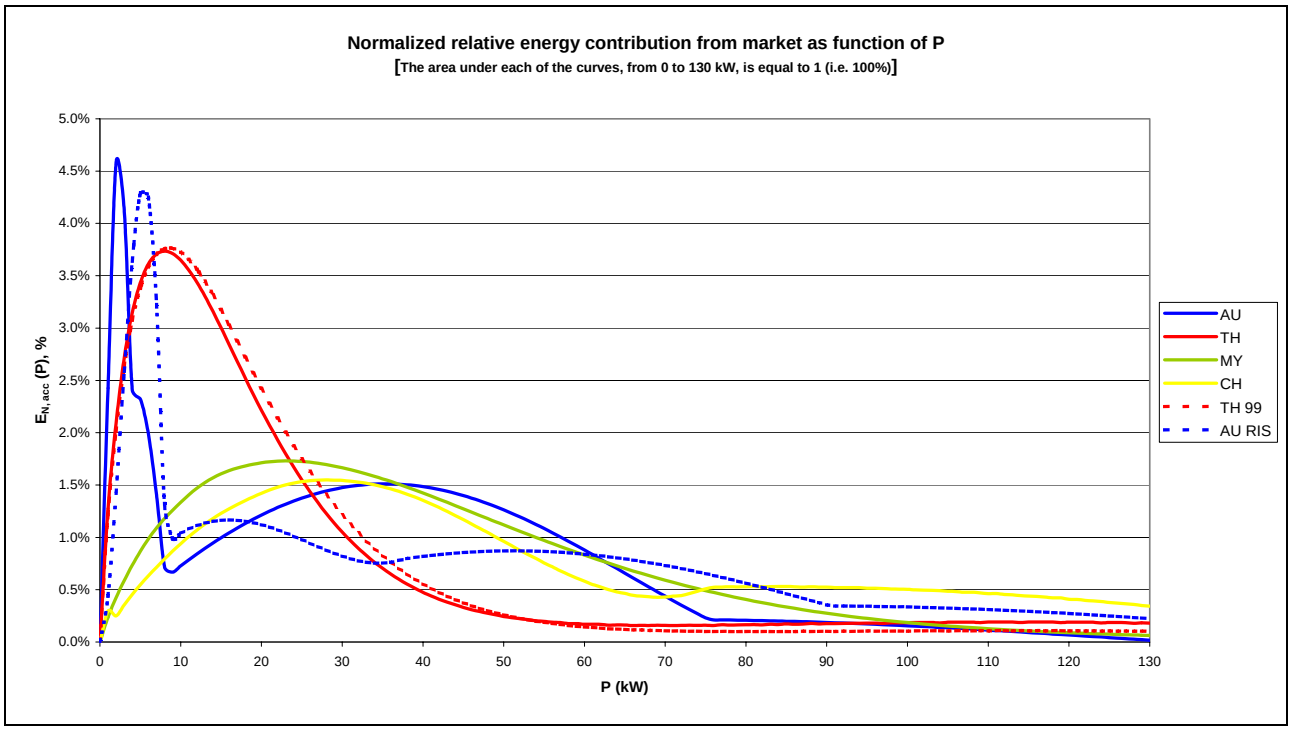

Figure 14. Annual Normalized Energy Consumption Contribution from Motor Market. The blue line represents data for Australia collected in the present study, the broken blue line shows Australia based on data from ref. 13, the green line represents Malaysia, the red line Thailand, the broken red line Thai data from ref. 9, and the yellow line represents China.

[25] Although not identical to

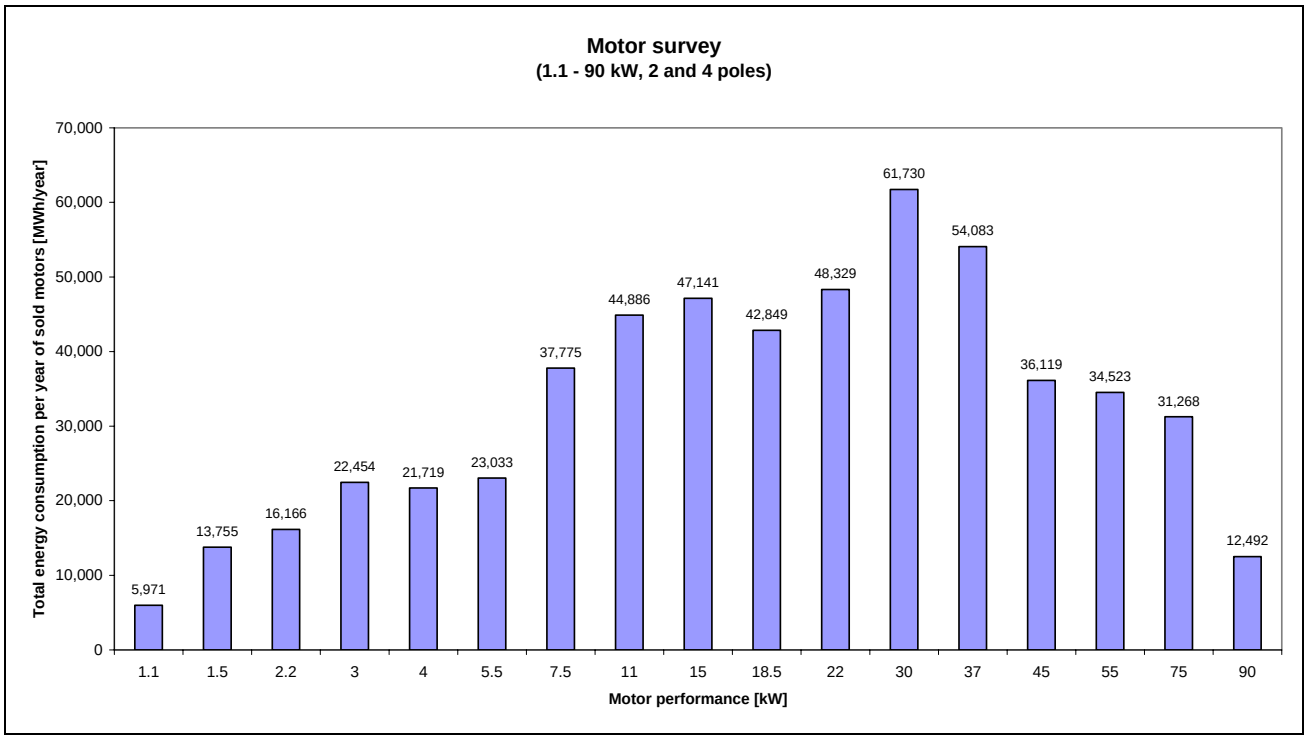

Figure 15. Annual Energy Consumption Contribution from Motor Market in Malaysia.
From ref.14. Please note that the distribution is not normalized, and that the x-axis scale is not linear. When adjusted for these differences in presentation it is clear that the result is qualitatively comparable to the distributions shown in figure 13 above.

Factors of Uncertainty Affecting the Analysis

The main sources of uncertainty in the present study are related to:

- The Chinese model data, which are relatively few and with significantly less spread in values compared to the other countries. Additionally they are not as evenly distributed over different size ranges as those for the other countries.
- The Chinese market, import and export figures that deviate substantially from those of the other countries by being apparently about three orders of magnitude too large
- The precise shape of the market share distribution of motors according to size. Here comparisons with earlier studies show a relatively large variation, and furthermore the Chinese distribution appears more extreme than those of the other countries. The main cause of the uncertainties is the relatively rough data on market share as function of motor size in all the countries. This has necessitated a numerical approximation based on a small number of reference points.
- The collected trade data display a number of inconsistencies, which makes it difficult to rely on the numbers other than qualitatively. Furthermore the Thai data for the trade in terms of number of units have been calculated on the basis of trade in terms of value and the rather rough division on different size intervals used in the customs data

- In the analysis of energy consumption contribution the uncertainties are accumulated since it is based on results that are themselves subject to uncertainties.
- The possibility of significant re-export of imported motors in Malaysia (and other countries) that is indicated in the section on trade flows could potentially change the net trade balances for motors.
- Uncertainties are incurred through the conversion of performance from IEC to IEEE values. On average, however, it is probable that this error cancel out when large data sets are analyzed.
- Additionally there is the issue of laboratory measurement uncertainties. Again it is probably fair to assume that this is more or less normally distributed and therefore on average cancels out when analyzing large datasets – i.e. is not a source of bias.

6. CONCLUSIONS

Data Collected. The study team carried out market surveys and characterized the three-phase electric motor market in each of the economies. Teams also reviewed manufacturers' catalogues of models available on the market; and collected available laboratory test data on motor performance. The data collection and analysis focused on motors with up to 100kW rated power. A massive amount of data was collected – ranging from 11 to 35 brands per economy; and from 228 up to 2,995 models per economy.

Test Procedures. All five economies have significant numbers of models on their markets using either IEC 60034-2 or IEEE 112-B for measuring energy performance. To compare efficiencies in the different markets the team used a correction algorithm based on the Australian/New Zealand MEPS standard, which include tabulated values of com-parable performance figures quoted in accordance with both standards. This allows a direct, albeit not exact, conversion method between performance data.

Catalogue Data Used. Because not all of the economies have comprehensive test data on models available in the market, the team decided to do the primary motor comparisons between the five economies using catalogue data. While there are some potential drawbacks to this approach, the catalogue data is the only common denominator of the avail-able data in each of the economies and thus the only way to ensure that we were com-paring "apples with apples." The exception to this argument is the Chinese catalogues, which apparently does not in general list motor efficiency data. Therefore the Chinese efficiency data are mostly test data.

Efficiency Comparisons. Of the five economies, Australia has the highest average motor efficiency over the range of motor sizes analyzed. Thailand and Malaysia have com-parable market characteristics as regards efficiency, slightly lower than those of Australia. India and China have lower average efficiency levels overall.

Other Comparisons. The main report presents a number of representative findings from the large dataset. This includes trade flow data and comparisons of MEPS standards and of the relative energy consumption contributed by different size motors in the market.

The Australian Benchmarking Initiative. This is second in a series of international benchmarking efforts of its kind for appliance and equipment energy efficiency. A similar benchmarking study was carried out for air conditioners and presented at an international conference in Sydney during June 2004. The results of these benchmarking studies will be used by Australia in implementing its policy of "international regulatory best practice" in the establishment of minimum energy performance standards (MEPS) and labeling grades for its energy labels. They also form the core of a new section on "performance benchmarking" that will be established on the web site of the APEC Energy Standards Information System (www.apec-esis.org) in order to promote international best practice in appliance and equipment efficiency

7. REFERENCES

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APPENDIX A: SAMPLE TOR FOR THE DATA COLLECTION

Task 1. Market Overview

Initial overviews of the markets will be carried out through interviews with the major manufacturers and importers of motors in each country (at least the 5 largest). The countries covered are Australia, Thailand, Malaysia, China and Taiwan (Chinese Taipei). The national consultants will research the market share of the largest manufacturers and give an indication of the total number of manufacturers, assemblers, and distributors in their respective country. Sales channels, and the competitive market situation in terms of pricing considerations and market drivers shall also be mapped out

This will result in a 5-10 page overview of the three-phase electric motor market in [*country*]. The overview will cover the following information:

- Primary sales channels
- Market size (number of units sold and value);
- Market breakdown for electric motors according to rated power and brands;
- Market share of the largest manufacturers (brands) – covering at least 75% of the total market;
- Total number of manufacturers, assemblers, and distributors in each country
- Relative efficiency levels, including MEPS[26] and labeling requirements as well as anticipated future development thereof;
- Description of the standard used for determining performance – national standard, international reference standard and variations in the national standard relative to the international reference

This task should be completed and a draft market overview submitted by early December 2004.

Task 2. Trade Flow Review

Initial data on the overall import/export market picture will be developed through collection of official data from the customs and commerce departments. These data will be supplemented with interviews with several major manufacturers and suppliers in each country (minimum 5 largest), with an aim to understand the competitive dynamics of the industry, and also to verify the primary trade flow data obtained from the customs and commerce departments.

The trade flow review (use the trade flow data collection form provided) will result in data tables, and a brief overview and "flow chart" of motors manufactured, exported and imported in [*name of country*], covering:

[26] MEPS = Minimum Energy Performance Standard

- Total imports and exports of electric motors broken down as described below;
- Primary export markets and import sources;
- Total import and export of electric motors to and from each of the other four countries (cf. list of countries above)
- Size and breakdown according to motor size of *national production* of motors (note that this is not necessarily the same as the breakdown of the *national market*, which is part of task 1)

Motors covered will be three phase units with 2, 4, and 6 poles, and in with a rated power in the range 0-100 kW. The intention is to cover standard motors, so specialized models with an overall small or negligible market share need not be covered. I.e. the coverage shall be representative of the whole size range 0-100 kW for standard motors with significant market share in [*country*]. The brands/manufacturers covered shall also be representative – i.e. all significant bands/manufacturers represented in the market shall be included in the data.

Data shall as a minimum address the figures for national production (i.e. motors manufactured within the country for both national sales and export) according to the above breakdown, as well as for each of the five countries the export and import volume (according to the same breakdown) between the them. Furthermore a total export and import statistic shall be given - i.e. in addition to flows between the 5 countries.

To the extent possible the data shall be broken down according to the different (major) manufacturers/brands.

Data collection shall be in conformance with the data collection form in annex 1, and shall be completed no later than by mid December 2004..

Task 3. Collect Catalogue Data

Primary data collection on rated power consumption and efficiency for three phase electric motors will be developed through a review of catalogues provided by manufacturers, distributors and retailers. The data reported for each model will include brand and manufacturer name; model number; number of poles; rated power consumption; and efficiency at full load, as well as the number of units sold, price and standard use for testing performance.

Motors covered will be three phase units with 2, 4, and 6 poles, and in with a rated power in the range 0-100 kW. The intention is to cover standard motors, so specialized models with an overall small or negligible market share need not be covered. I.e. the coverage shall be representative of the whole size range 0-100 kW for standard motors with significant market share in [*country*]. This is one reason why getting the sales numbers right is important (cf. data collection form). Another is to enable a quantitatively correct sales weighting when comparing between different countries' motor markets. The brands/manufacturers covered shall also be representative – i.e. all significant bands/manufacturers represented in the market shall be included in the data.

The consultant will provide the data in the Motor Manufacturer Data Collection Form supplied by DEM

This task should be completed by mid December 2004.

Task 4. Collect Test Data

The consultant will also to the extent the information is available collect data from laboratory tests of three phase electric motors. This will be a secondary source of data collection on motor efficiency, since it is recognized that similar test data will not be available across all 5 countries, e.g. due to differences in regulation of electric motors. However, the motor test data will be used to (a) to cross check the motor performance data provided by the manufacturers in their catalogues; and (b) to provide an overview of the efficiency range of models verified by laboratory testing.

Motors covered will be three phase units with 2, 4, and 6 poles, and in with a rated power in the range 0-100 kW. The intention is to cover standard motors, so specialized models with an overall small or negligible market share need not be covered. I.e. the coverage shall be representative of the whole size range 0-100 kW for standard motors with significant market share in [*country*]. The brands/manufacturers covered shall also be representative to the extent possible – i.e. all significant bands/manufacturers represented in the market shall be included in the data.

The data from test results will be entered into the Motor Test Data Collection Form provided by DEM.

This task should be completed by mid December 2004.

Reporting

The reporting will consist of a market overview, a trade flow review and data, catalogue and test data, and a draft and final summary report covering all the above tasks after commenting.

DEM will comment on the draft final reports, and the consultant shall incorporate the comments in the final report.

The report and supporting documentation shall be in English (catalogues may be in another language if English is not available).

All reporting and spreadsheets will be submitted electronically in MS Word and Excel format, following the template attached (annex 2).

Copies of catalogues will be attached in hardcopy unless electronic versions are available (MS Word, Excel or PDF format).

B1. Conversion of efficiencies (IEC to IEEE)

The conversion from IEC to equivalent IEEE efficiency values has been based on the tables of equivalent motor efficiencies in the Australian MEPS regulation [27]. To interpolate to values in between the discrete points given in those tables a best fitting continuous function has been determined. The result is shown in figure B1 below. *f*(P) denotes the fraction the IEEE value is relative to the IEC value for h as a function of the rated power P.

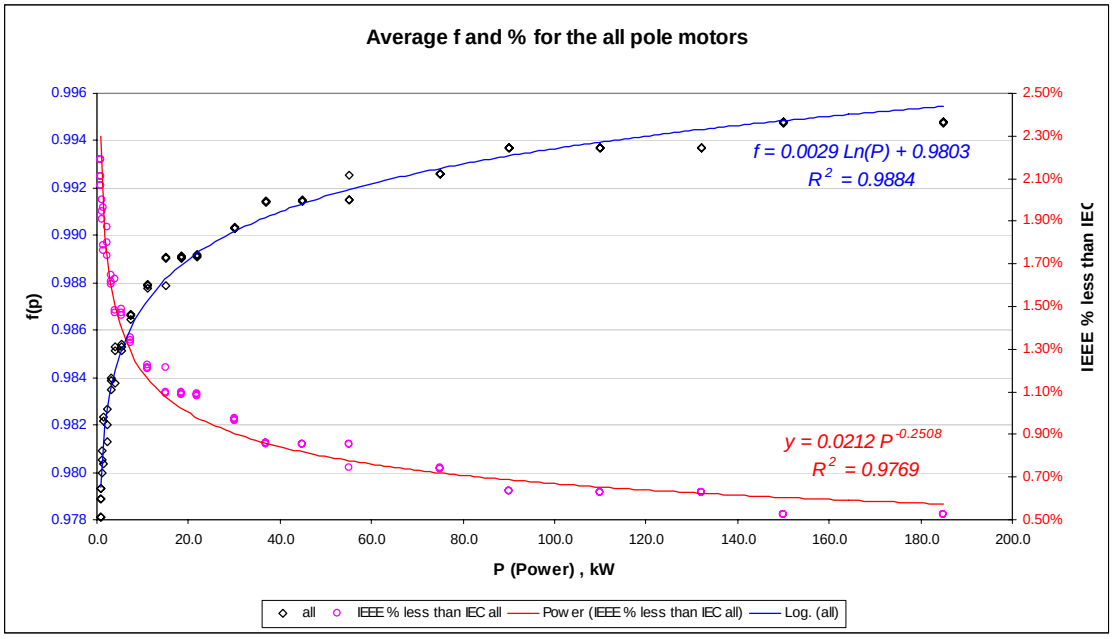


Figure B1. Conversion between IEC and IEEE efficiencies. *f*(P) denotes the fraction the IEEE value is relative to the IEC value for η as a function of the rated power P.

B2. Cumulated market shares

The cumulated market share graphs shown in figure 3 in section 5, are based on the information provided by the local consultants in their country reports. The main reason for constructing the smooth cumulated market share graphs was that the size intervals for reported motor market shares varied from one country to another.

Therefore, to make possible a comparison, for each country the end points of each size-interval for which a market share has been reported was tabulated together with the (accumulated) market share. In two instances (India and China) the data reported

[27] AU/NZS 1359.102.1/102.3

by the local consultant were insufficient for a direct tabulation, and as a proxy the distribution of imports were used instead of actual market shares of different size motors. This approximation is not ideal, as it may me anticipated to show a certain bias towards larger motors, but overall the results are similar to what was found for Thailand, Malaysia and Australia where the market shares were reported directly.

A smooth best-fitting curve using these fixed points were then constructed using the Matlab™ software package. The type of function that best fitted each country's data varied but was in most cases based on either an interpolating spline function, an exponential function or a rational function involving first degree polynomials.

The other main reason for constructing the graphs was that some subsequent calculations needed the values of the market share in-between the relatively small number of discrete values provided in the country reports.

The actual market share can of course, being the derivative, be easily estimated using the cumulated market-share function.

B3. Model average efficiency curves

The model-weighted average efficiency curves are splines determined on smoothed data generated by using the Matlab™ software package. As an alternative the data points were divided into narrow intervals (rated power) and the average efficiency in each interval calculated as if the rated power of all models in the interval corresponded to the centre-value of the interval. Since the intervals used were narrow this in itself gives only small errors. Based on these averages and the cantre-values of the intervals a spline function through them can be constructed. A comparison of the two methods showed that using a suitably strong "dampening" factor in the spline "smoothing" in Matlab™ gave comparable results. In any case both methods gave the same overall result and therefore the conclusions made are considered robust.

B4. Calculation of % of models to pass the 2006 OZ MEPS

The Calculation of % of models to pass the 2006 OZ MEPS were done by summing up the number of models equal to or above the MEPS curve in each of a large number of narrow intervals (rated power) and dividing by the total number of models present in the sample. This involves a possible minor source of error since it is not entirely clear if the MEPS curve is a smooth curve going through the fixed points determined in the regulation, or whether it should actually be a step-function instead (two different step-function could be envisioned). In any event the uncertainty resulting from interpreting the MEPS as a step-function rather than a smooth curve does not influence the overall conclusions drawn.

APPENDIX C: AUSTRALIA MARKET OVERVIEW

This report covers the initial data on the overall market picture of electrical motors in Australia. This report only covers three phase induction motors of up to 100kW nominal rating, traded in brand new condition.

Market Overview

Primary Sales Channels;

Electric motors are used in a very large range of residential, commercial, industrial and agricultural appliances, processes and systems as prime mover (main source of delivering mechanical power) or a controlling device. However, electric motors on their own do not constitute useable appliances. Therefore, electric motors are generally not available from sales channels normally used for selling commonly used residential, commercial, industrial and agricultural machines and appliances.

Primarily there are two segments of the motor market;

- Original Equipment Manufacturers (OEM) or bulk market. The OEMs buy motors directly from the manufacturer or importer for use as prime mover or a control in a new appliance, machinery, process or a system. This segment includes motors of sizes up to 7.5kW that are estimated to account for between 80% - 85% of all ac motors sold in Australia. Local manufacturers and repairers of HVAC equipment are the largest users of bulk market motors.
- Project Market. Larger size motors dominate this segment. These motors are required for specific use in a large-scale engineering project e.g. mining, construction of manufacturing plants etc.

A key difference between the two segments is variation in demand. The bulk market is generally dependent upon general economic conditions and business activity. It is often very stable and has slight fluctuations in annual demand. In contrast the projects segment of the market is closely related with large-scale industrial/ economic activity. Consequently large-scale fluctuations in annual demand are very common.

In Australia, the most common sales channels for new motors are;

a. Manufacturers; normally selling brand new

b. Importers/Distributors; resellers for local and overseas manufacturers. Generally they sell new motors and some also trade second hand and used/reconditioned motors.

c. Retailers; may purchase brand new motors from manufacturers and/or importers/distributors and sell directly to the customers. They also tend to sell both new and used/reconditioned motors. Motor retailers are most often the spare parts retailers that sell parts of a variety of machines.

At present there is only one motor manufacturer (CMG Pty Ltd) in Australia with ability to produce electric motors at industrial scale. However, a large proportion of locally produced CMG motors are single phase and only a few are three phase a.c. induction motors that are the focus of this study. Consequently nearly all three phase motors up to the size of 100kW traded in Australia are imported from overseas. As such the market information provided in this report relies heavily on the imports and exports data supplied by Australian Bureau of Statistics (ABS)[28].

Apart from importers/distributors of major/popular brands, it is often difficult to differentiate between distributors and retailers, as a number of retailers are also nominated distributors of some small brands. In few cases distributors of popular brands of motors are dedicated distributors/resellers of new motors of their brand.

A comprehensive search using Yellowpages phone directory, on the basis of electric motors being a business concern, identified 366 businesses in Australia. These businesses include manufacturer, importers/ distributors/ sole agents/ brokers, retailers/ spare parts sellers, and motor repairers/ resellers.

On the other hand a regularly updated comprehensive database of all registered models (registered for MEPS qualification) of electric motors provides a list of 35 key players that supply new motors of all major brands and models sold in Australia[29]. A detailed list of all major brands and their models that are registered for MEPS for electric motors is attached with this report as MS Excel spreadsheet.

Market size (number of units sold and value):

The data supplied by ABS[28], suggests that the market of 3 phase induction motors in Australia has steadily increased during past 5 years. The sale of three phase motors of the sizes up to 132kW increased at an average rate of around 7% per year for the past 5 years. In the calendar year 2004 nearly 381,000 motors of up to 132kW size were sold in Australia at an estimated cost of A$318 M. As noted earlier , a very large proportion (between 92% - 97%) of these motors were imported from overseas, hence the estimated cost is the FoB value as estimated by Australian Customs. It is estimated that the actual cost to the end-user would be higher , as this would need to include operational costs and commissions of importers/distributors, and local duties etc.

Tables C-1 and C-2 show estimated sales figures for electric motors by size as number of units and value of sales. Correspondingly, Figures C-1 and C-2 graphically illustrate the growth in trade figures, both in number of units imported and dollar value, over past five years. These figures include all multi-phase AC motors (excl. universal AC/DC or flameproof) imported in Australia. The total sales figures would be only slightly higher when some local manufacturing by CMG Pty Ltd is taken into account.

[28] "Imports of A/C Multi Phase motors by Country of Origin/State of Final Destination/Quantity/Value (FOB) for 2000 – 2004" and "Exports of A/C Multi Phase motors by Country of Destination/State of Origin/Quantity/Value (FOB) 2000 – 2004 ", supplied by ABS

[29] http://www.worthit.com.au/energylabel/motors.asp

Table C-1. Estimated number of three phase electric motors sold in Australia (2000 -2004)

Annual Sales by Size (Units)						
Year	**> 37.5W – 750W**	**> 750W - 3.0kW**	**> 3.0kW - 7.46kW**	**> 7.46kW - 75kW**	**> 75kW - 132kW**	**TOTALS**
2000	86,380	82,178	58,627	50,400	1,240	**278,825**
2001	90,270	86,706	58,260	47,500	1,760	**284,496**
2002	87,644	91,213	45,933	55,235	1,414	**281,439**
2003	120,018	103,786	53,723	47,918	1,178	**326,623**
2004	148,611	119,632	48,397	62,345	1,843	**380,828**
TOTALS	**532,923**	**483,515**	**264,940**	**263,398**	**7,435**	**1,552,211**

Table C-2. Estimated cost of three phase electric motors sold in Australia (2000 -2004)

Annual Sales by Size (Value A$ '000)*						
Year	**> 37.5W - 750W**	**> 750W - 3.0kW**	**> 3.0kW - 7.46kW**	**> 7.46kW - 75kW**	**> 75kW - 132kW**	**TOTALS**
2000	$10,234	$8,709	$12,207	$22,393	$4,588	**$58,130**
2001	$13,146	$8,680	$13,313	$22,605	$10,182	**$67,926**
2002	$10,435	$10,387	$10,483	$25,524	$6,409	**$63,238**
2003	$9,827	$11,080	$10,847	$25,377	$4,924	**$62,055**
2004	$11,651	$11,651	$9,945	$26,433	$6,730	**$66,410**
TOTALS	**$55,292**	**$50,506**	**$56,795**	**$122,332**	**$32,833**	**$317,759**

* FoB value determined by Australian Customs

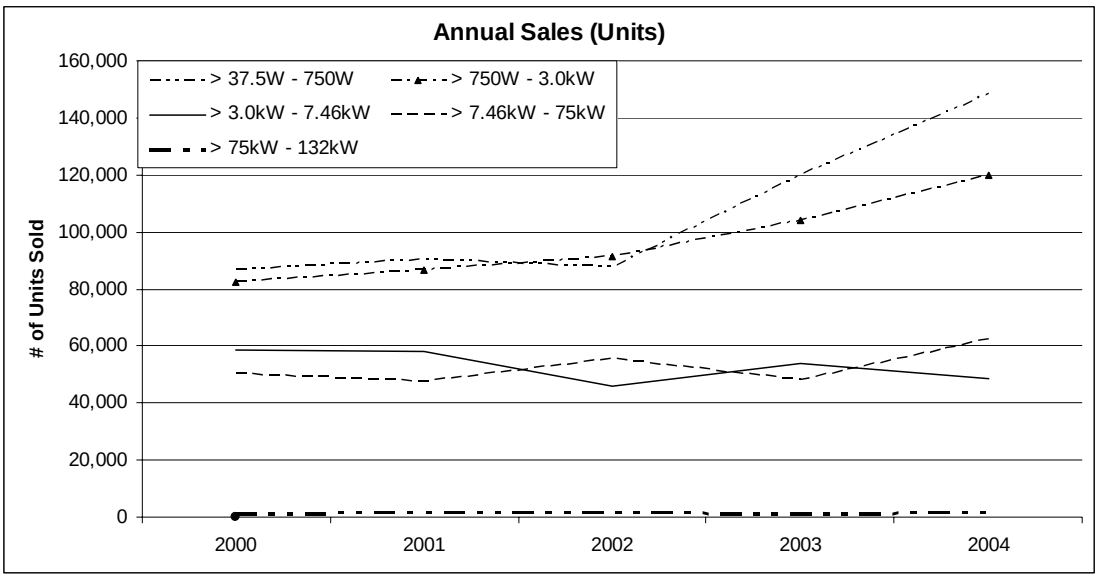


Figure C-1. Trend of trade of three phase electric motors in Australia (2000 - 2004)

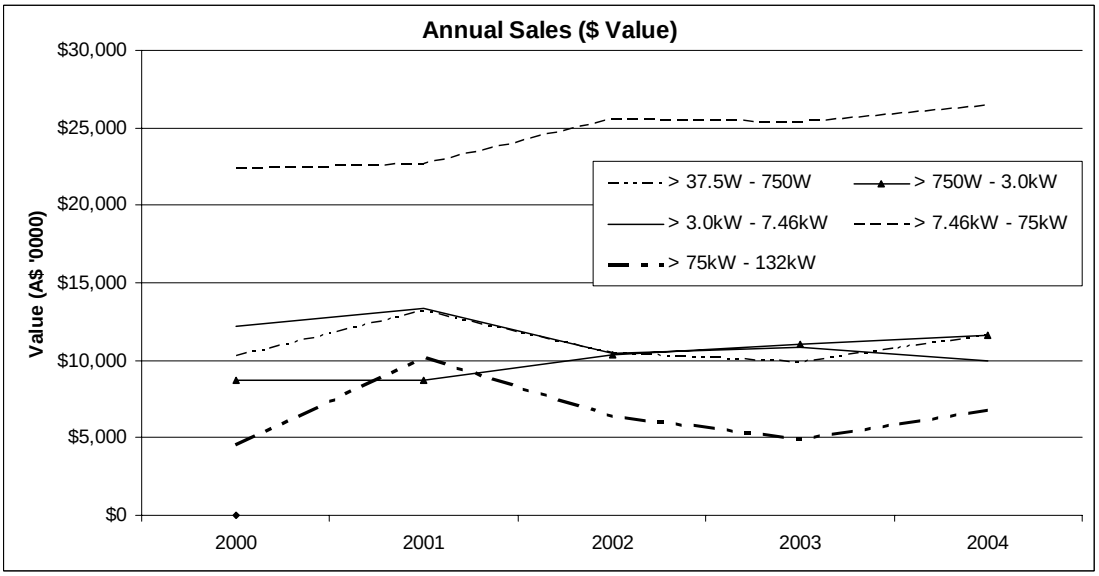


Figure C-2. Trend of trade value of three phase electric motors in Australia (2000 - 2004)

Market Breakdown and Market Shares

Based on motor imports and exports data together with local manufacturing, the market breakdown by categories of rated power was estimated. Table C-3 below shows such breakdown.

Table C-3. Market breakdown by rated power

Market Share by Motor Size					
Year	**> 37.5W - 750W**	**> 750W - 3.0kW**	**> 3.0kW - 7.46kW**	**> 7.46kW - 75kW**	**> 75kW - 132kW**
2000	30.98%	29.47%	21.03%	18.08%	0.44%
2001	31.73%	30.48%	20.48%	16.70%	0.62%
2002	31.14%	32.41%	16.32%	19.63%	0.50%
2003	36.75%	31.78%	16.45%	14.67%	0.36%
2004	39.02%	31.41%	12.71%	16.37%	0.48%

Due to the lack of data, accurate and reliable estimates of the market breakdown by brand and by size categories could not be ascertained. Confidentiality requirements did not allow the ABS to provide the breakdown of imports/exports by brand or the importer/exporter. In addition, as the market of electric motors in Australia is very competitive, there is a significant level of reluctance demonstrated by manufacturers and distributors/resellers to reveal market shares or annual sales volumes.

However, during our interviews with key sales personnel of major players in the market we asked about their estimate of net market share (by annual number of units sold) of 5 top players in the market. These estimates were compared and it was found that there were no significant differences between the estimates of the respondents of the market share of large players.

According to these estimates TECO, CMG, WEG, Toshiba, and ABB are the major market players covering between them nearly 95% of the market for three phase electric motors of the size up to 100kW. According to these estimates TECO holds about 26%, CMG around 27%, WEG about 20%, Toshiba and ABB together nearly 17% of the market. The remaining market is controlled by a large number of small brands.

The interviews with sale personnel revealed further information on market shares by brand and by motor output. On the basis of such information, TECO and CMG are considered to have larger shares in the OEM or bulk market segment, while WEG tend to have uniform shares across all size categories. Both Toshiba and ABB are estimated to have larger shares in Project segment of the electric motor market. Estimated market shares by brand and by size that are shown in Table C-4.

Table C-4. Market Shares by Brand and Motor Output

BRAND	**> 37.5W - 750W**	**> 750W - 3.0kW**	**> 3.0kW - 7.46kW**	**> 7.46kW - 75kW**	**> 75kW - 100kW**	**TOTALS**
TECO	25%	26%	28%	28%	27%	**26%**
CMG	30%	25%	26%	25%	28%	**27%**
WEG	18%	21%	18%	20%	18%	**20%**
Toshiba	8%	11%	13%	16%	20%	**11%**
ABB	5%	5%	7%	9%	6%	**6%**
Others	14%	12%	8%	2%	1%	**10%**

Total number of manufacturers, assemblers, and distributors;

At present there is only one motor manufacturer (CMG Pty Ltd) in Australia with ability to produce electric motors at industrial scale. Most of CMG products are single phase ac motors, with a small number of three phase motors of various sizes.

A business search, on the basis of electric motors being a business concern, identified 366 businesses in Australia. These businesses include manufacturer, importers/ distributors/ sole agents/ brokers, retailers/ spare parts sellers, and motor repairers/ resellers.

The comprehensive database of all registered models (registered for MEPS qualification) of electric motors show 35 brands and just under 3000 models registered for sale in Australia[30]. A detailed list of all major brands and their models that are registered for MEPS for electric motors is attached (as MS Excel spreadsheet data).

Relative efficiency levels, including MEPS and labelling requirements

The actual operating efficiencies of all models registered for MEPS requirements are provided in the motor data supplied with this report. However, the sales weighted efficiencies could not be determined accurately as sales data by model could not be obtained.

It has been established that OEM segment (motor sizes up to 7.5kW) of the electric motor market accounts for almost 80% - 85% of all the units sold in Australia. Our interviews with motor sales personnel noted that each the OEM and Project market segments have differing characteristics. These characteristics highly influence the relative motor efficiency expectations for these segments.

In the OEM segment, since motor becomes part of larger equipment/ process or system, the manufacturers are less concerned about the efficiency but more concerned about the price of the motor. As the cost of motor generally increases as its design efficiency is increased, the equipment manufacturers are more likely to purchase the lowest cost motors that fulfil their requirements. Consequently it is estimated that a very large proportion (75% - 85%) of motors of output up to 7.5kW would have operating efficiencies in the lowest bands under MEPS requirements. Please refer to Table C-13 through Table C-18 for current and 2006 expected MEPS requirements for electric motors by motor output.

On the other hand in the Projects segment, motors are purchased for specific needs. Generally during the design process, the issues associated with technical and non-technical attributes of the electric motor, including its efficiency, hours of operation and operating costs, are also estimated. Hence it is more likely that efficiency influences the choice of motor (when the decision is made on the basis of cost benefit analysis over the period of life of the motor or the project). Consequently, majority of the motors sold in Projects segment (especially large size motors) are estimated to have efficiencies in the higher bands of MEPS requirements. Please refer to Table C-13 through Table C-18 for current and 2006 expected MEPS requirements for electric motors by motor output.

[30] http://www.worthit.com.au/energylabel/motors.asp

It is also worth noting that all motors sold or imported in Australia must comply with MEPS requirements as shown in Table C-13 through Table C-18. Where motors are imported in some packaged equipments e.g. water pumps, agricultural machines, air conditioners, appliances and equipments, they are not subject to the Motor MEPS requirements. However, most of these packaged equipments are also being subjected to MEPS requirements for their own categories e.g. MEPS for air conditioners, Chillers, etc. The motors included in locally manufactured packaged equipment must pass MEPS requirements before being purchased or imported by these OEMs.

Description of the Standard used for determining performance

For a description of energy performance standard -- national standard, international reference standard and variations in the national standard relative to the international reference -- please refer to the section "Test Standards for MEPS Requirements for Three Phase Electric Motors", later in this Appendix.

Trade Flow Review

Total imports and exports of electric motors;

Australia is a net importer of electric motors. Number of motors imported is significantly higher than the number of units exported. During past 5 years, the volume of electric motor exported as a percentage of net imports has varied between the lowest at less than 1% in 2000 and the highest at 9.5% in 2002. Table C-5 and Table C-6 respectively show the imports and export figures by categories of motor output for the years 2000 to 2004.

Table C-5. Total Number of Electric Motors Imported by Size & Year

Annual Imports by Size (Units)						
Year	> 37.5W - 750W	> 750W - 3.0kW	> 3.0kW - 7.46kW	> 7.46kW - 75kW	> 75kW - 132kW	TOTALS
2000	86,380	82,178	58,627	50,400	1,240	**278,825**
2001	90,270	86,706	58,260	47,500	1,760	**284,496**
2002	87,644	91,213	45,933	55,235	1,414	**281,439**
2003	120,018	103,786	53,723	47,918	1,178	**326,623**
2004	148,611	119,632	48,397	62,345	1,843	**380,828**
TOTALS	**532,923**	**483,515**	**264,940**	**263,398**	**7,435**	**1,552,211**

Table C-6. Total Number of Electric Motors Exported by Size & Year

Annual Exports by Size (Units)					
Year	> 0 - 750W	> 750W - 75kW	> 75kW	TOTALS	% of Imports
2000	779	1,093	60	**1,932**	**0.69%**
2001	14,830	1,319	120	**16,269**	**5.72%**
2002	5,861	15,454	5,195	**26,510**	**9.42%**
2003	1,016	21,038	342	**22,396**	**6.86%**
2004	26,118	3,349	795	**30,262**	**7.95%**
TOTALS	**48,604**	**42,253**	**6,512**	**97,369**	**6.27%**

Primary export markets and import sources;

Imports

During past 5 years, Australia has imported three phase electric motors of the size up to 132kW from 156 different countries. China, Italy, Brazil and Germany have been the top source countries for motors imports. However, motor imports from Thailand have increased significantly during past 2 years. Table C-7 shows the number of electric motors imported from top 10 source countries over past 5 years.

Table C-8 shows the number of electric motors imported from top 10 source countries by motor output. It can be seen that, except Thailand and USA where significant majority of imports were small size motors, the number of imports are largely similar in terms of category of motor output. While this may be the case, it is also possible that any pattern is masked by very broad size category of ">7.46kW to 75kW", that Australian Customs and ABS use for tariff and data organization purposes.

Table C-7. Number of Electric Motors Imported from Top 10 Countries by Year

Annual Imports by Country of Origin and Year						
Country	**2000**	**2001**	**2002**	**2003**	**2004**	**Total for 5 Years**
China	65,263	71,166	73,870	90,824	128,509	**429,632**
Italy	54,649	52,309	59,478	62,410	48,146	**276,992**
Brazil	23,543	22,068	30,072	33,823	31,829	**141,335**
Germany	30,639	21,555	34,528	22,460	16,840	**126,022**
Taiwan	26,122	25,664	22,600	20,442	22,060	**116,888**
Thailand	269	469	3,511	34,679	53,915	**92,843**
USA	9,709	44,402	8,431	7,835	8,184	**78,561**
Malaysia	12,259	11,056	8,544	11,211	13,310	**56,380**
UK	13,056	10,033	6,867	8,839	3,651	**42,446**
S. Korea	5,010	4,660	496	308	21,690	**32,164**
Others	38,306	21,114	33,042	33,792	32,694	**158,948**

Table C-8. Number of Electric Motors Imported from Top 10 Countries by Size

Annual Imports Country of Origin and Motor Output						
Country	**> 37.5W - 750W**	**> 750W - 3.0kW**	**> 3.0kW - 7.46kW**	**> 7.46kW - 75kW**	**> 75kW - 132kW**	**TOTALS**
China	132,951	91,791	121,999	81,503	1,388	**429,632**
Italy	53,531	175,135	17,067	31,217	42	**276,992**
Brazil	33,082	42,306	29,321	35,586	1,040	**141,335**
Germany	44,431	26,245	29,284	25,678	384	**126,022**
Taiwan	33,615	34,221	24,470	22,602	1,980	**116,888**
Thailand	88,542	4,123	140	35	3	**92,843**
USA	52,162	11,171	4,960	9,516	752	**78,561**
Malaysia	21,184	8,601	7,913	18,658	24	**56,380**
UK	9,736	24,108	4,554	3,701	347	**42,446**
S. Korea	3,782	26,870	100	1,296	116	**32,164**
Others	59,907	38,944	25,132	33,606	1,359	**158,948**

EXPORTS

New Zealand is top destination for Australian exported electric motors. For past 5 years New Zealand has received more than half of all electric motors exported from Australia. Table C-9 shows the number of electric motors exported to top 10 destination countries over past 5 years. Table C-10 shows the number of multi-phase electric motors exported to top 10 destination countries by motor output. Please note that export data contains motors of all sizes.

Table C-9. Number of Electric Motors Exported to Top 10 Countries by Year

Annual Exports by Country of Destination and Year						
Country	**2000**	**2001**	**2002**	**2003**	**2004**	**TOTALS**
New Zealand	1,262	15,089	10,054	1,565	25,824	**53,794**
Italy	8	1	9	14,977	20	**15,015**
Hong Kong	8	15	5,066	35	2,008	**7,132**
Thailand	1	15	5,826	17	30	**5,889**
Malaysia	323	3	2,295	628	23	**3,272**
China			1,303	1,611	5	**2,919**
UK	126	37	88	2,296	18	**2,565**
USA	13	78	117	326	906	**1,440**
Singapore	19	44	860	25	318	**1,266**
S Korea	2	682	15	155	1	**855**
Others	170	305	877	761	1,109	**3,222**

Table C-10. Number of Electric Motors Exported to Top 10 Countries by Size

Annual Exports by Country of Destination and Year				
Country	**> 0 - 750W**	**> 750W - 75kW**	**> 75kW**	**TOTALS**
New Zealand	41,980	11,498	316	**53,794**
Italy	1	15,014		**15,015**
Hong Kong	2,079	52	5,001	**7,132**
Thailand	1,511	4,371	7	**5,889**
Malaysia	1,225	2,037	10	**3,272**
China	7	2,911	1	**2,919**
UK	152	2,243	170	**2,565**
USA	70	1,327	43	**1,440**
Singapore	689	547	30	**1,266**
S Korea	24	831		**855**
Other	866	1,422	934	**3,222**

Total import and export of electric motors to and from each of the other four countries;

During past 5 years nearly half (46%) of all three phase electric motors, of output up to 132kW, imported in Australia were sourced from 4 APEC countries i.e. China, Malaysia, Thailand and Taiwan. The data suggests a consistent growth in imports of electric motors from these countries. Table C-10 summarizes the imports of motors of output up to 132kW from the 4 countries.

However, exports of all three phase electric motors to these four countries accounted for only 12.5% of net exports of this type of motors. Thailand being the largest recipient by receiving 6% of all Australian exports of multi-phase electric motors.

Figure F-3 graphically illustrates the Australian trade of electric motors with above four countries and the rest of the World.

Table C-10. Annual Number of Electric Motors Imported from China, Malaysia, Taiwan and Thailand by Year

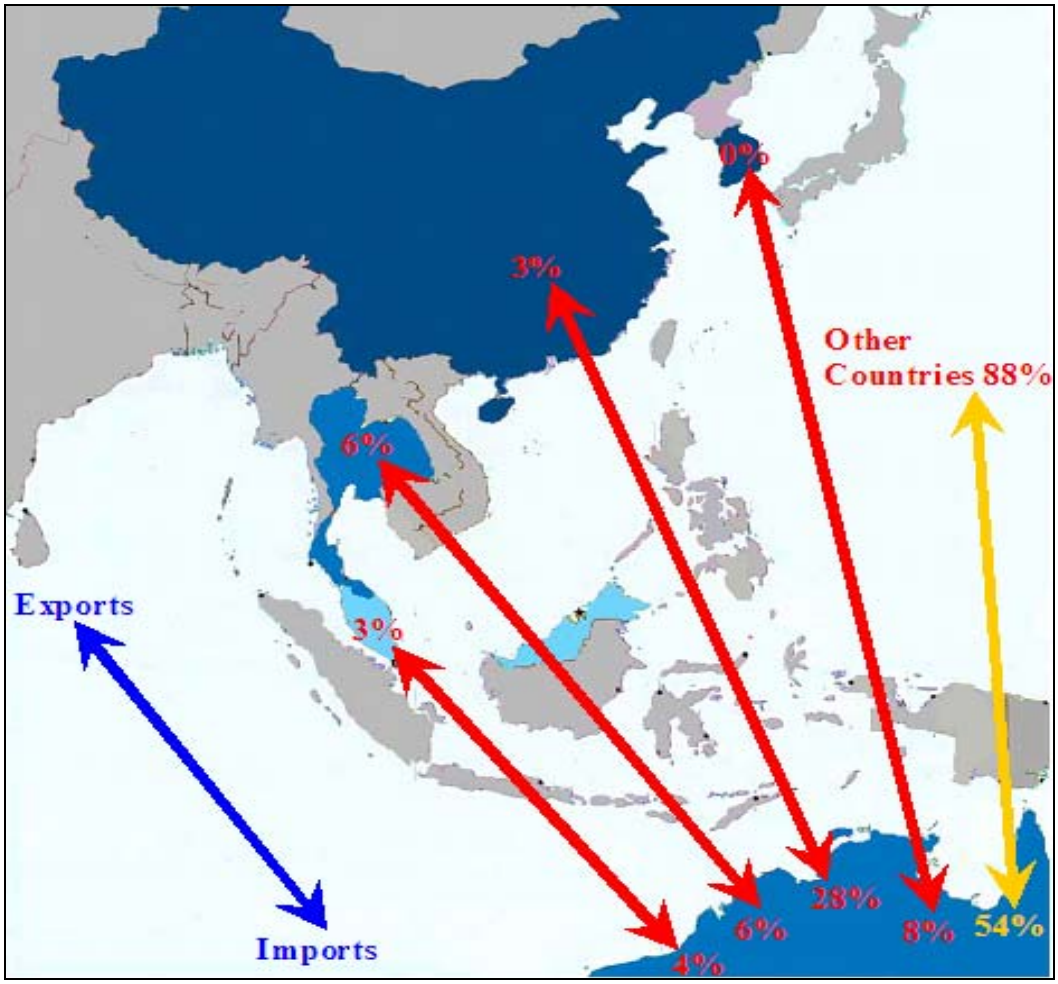
Annual Imports by Country of Origin (Number of Units)						
Country	**2000**	**2001**	**2002**	**2003**	**2004**	**TOTALS**
China	65,263	71,166	73,870	90,824	128,509	**429,632**
Taiwan	26,122	25,664	22,600	20,442	22,060	**116,888**
Thailand	269	469	3,511	34,679	53,915	**92,843**
Malaysia	12,259	11,056	8,544	11,211	13,310	**56,380**
Australia*	196	97	32	46	79	**450**
Others	174,716	176,044	172,882	169,421	162,955	**856,018**

* Re-imports

Table C-11. Annual Number of Electric Motors Exported to China, Malaysia, Taiwan and Thailand by Year

Annual Exports by Country of Destination (Number of Units)						
Country	**2000**	**2001**	**2002**	**2003**	**2004**	**TOTALS**
Thailand	1	15	5826	17	30	**5,889**
Malaysia	323	3	2295	628	23	**3,272**
China			1303	1611	5	**2,919**
Taiwan	1			29	10	**40**
Others	1607	16251	17086	20111	30194	**85,249**

Figure F-3. Trade Flow of 3 Phase Electric Motors to China, Malaysia, Taiwan and Thailand



Size and breakdown according to motor size of national production of motors:

As noted earlier there is only one motor manufacturer in Australia whose local manufacturing contributes to between 3% and 8% of the market for 3 phase electric motors of output up to 100kW. The breakdown of their local production as a function of motor size could not be obtained. However, on the basis of breakdown provided in Table C-4, the breakdown of local production by motor size can be estimated as shown in Table C-12 below.

Table C-12. Proportion of Local Manufacturing of Electric Motors by size

Percentage Share of Local Production by Motor Size					
> 37.5W - 750W	> 750W - 3.0kW	> 3.0kW - 7.46kW	> 7.46kW - 75kW	> 75kW - 132kW	TOTALS
5% - 9%	2% - 4%	<1%	0%	0%	3% - 8%

Motor Catalogue Data

Since the catalogue data for all motor models sold in Australia is too numerous to be reported here, the required catalogue data on each model sold and registered under MEPS requirements is available in the attached MS Excel spreadsheet. This data has been reported by the manufacturers or importers of various model registered under MEPS requirements. We randomly selected electronic catalogues of 5 models of top 5 brands to verify the performance claims in catalogues against the same reported in the motor registration database.

Motor Test Data

Complete details of test data for all models could not be collected. However, the motor database, attached as MS Excel spreadsheet with this report, contains the testing standard used to provide performance of the model for MEPS registration purpose. The motor test used for performance verification purpose is provided in the field titled, "N-Standard" in column M of the spreadsheet.

The motor manufacturers and importers may have their models tested from an internationally recognized testing facility. At present the only motor testing laboratory that complies with testing requirements is owned and operated by the only motor manufacturer in Australia, i.e. CMG Pty Ltd.

Current and Proposed MEPS and Relevant Testing Standards

MEPS Requirements for Three Phase Electric Motors from 0.73kW to <185kW[31]

MEPS applies to three phase electric motors, manufactured in or imported into Australia with a rated output in the range 0.73 kW to <185kW and with 2, 4, 6 or 8 poles. From 21 June 2002, state and territory laws require all such electric motors to be registered by the manufacturer or importer and their sale is illegal unless they are registered and comply with the MEPS efficiency requirements.

Since 1 October 2001, three phase electric motors from 0.73kW to <185kW manufactured in or imported into Australia must comply with Minimum Energy Performance (MEPS) requirements which are set out in AS/NZS 1359.5-2000. The Australian MEPS levels are essentially harmonised with the European High Efficiency Level 2. High efficiency motors in Australia approximately correspond to European High Efficiency Level 1 and US MEPS levels for electric motors.

Three phase electric motors within the scope of the regulation must meet or exceed the minimum efficiency level stated in AS/NZS1359.5. Motors may be tested to either of the following testing methods[32]:

[31] Source: http://www.energyrating.gov.au/motor2.html

AS1359: Rotating electrical machines - General Requirements Part 102.1: Methods for determining losses and efficiency – General. This test is also termed as "Test Method B" and is equivalent to IEC 60034-2A.; or

AS/NZS1359: Rotating electrical machines - General Requirements Part 102.3: Methods for determining losses and efficiency - Three phase cage induction motors. This test is also termed as "Test Method A" and is equivalent to the forthcoming IEC standard and US ANSI/IEEE 112 method B.

In addition, motors are required to comply with the relevant parts of AS1359: Rotating electrical machines - General Requirements Part 101: Rating and Performance (IEC 60034.1). Part 5 of the standard also specifies minimum levels for motors claimed as "high efficiency" in the market place. This specification means that suppliers' should no longer make advertising claims about their motor's high efficiency unless it meets the more stringent level.

There are a number of motor types that are exempt from MEPS including:

- submersible motors;
- integral motor-gear systems (non separable);
- variable or multi-speed speed motors;
- motors rated only for short duty cycles (IEC60034-2 duty rating S2); and,
- rewound motors or motors sold as second hand.

From 1 April 2006, MEPS levels for three phase electric motors will be revised to become more stringent. The "High Efficiency" level from 2001 will become the MEPS level on 1 April 2006. From 1 April 2005 a revised "High Efficiency" level will also come into force. These new MEPS and high efficiency requirements together with transition arrangements are set out in detail in AS/NZS 1359.5-2004 which was published in September 2004. This standard supersedes AS/NZS 1359.5-2000.

MEPS levels and "High Efficiency" levels are set out in Table C-13 through Table C-18 below.

[32] Details on Test Standards are available in Section 0 of this report.

Table C-13. Efficiency Levels for Three Phase Electric Motors - Test Method A. MEPS for 2001

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

NOTES:
1. For intermediate vales of rated output, the efficiency shall be determined by linear interpolation.
2. Tolerances specified in Table 1.1 of AS/NZS 1359.5 are applicable to the above values only in the case of a verification test.

Table C-14. Efficiency Levels for Three Phase Electric Motors - Test Method A. MEPS for 2006, High Efficiency Levels for 2001

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	84.0	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

NOTES:
1. For intermediate vales of rated output, the efficiency shall be determined by linear interpolation.
2. Tolerances specified in Table 1.1 of AS/NZS 1359.5 are applicable to the above values only in the case of a verification test.

Table C-15. Efficiency Levels for Three Phase Electric Motors - Test Method A. High Efficiency Levels for 2005

Rated Output kW	Minimum Efficiency %			
	2 pole	4 pole	6 pole	8 pole
0.73	81.4	82.9	78.8	75.0
0.75	81.4	82.9	78.8	75.0
1.1	83.0	84.5	80.9	77.6
1.5	84.8	85.6	82.4	79.6
2.2	86.2	86.9	84.2	81.9
3	87.2	87.8	85.6	83.6
4	88.1	88.7	86.7	85.0
5.5	88.9	89.5	87.9	86.5
7.5	89.9	90.4	89.0	87.8
11	90.9	91.3	90.2	89.3
15	91.6	92.1	91.0	90.4
18.5	92.1	92.4	91.6	91.1
22	92.4	92.8	92.1	91.5
30	93.1	93.4	92.8	92.4
37	93.6	93.8	93.3	92.9
45	93.9	94.1	93.7	93.5
55	94.2	94.4	94.1	93.9
75	94.8	94.9	94.6	94.6
90	95.0	95.2	95.0	94.9
110	95.3	95.5	95.3	95.3
132	95.5	95.6	95.5	95.5
150	95.7	95.9	95.8	95.9
<185	95.7	95.9	95.8	95.9

NOTES:

1. For intermediate vales of rated output, the efficiency shall be determined by linear interpolation.
2. Tolerances specified in Table 1.1 of AS/NZS 1359.5 are applicable to the above values only in the case of a verification test.

Table C-16. Efficiency Levels for Three Phase Electric Motors - Test Method B. MEPS for 2001

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

NOTES:
1. For intermediate vales of rated output, the efficiency shall be determined by linear interpolation.
2. Tolerances specified in Table 1.1 of AS/NZS 1359.5 are applicable to the above values only in the case of a verification test.

Table C-17: Efficiency Levels for Three Phase Electric Motors - Test Method B. MEPS for 2006. High Efficiency Levels for 2001

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

NOTES:
1. For intermediate vales of rated output, the efficiency shall be determined by linear interpolation.
2. Tolerances specified in Table 1.1 of AS/NZS 1359.5 are applicable to the above values only in the case of a verification test.

Table C-18. Table B3: Efficiency Levels for Three Phase Electric Motors - Test Method B. High Efficiency Levels for 2005

Rated Output kW	Minimum Efficiency %			
	2 pole	4 pole	6 pole	8 pole
0.73	82.9	84.5	80.4	76.5
0.75	82.9	84.5	80.4	76.5
1.1	84.5	85.9	82.4	79.1
1.5	86.2	87.0	83.8	81.0
2.2	87.5	88.2	85.5	83.3
3	88.5	89.1	86.9	84.9
4	89.3	89.9	87.9	86.2
5.5	90.1	90.7	89.1	87.7
7.5	90.9	91.5	90.1	88.9
11	91.9	92.2	91.2	90.3
15	92.5	92.9	92.0	91.4
18.5	92.9	93.3	92.5	92.0
22	93.3	93.6	92.9	92.4
30	93.9	94.2	93.6	93.2
37	94.2	94.5	94.0	93.7
45	94.6	94.8	94.4	94.2
55	94.9	95.0	94.8	94.6
75	95.4	95.5	95.2	95.2
90	95.5	95.7	95.5	95.5
110	95.8	96.0	95.8	95.8
132	96.1	96.1	96.1	96.1
150	96.1	96.3	96.2	96.3
<185	96.1	96.3	96.2	96.3

NOTES:
1. For intermediate vales of rated output, the efficiency shall be determined by linear interpolation.
2. Tolerances specified in Table 1.1 of AS/NZS 1359.5 are applicable to the above values only in the case of a verification test.

Test Standards for MEPS Requirements for Three Phase Electric Motors

Regulatory standards for motors are published jointly by Standards Australia and Standards New Zealand. Some of the test standards (IEC based standards) are only issued as AS standards.

AS1359: Rotating electrical machines - General Requirements Part 101: Rating and Performance

AS1359: Rotating electrical machines - General Requirements Part 102.1: Methods for determining losses and efficiency - General

AS/NZS1359: Rotating electrical machines - General Requirements Part 102.3: Methods for determining losses and efficiency - Three phase cage induction motors

AS/NZS1359: Rotating electrical machines - General Requirements Part 5: Three phase cage induction motors - High efficiency and minimum energy performance standards (MEPS) requirements

Part 101 of the standard sets out methods for determining the rated output of the electric motor, thermal performance and other related performance tests (pull up torque, various short circuit tests etc.). This standard is based on and is equivalent to IEC60034.1.

Part 102.1 (also known as Test Method B) of the standard sets out methods for determining the efficiency of an electric motor, primarily using the summation of losses for AC cage induction motors (it also covers other motor types and methods of determining efficiency). This standard is based on and is equivalent to IEC60034.2 including up to amendment 2 (1996). Note that this standard assumes that additional losses (also called stray losses) are fixed at 0.5% for all motor types and sizes.

Part 102.3 (also known as Test Method A) of the standard sets out methods for determining the efficiency of a three phase electric motor using the summation of losses method, and includes the direct measurement of additional load losses (also called stray losses) by use of accurate torque measurements over a wide range of outputs. This standard is based on and is equivalent to US test procedures ANSI/IEEE 112-1984 (Method B) and NEMA MG1-1987. It is also equivalent to the recently published IEC motor test procedure IEC 61972 which was published in November 2002.

Part 5 of the standard sets out the requirements for MEPS for three phase electric motors in Australia. Three phase products from 0.73kW to <185kW have to be registered for MEPS.

Description Of Test Methods A And B

Method A: This method is identical to Method 1 of IEC 61972. It is also technically equivalent to the method specified in IEEE 112-B(USA). This method requires direct measurement of additional load losses and differs from Method B described below.

Method B: This method is drawn from AS 1359.102.1, which is based on IEC 60034-2, including Amendment 1:1995 and Amendment 2:1996. In this method, an allowance of 0.5% fixed stray (additional load) loss is assumed for all the motors.

It is important to note that the previous surveys of the efficiency of machines on the Australian market used figures based on Method B.

Please note that tests can be conducted by any motor testing laboratory that has been accredited by National Association of Testing Authorities (NATA) of Australia. Currently there is only such laboratory operating in Australia. This laboratory is owned and operated by the only motor manufacturer in Australia i.e. CMG Pty Ltd.

APPENDIX D: CHINA MARKET OVERVIEW

Overview of China Motor Market

Introduction

Electric motors are primary motive power machines in people's life and production, which are widely applied and are closely related to people's life. The yearly power consumption of electric motors in China takes more than 60% of the total industrial load, while the output of medium/small electric motors takes 70% of the total output of electric motor, therefore, promotion of power utilization efficiency of medium/small electric motors is important for energy conservation, environmental protection and sustainable economic growth in China.

Market Review

Market Size

Presently, China has about 3000 motor manufacturers, ranging from small backyard manufacturers to large industrial enterprises. However, there are 484 manufacturers with consistent productivity in 2003, as showed in Table D-1 About 70 manufacturers are key manufacturers with 60% market share. Those key manufacturers are mainly from old state-owned Chinese factories and foreign joint-ventured factories. The number of total employees in motor industry in 2003 is 154,300. And the value of total assets in motor industry is about 31.966 billion RMB, equivalent US$ 3.87 billion.

Table D-1. Overview of motor industry in 2003

No. of motor manufacturers	484
Total employees in motor industry	154,300
Total assets in motor industry (billion RMB)	31.966
Total sales income in motor industry (billion RMB)	25.291
Total production in motor industry (MW)	89.2

Figure D-1 shows the yearly outputs of motor industry in China. In 2003, the total production in China motor industry is 89.2MW.

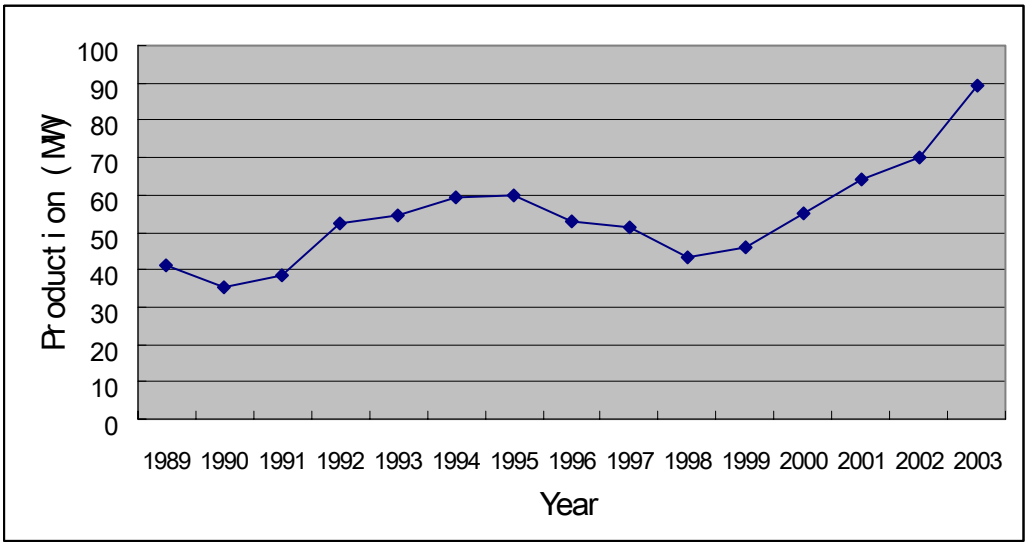


Figure D-1. Production increase of electrical motor in China

Market Breakdown

In China, the total load volume of in-use motor is above 0.4TW, among which 0.13TW motors are used to drive fans, bumps and compressors. For the moment, there are more than 300 series of medium/small electric motors with almost 1500 models produced in China. Products with a rated power between 0.55kW and 315kW, 2, 4 or 6 poles (and sometimes 8), and with frame numbers between 80 and 355mm are widely applied in industry, agriculture, national defense, general services and household electrical appliances.

Most of in-use motors in China are tri-phase asynchronous motors with a rated power between 0.55kW and 100kW, among which Y series account for 70% and Y2 series account for 10%. Y series were designed in a unified way at the beginning of 1980's, whose energy efficiency level is similar to world average level at the end of 1970's. The annual production of Y series is about 20 million kW with a grow rate of 5%. The energy efficiency level of Y2 series is similar to world average level at the end of 1980's. The annual production of Y2 series can reach 4 million kW.

Market Share

Table D-2 shows sales income of top ten motor manufacturers. The sales income in those 10 manufactures accounts for 26.2% in China motor industry.

Table D-2. Sales income of top ten motor manufacturers

No.	Manufacturers	Year 2003	
		Sales Income (billion RMB)	Percentage of national total sales income (%)
1.	Zhejiang Wolong Group	1.279	5.06
2.	Toshiba Dalian Co. Ltd.	0.976	3.86
3.	Hunan Electric Manufacturing Co. Ltd.	0.936	3.70
4.	Yongji Electric Factory	0.662	2.62
5.	Shanghai Electric Machinery Works	0.619	2.45
6.	Shanghai United Electrical Machinery (Group) Co. Ltd.	0.525	2.08
7.	Shandong Huali Electric Motor Group Co.,Ltd	0.426	1.68
8.	Nanyang Explosion Protect Froup	0.417	1.65
9.	Jiangsu Qingjiang Electric Motor Co., Ltd.	0.394	1.56
10.	Jiangsu Electric Manufacturing Co. Ltd.	0.391	1.54
11.	others	18.666	73.81

Primary Sales Channels

It's estimated that Equipment manufacturers such as bumps, fans, compressors purchase at least 60% motors. And about 20% motors are purchased by project service companies or project contractors. The primary sales channels are shown in Figure D-2.

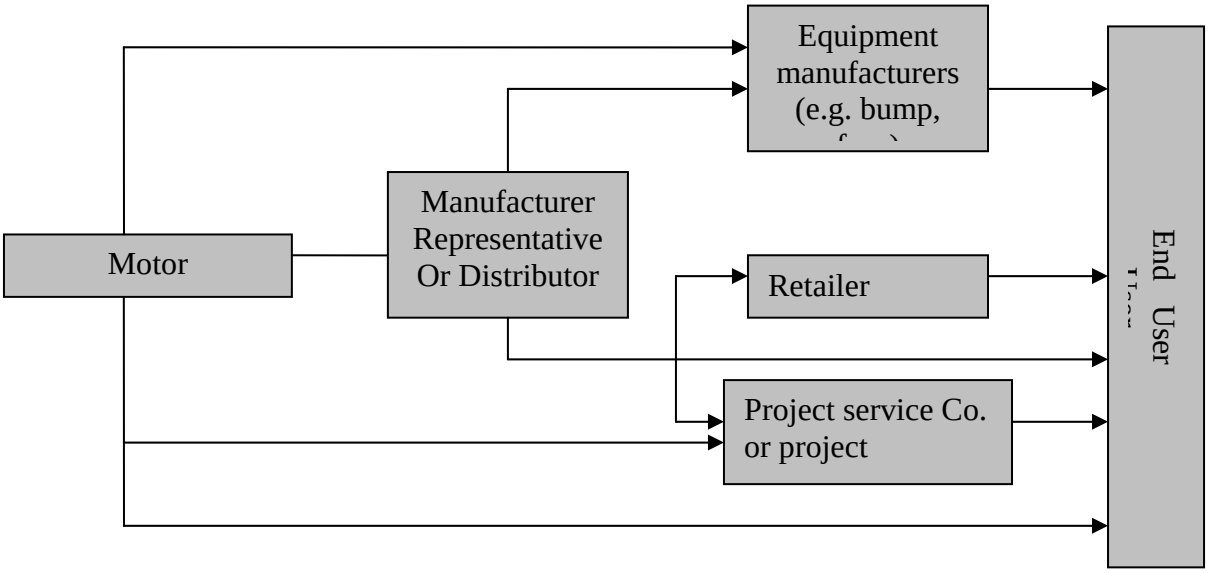


Figure D-2. Primary sales channels for motors in China

Trade Flow Review

Overview of Trade Flow

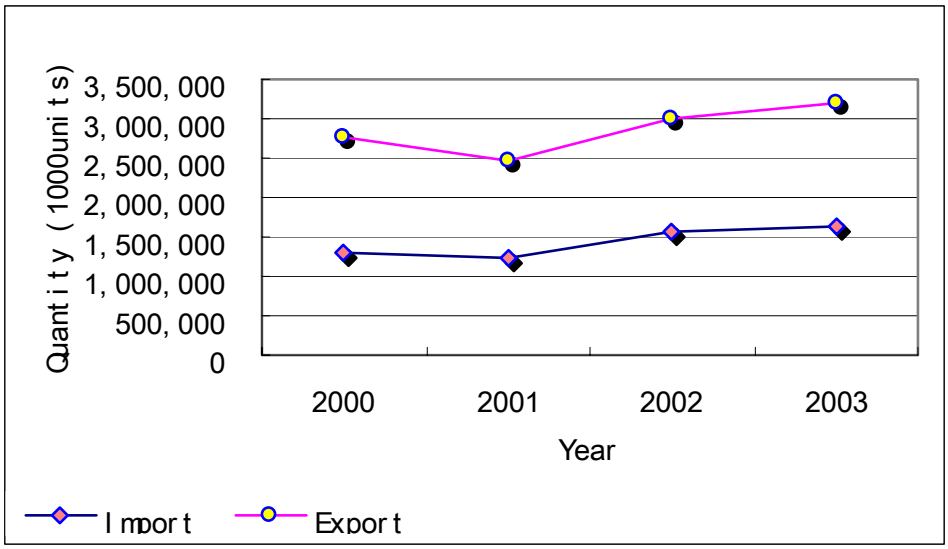


Figure D-3. Import and export quantity change in different years

The export volume of electric motors is 7 GW yearly, 20% of the total output of AC electric motors, and they are the most important electromechanical products for export in China. In 2003, total number of units exported and imported is 3,199,677,100 and 1,641,869,300 respectively. The total value of units exported and

imported is US$ 2,154,925,100 and US$ 1,395,700,800 respectively. Figure D-3 shows import and export quantity change in different years. Figure D-4 shows Import and export value in different years.

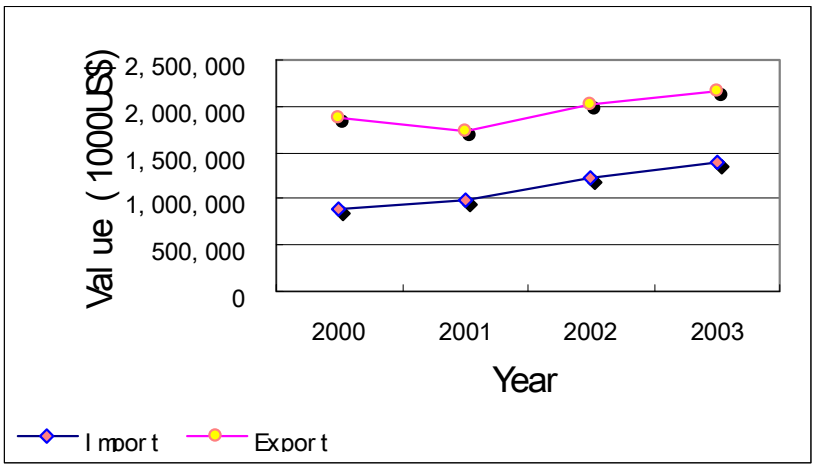


Figure D-4. Import and export value in different years

The top 15 manufacturers account for about half of the market. In recent years, economic growth has slowed in China (although growth is still rapid by international standards). With the slowdown, and due to economic troubles at many old state-owned Chinese factories, the size of the Chinese domestic motor market has shrunk significantly. As a result, competition in the domestic market is fierce, and customers are expecting steadily lower prices for motors. In this market, the majority of Chinese motor manufacturers are now losing money. On the other hand, the export market has been growing rapidly. The top-five Chinese manufacturers serve approximately half the export market.

Primary export markets and import sources

Table D-3 and Table D-4 show motor export and import in 2003 respectively.

Table D-3. Export in 2003

Item	Export in 2003		Growth in 2003 than 2002	
	Value (1000US$)	Quantity(1000units)	Value	Quantity
Hong Kong	557,238.64	1,512,777.67	-3.04	5.10
Japan	399,251.83	466,178.30	-10.18	-6.64
US	252,368.99	166,707.92	32.09	-3.39
Korea	246,115.20	296,828.62	18.54	17.45
Singapore	66,011.01	164,477.49	-5.33	27.64
Malaysia	51,712.19	44,131.11	31.60	41.59
German	43,499.83	119,285.24	10.32	5.20
Italy	42,255.27	19,293.93	31.50	29.52
Thailand	40,207.21	25,199.63	7.88	14.79
Philippines	39,855.03	28,417.34	38.27	51.42
Other	416,409.89	356,379.83	18.96	15.52

Table D-4. Import in 2003

Items	Import in 2003		Growth in 2003 than 2002	
	Value (1000US$)	Quantity(1000units)	Value	Quantity
China	552,342.22	1,098,106.65	22.88	16.26
Japan	157,372.43	55,707.44	31.34	-34.21
German	105,225.80	3,583.08	90.96	40.18
Thailand	95,140.69	72,975.82	-9.07	15.20
Hong Kong	93,903.31	146,868.76	-24.39	-23.16
Taipei, China	86,723.21	47,700.83	8.76	-20.21
Korea	47,419.63	20,521.81	25.08	-22.01
Malaysia	45,988.48	82,698.20	-8.58	-18.58
Philippines	31,927.31	15,255.62	-34.50	-17.75
Singapore	29,338.42	34,836.34	-6.08	-12.90
other	150,319.27	63,614.74	20.56	65.53

Figure D-5 and Figure D-6 show export and import share in different countries or areas in 2003.

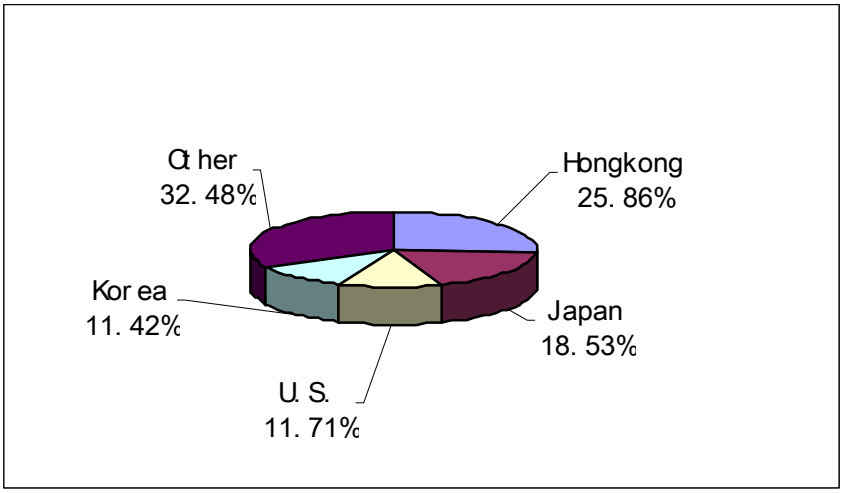


Figure D-5. Export share in different countries or areas

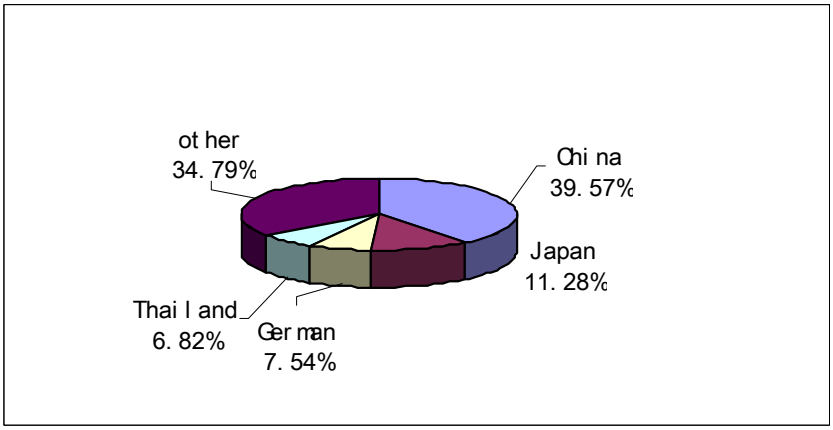


Figure D-6. Import share in different countries or areas

Size and Breakdown of Motor Exported and Imported

Following table and figures show detailed size and breakdown of motor exported and imported.

Table D-5. Size and breakdown of motor exported and imported

Product category	Export in 2003		Growth in 2003than 2002(%)		Import in 2003		Growth in 2003than 2002(%)	
	Value (1000US$)	Quantity (1000units)	Value	Quantity	Value (1000US$)	Quantity (1000units)	Value	Quantity
Tool motor , P≤37.5W	32187.06	239432.53	-16.49	-24.10	20173.83	143434.65	-0.55	-17.01
Micro-motor , P≤37.5W , 20mm≤pedestal diameter <39mm	482853.56	1502534.91	-9.46	-2.54	374450.53	728709.88	18.65	11.27
Other motors , P≤37.5W	969155.54	1364826.74	3.70	26.84	635575.27	743383.16	-0.95	2.71
A.C. and D.C.motors , P> 37.5W	46714.94	15921.64	64.95	18.99	28584.98	6550.85	42.07	36.21
Other A.C. motors with single phase	356250.14	71881.68	43.01	60.19	92464.70	15159.83	56.83	58.79
Other A.C. motors with multiphase , P≤750W	47032.98	3297.83	-14.86	-61.82	62583.03	4323.89	17.33	-3.64
Other A.C. motors with multiphase , 750W < P≤75KW	199824.37	1768.07	27.71	20.89	78276.67	302.59	25.75	-39.94
Other A.C. motors with multiphase , P>75KW	20906.49	13.70	9.77	29.28	103591.75	4.44	92.87	85.58

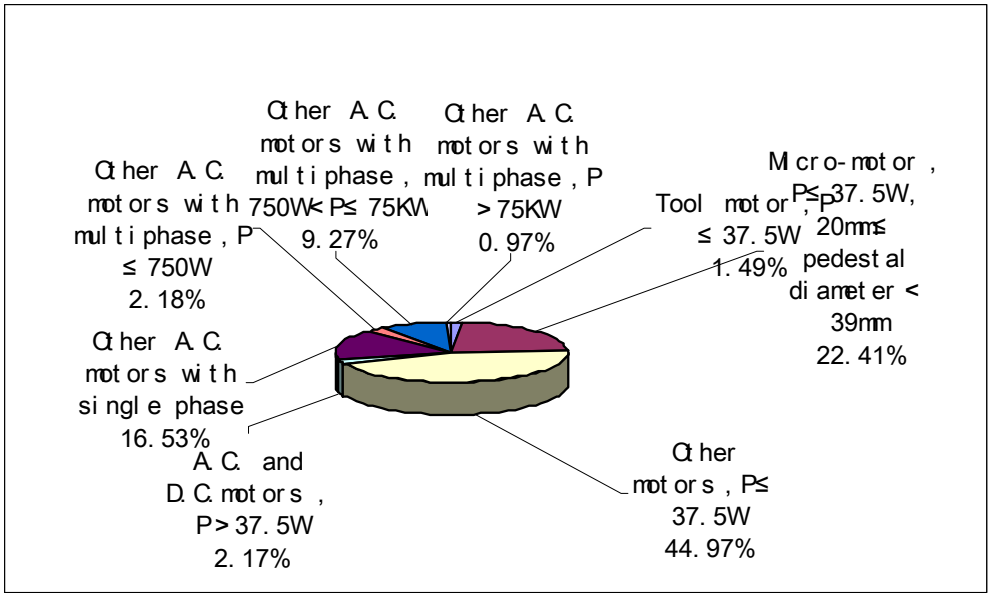


Figure D-7. Exported product value in 2003

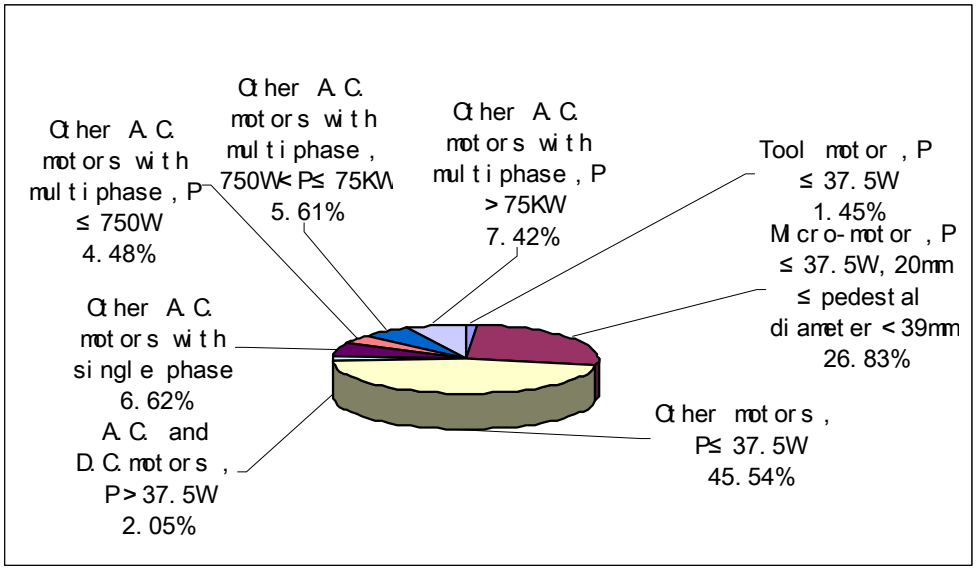


Figure D-8. Imported product value in 2003

Standards Review

In China, most factories operate on 380 volt, 50hz electricity, and most motors follow the IEC design parameters, the same parameters that are widely used in Europe. In China today, there are presently three series of motors in widespread use – the JO series (originally developed in the 1950s in Russia and redesigned in China in the 1970s), the Y series (designed in China in the 1980s), and the Y2 series (developed in China in the early 1990s). In general, the newer series of motors have better optimized designs and use less material. However, while the newer series are better optimized, much of this optimization has been used to reduce materials, efficiency improvements from series to series are generally either small or non-existent. Under government regulations, the production of JO series motors has been banned since 1984, but these motors are still in place in many factories and now account for about one-third of the installed motor stock. Approximately 95% of motor sales in China are now of the Y series, with the Y2 series accounting for about 5%. In addition, a higher efficiency Y2e series has recently been introduced but currently is a special order item produced by just a few manufacturers.

Chinese energy efficiency standards titled by Limited Values of Energy Efficiency and Evaluating Values of Energy Conservation of Small and Medium Three-phase Asynchronous Motors (GB 18613-2002) was publicized in 2002. Table 6 shows the evaluation value for energy-efficient motors specified in the standards. For the moment, the motor energy efficiency restriction value in China is equal to the minimum limit of eff2 of EU, and the efficiency value is close to former Y2 series, so current motor energy efficiency standard in China can't promote the integrated level of motors in China greatly. This issue has been captured and the revision of energy efficiency standard is underway.

Table D-6 summarizes the evaluation value for energy-efficient motors in China.

Table D-6. Evaluation value for energy-efficient motors

Power (k W)	Efficiency (%)		
	2 poles	4 poles	6 poles
0.55	—	80.7	75.4
0.75	77.5	82.3	77.7
1.1	82.8	83.8	79.9
1.5	84.1	85.0	81.5
2.2	85.6	86.4	83.4
3	86.7	87.4	84.9
4	87.6	88.3	86.1
5.5	88.6	89.2	87.4
7.5	89.5	90.1	89.0
11	90.5	91.0	90.0
15	91.3	91.8	91.0
18.5	91.8	92.2	91.5
22	92.2	92.6	92.0
30	92.9	93.2	92.5
37	93.3	93.6	93.0
45	93.7	93.9	93.5
55	94.0	94.2	93.8
75	94.6	94.7	94.2
90	95.0	95.0	94.5
110	95.0	95.4	95.0
132	95.4	95.4	95.0
160	95.4	95.4	95.0
200	95.4	95.4	95.0
250	95.8	95.8	95.0
315	95.8	95.8	—

APPENDIX E: INDIA MARKET OVERVIEW

Introduction

Electric motors for operating pumps, fans and compressors account for more than 70% of the total power consumption by the industrial sector which constitutes close to 40% of the electrical consumption in India. Electric motors, furthermore, account for almost all of the electricity consumption in agricultural sector as they are widely used to run irrigation pump-sets. Motors, in various forms, are also required for various household and commercial applications.

In India, AC induction type motors are manufactured for ratings from fractional horse power in single phase and three phase to motors up to 160 KW in three phase. High tension motors of 6.6 KV to 11 KV also form a part of regular production. Indian motor industry has also been manufacturing motors for special applications such as traction type, increased safety and flame proof motors for hazardous areas in addition to DC motors.

The AC electric motor market in India can be broadly classified as,

- Low tension motors (Squirrel cage, slip ring and flame proof)
- Fractional Horse Power motors (FHP)
- High tension motors (squirrel cage, slip ring)

The following sections describe the overall motors market in India with a specific reference to three phase units in the rated power range of 0-100 KW category with 2, 4 and 6 poles.

Market Review

Market Size

The Indian motor manufacturing sector comprises of more than 300 manufacturers, with 22 organized large scale industries and a majority of small scale enterprises in the unorganized sector. At the end of last decade the market size stood at INR 34 Billion. Large industries dominate the market for motors of rating 7.5 KW and above. In terms of value, around 10 key manufacturers account for more than 80% of the motors market; whereas in terms of quantity more than 70% of the motors are manufactured by the small and unorganized sector. LT motor manufacturing sector in India grew exponentially from 3060 million KW in 1980 to 6657 million KW in 1995-96; which could be attributed to higher industrial growth. From 1995-96 however, the market has steadily declined to a level of 3021 million KW by 2002-03.

As per various studies and surveys, the total capacity of motors in use, in all sectors, till 2000 was estimated to be about 71,600 MW, which includes 45% of three-phase squirrel cage induction motors, 17% of other three-phase motors and the remaining single-phase motors. Although Industrial consumers account for more than half of all

the motors in use, residential and agricultural consumers account for more than 65% of the motors of ratings less than 7.5 KW.

Figure E-1: Production Increase of Electric Motor in India

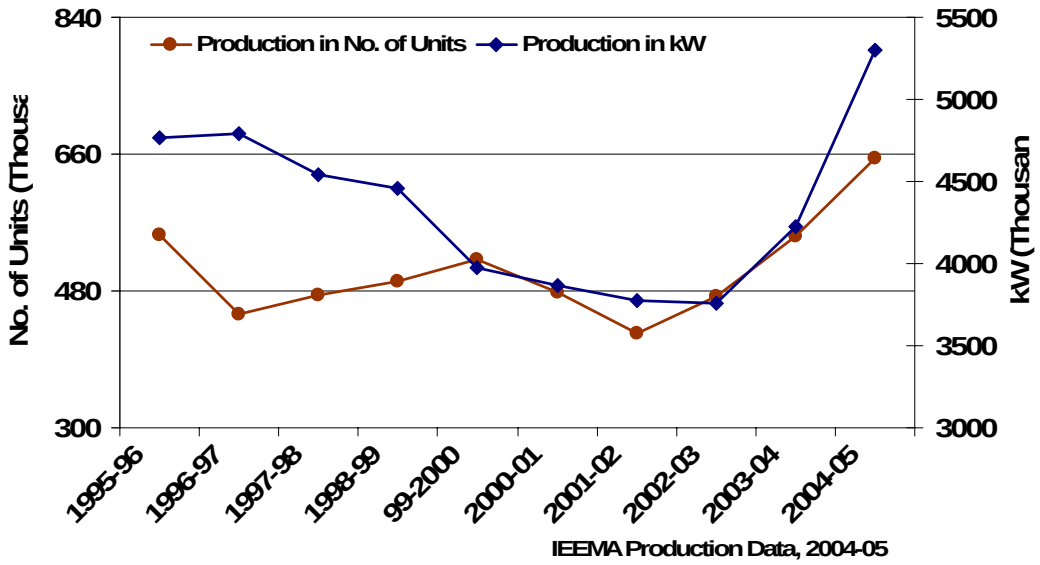


Figure E-1, reports the increase in production of electric motors over the past 10 years, as reported by the association of large manufacturers in India, Indian Electrical and Electronic Manufacturers Association (IEEMA). The financial year in India is from April to March, thus a figure showing 2003-04 means April 2003 to March 2004. This production data covers all ratings and sizes of motors, including three-phase motors, FHP, low tension and high tension motors. In 2003-04, more than 4.5 million motors, amounting to 5273 MW were manufactured by IEEMA members, 68% of this were various low tension motors, followed by 15% FHP and 12% high tension motors.

As mentioned earlier, the Indian motor industry is divided between manufacturers in the large organized and small unorganized sectors. IEEMA members are the large manufacturers with an international presence and a strong export orientation. According to market sources, IEEMA members enjoy the following market shares for different type and ratings of motors.

Table E-1: Estimation of National Motor Production

Type of motor	Reported share of IEEMA members	Production estimation, 2003 (Quantity, in Numbers)	
		IEEMA members	National
< 7.5 KW	35%	400069	1143054
>7.5 KW & <45 KW	80%	66680	83350
>45 KW, <190 KW	95%	19103	20108
> 225 KW	98%	209	213
Total LT Motors	*39%*	*486061*	*1246725*
FHP Motors	30%	*65259*	*217530*
HT Motors	90%	*916*	*1018*

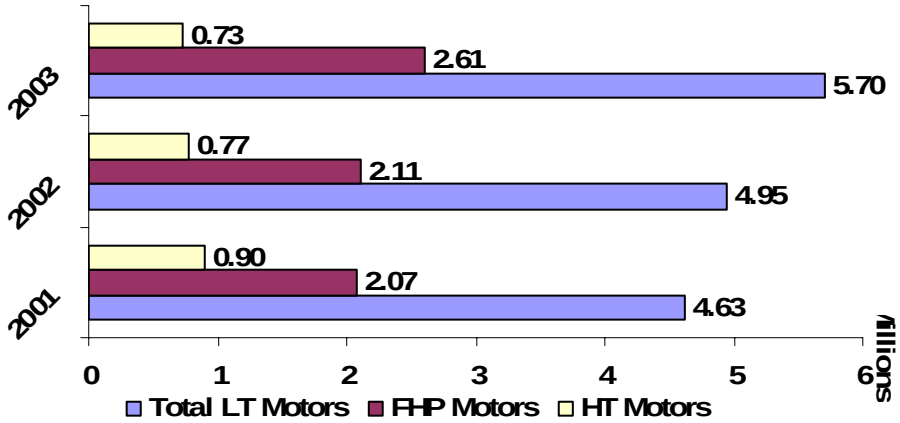
Total Production	***30%***	***552,236***	***1,465,274***

From the estimation in table E-1 above it is evident that the actual production of motors in India is approximately three times the production by IEEMA members, therefore the national production of motors in 2003-04 is approximately 14 million amounting to approximately 17000 MW in capacity. It is reported that the share of IEEMA members in the national production has largely remained constant over the past few decades and the annual national trend in production will be approximately three times the IEEMA member's production trend given in figure E-1 earlier.

Market Breakdown

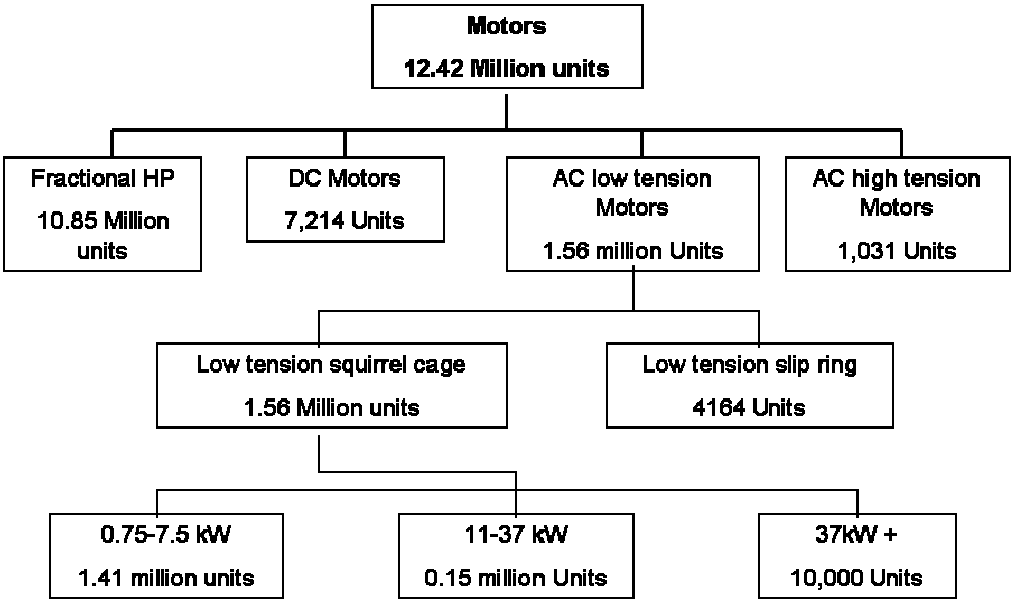
In India, motors with a rated power between 0.12 KW to 350 KW, frame sizes 63 to 450, are available in the market. The Indian standards IS 8789, stipulates rated voltage of 415 V +10% and frequency of 50 Hz +5%. Low tension and FHP motors, of all types and rating less than 45 KW, account for around 90% of the market in terms of numbers and 30% in terms of KW. The most widely used motors are three-phase 0.12 KW to 18.5 KW motors. In this range, the 4-pole (1500 rpm) motors have a 65% market share, with 2-pole (3000 rpm) and 6-pole (1000 rpm) sharing 15% each and the 8-pole (750 rpm) motors accounting for the remaining 5% market share. Figure E-2, gives the break-up of the motor production for the three broad rating segments, with quantity of production indicated for year 2002-03.

Figure E-2: Rating-wise production and market break-up



Installed capacity of low tension motors, of all types, is estimated to be 59,416 MW, out of which three-phase motors account for 32,204 MW. Figure E-3, gives the motors market categorization in 2002-03. The market for AC and DC motors of all ratings, manufactured in the organized and unorganized sectors in 2002-03, is estimated at 12.42 million units, which by output would be approximately 14597 MW.

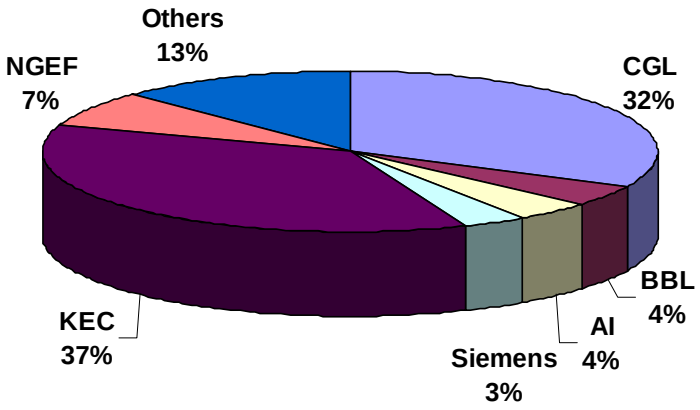
Figure E-3: Segment-wise Market for Motors, 2002-03



Market Share

The Indian motor manufacturing sector is divided into large organized and small unorganized manufacturers. The large organized sector accounts for more than 80% of the market share in value and caters to the higher rating, (>7.5 KW) and specialized motors market. The small unorganized sector accounts for a smaller share of the market in terms of value and caters to the lower ratings motor market (<7.5 KW). Figure E-4 shows indicative sales shares of the top manufacturers, and IEEMA members, in India in 1998. These manufacturers are Kirloskar Electric Co. (KEC), Crompton Greaves Ltd (CGL), NGEF (Hubli) Ltd, Bharat Bijlee Ltd. (BBL), Alstom India (AI) and Siemens. According to market sources, these manufacturers have remained market leaders over the years.

Figure E-4: Sales Share of Major Motor Manufacturers (1998)

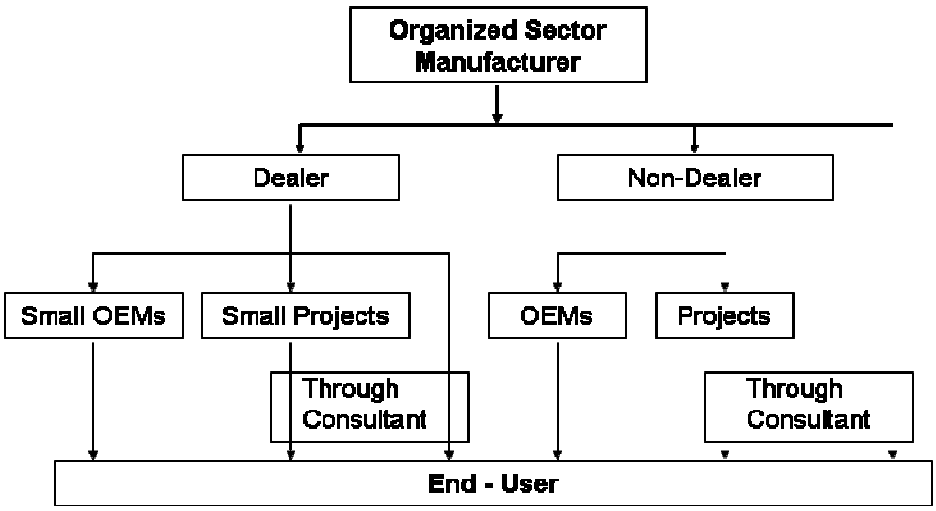


As discussed earlier, in terms of value around ten companies account for more than 75% of the total market. Of the total motors produced in India, more than 20% are reported to be deployed in the agricultural economy.

Primary Sales Channels

The motors sales and distribution channels in India are given below in figure E-5. The Original Equipment Manufacturers (OEM) segment is the single largest segment accounting for more than 60% of the motors, especially the small rating and FHP motors, in volume terms. Dealers route around 30% of the total market volume. Projects, which require high-end, customized motors, are generally serviced through consultants, either through dealer or directly. Some of the larger manufacturers also undertake turn-key projects which includes motors.

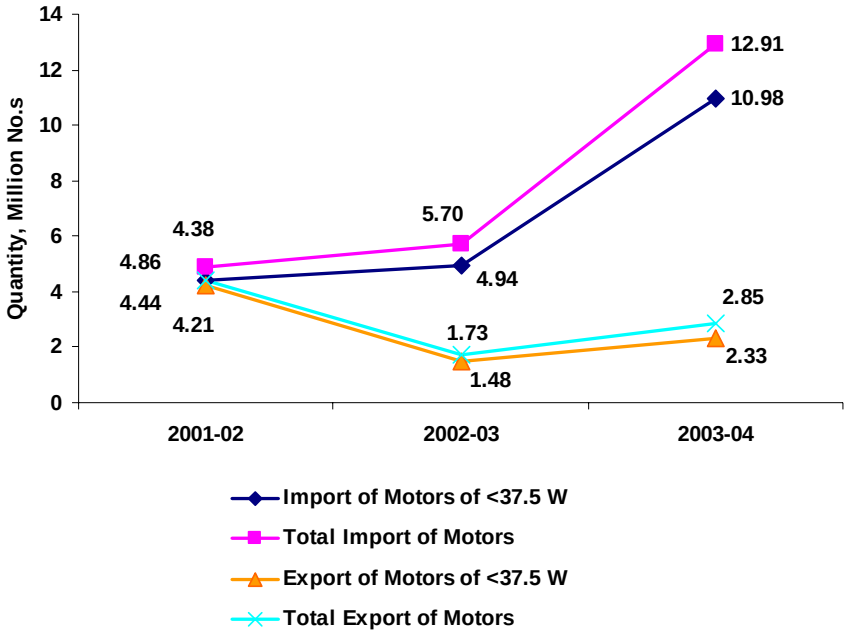
Figure E-5: Motors Sales and Distribution Channels in India



Trade Flow Review

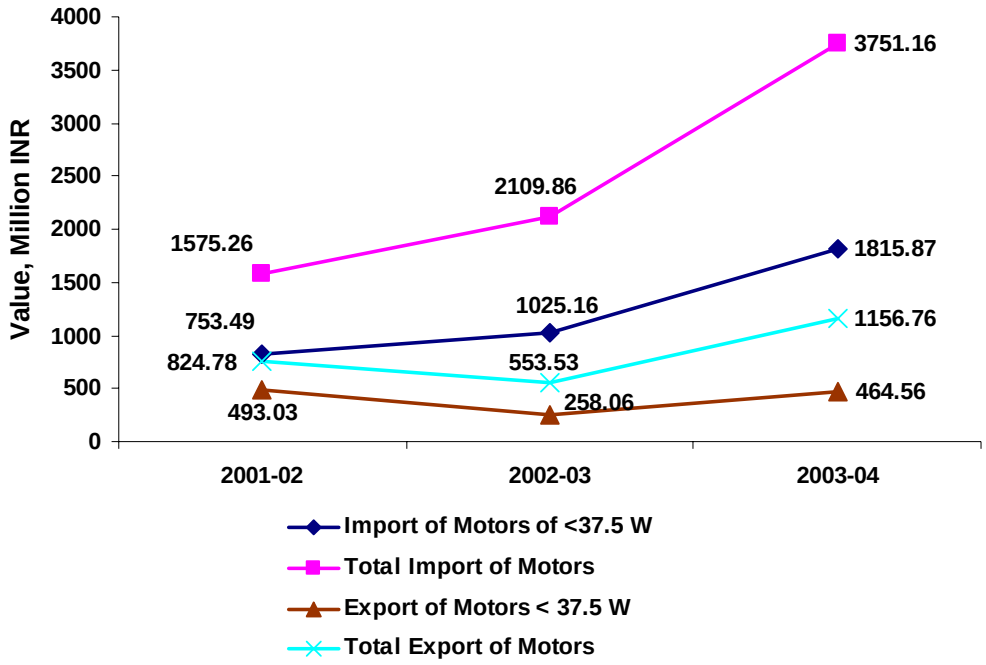
India is a net importer of electric motors, as seen in figure E-6 and E-7. The import and export data used in this report is from the official website of the Director General Commercial Intelligence and Statistics (DGCIS), sourced and compiled by IEEMA. In 2003, almost 13 million motors were imported at a cost of INR 37.5 Billion. From the figure below, it is evident that almost 85% of this import is of electric motors of ratings less than 37.5 W. These motors are largely imported by OEMs. In terms of exports, in 2003, more than 1.5 Million motors were exported with revenue of INR 5.53 Billion, with a majority of the trade concentrating on smaller rating electric motors.

Figure E-6. Trend in Import and Export, in Quantity



In the last few years, Indian motors market has registered a trend, wherein small rating, mechanization intensive electric motors are bulk imported and varied rating, precision and labor intensive custom designed motors are exported. This partially explains the upward trend shown by the revenue from total exports of motors from Rs.600 million in 2002 to 1200 million in 2003.

Figure E-7: Trend in Import and Export, in Value



Primary export markets and import sources

Table E-2 and Table E-3 show motor export and import in 2003 respectively. The trend shown by exports in the past 3-4 years, have been explained earlier. The Indian motor manufacturing industry, especially the organized sector has been traditionally geared for the European markets and most of the companies adhere to the IEC standards. In the past few years, the Indian manufacturers have diversified and are in a position to comply with the North American standards as well. From table E-2, we can see that UK and USA were the largest importers of Indian motors, and continue to retain the position even through their purchases have reduced substantially. Year 2002-03 was a slack year for the motor market worldwide and has led to a very interesting development in motor exports for India. Till 2001, Indian companies were exporting electric motors to 68 countries around the world, with a major focus on western European and US market. In 2003-04, companies have reported almost 90 countries as export destinations, with new countries being added from central Europe, Africa and the middle-east.

Table E-2: Export from 2001 to 2003

Quantity in No., Value in INR

Details	2001-02		2002-03		2003-04	
	Quantity	Value	Quantity	Value	Quantity	Value
Total Exports - Worldwide	**4383016**	**753485779**	**1726630**	**553530837**	**2851037**	**1156761870**
Major Export Destinations						
UK	1321329	156116659	284440	90057481	134648	13219525
USA	1168078	184271763	605645	147866271	818834	409586266
Thailand	452551	40275966	36356	14287665	109921	20398002
Canada	302321	55289664	127186	48234621	29807	17001984
UAE	222078	36605429	33662	23205636	64730	35114674
Iran	105796	16130093	47260	21858614	124106	20880930
Nigeria	138394	68493176	41574	23014237	127314	63285461
Malaysia	75188	12549033	3835	6289530	56577	14830191
China	2240	212173	6210	5551245	14260	13467782
Australia	508	2963681	18155	9668616	5572	7188393
Other Countries	***594533***	***180578142***	***522307***	***163496921***	***1365268***	***541788662***
Total Exports to major destinations	*3788483*	*572907637*	*1204323*	*390033916*	*1485769*	*614973208*
% of major destinations to total worldwide Exports	**86.44**	**76.03**	**69.75**	**70.46**	**52.11**	**53.16**

India has emerged as a major importer of motors, the demand increasing from 4.8 million motors in 2001-02 to more than 12.9 million in 2003-04. The number of low-cost imported motors from China has almost trebled in quantity and value between 2002 and 2003 and has a 57% share of the total import market. East and South-east Asian countries dominate the import scene, with Republic of Korea and Hong Kong being the 2nd and 3rd highest exporters to India. As seen below, ten major manufacturing nations supply around 95% of the total imports demand, with the total import bill being pegged at INR 37.5 Billion.

Table E-3: Import from 2001 to 2003

Quantity in No., Value in INR

Details	2001-02		2002-03		2003-04	
	Quantity	**Value**	**Quantity**	**Value**	**Quantity**	**Value**
Total Imports – Worldwide	**4863329**	**1575255039**	**5702490**	**2109856101**	**12914775**	**3751161863**
Major Import Sources						
China	2511586	220616239	2654668	269236817	7411718	615900737
Korea R	902627	337863889	1156637	385479957	1674787	620715922
Hong Kong	284328	30156424	404110	39737431	972442	52370662
Germany	229693	287930722	263843	364591744	547326	742294336
Japan	160495	93680118	290137	107675890	774497	297873829
Italy	167127	115294576	280844	265370395	267098	259540804
Taiwan	117858	23106588	102646	47017274	126819	39478124
Thailand	89798	38630032	81215	34812049	176443	43195451
Australia	7170	4488711	9618	6436454	2215	2774848
Malaysia	50734	5361264	82491	14067326	202532	22819229
Other Countries	***341913***	***418126476***	***376281***	***575430764***	***758898***	***1054197921***
Total Imports from major sources	*4521416*	*1157128563*	*5326209*	*1534425337*	*12155877*	*2696963942*
% of major sources to total worldwide Imports	**92.97**	**73.46**	**93.40**	**72.73**	**94.12**	**71.90**

Figure E-8 and Figure E-9 show export and import share of the three major countries between 2001 and 2003.

Figure E-8: Exports to Major Destinations

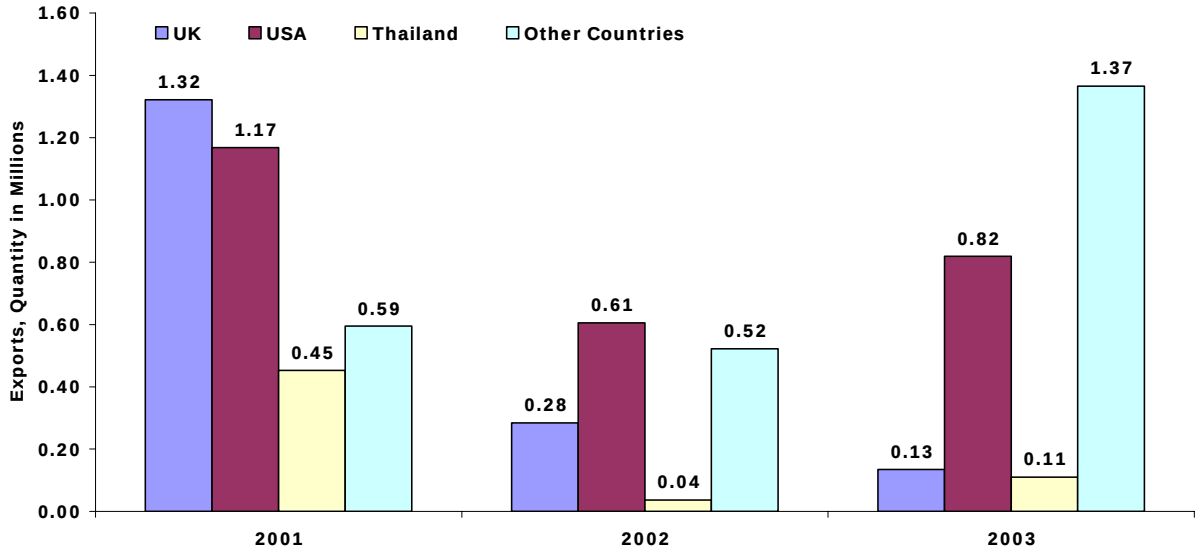
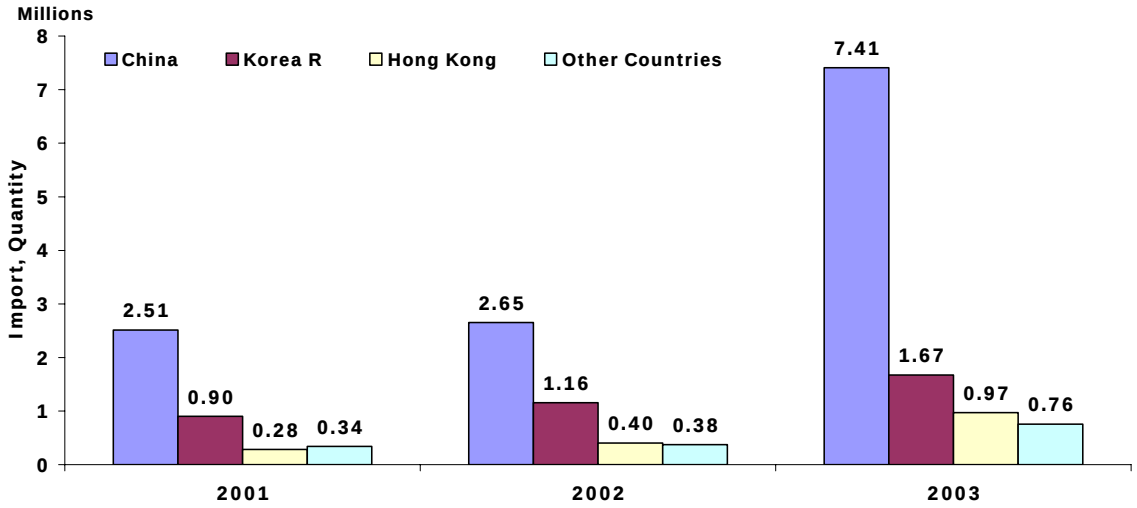


Figure E-9: Imports from Major Source Countries



Size and Breakdown of Motor Exported and Imported

Following table E-4 gives detailed size and breakdown of motor exported and imported. The categorization of motors is as per the database maintained by the office of the Director General of Commercial Intelligence and Statistics (DGCIS). From the data given in table E-3 and E-4, it can be seen that in 2003-04, motors of an output less than 37.5 W comprise 85% of the total imports and 81% of the total exports.

Table E-4: Size and Breakdown of Motors Imported

Quantity in No., Value in Million INR

Motor Categories	2001-02		2002-03		2003-04	
	Quantity	Value	Quantity	Value	Quantity	Value
Motors of an output < 37.5 W	4435231	824.78	4940954	1025.16	10976174	1815.87
Motors universal AC/DC, of an output > 37.5 W	413334	401.01	733183	481.66	1912482	1002.65
AC motors, multi-phase, of an output < 750 W	5806	64.26	6515	89.75	10879	131.02
AC motors, multi-phase, > 750 W And < 75 KW	8533	122.99	20025	212.22	13776	337.99
AC motors, multi-phase, of an output > 75 KW	425	162.22	1813	301.07	1464	463.62
Total	**4863329**	**1575.26**	**5702490**	**2109.86**	**12914775**	**3751.16**

Table E-5: Size and Breakdown of Motor Exported

Quantity in No., Value in Million INR

Motor Categories	2001-02		2002-03		2003-04	
	Quantity	Value	Quantity	Value	Quantity	Value
Motors of an output < 37.5 W	4205356	493.03	1480822	258.06	2332461	464.56
Motors universal AC/DC, of an output > 37.5 W	160168	110.59	178937	114.13	493105	419.15
AC motors, multi-phase, of an output < 750 W	11606	61.58	27018	73.37	16627	78.63
AC motors, multi-phase, of an output > 750 W and < 75 KW	1451	59.60	39046	79.70	5146	94.48
AC motors, multi-phase, of an output > 75 KW	4435	28.68	807	28.27	3698	99.95
Total	4383016	753.49	1726630	553.53	2851037	1156.76

Standards Review

In India, the design and efficiency standards consider 415+10% volts, 50+5% Hz frequency, maximum altitude as 1000m, a temperature range of –30degreeC to +65degreeC and maximum cooling medium temperature of 40C, as standard site conditions. Three phase induction motors manufactured and sold in India have to adhere to the Indian Standard IS 325: 1996 by the Bureau of Indian Standards (BIS). As many of the large manufacturers target the export market, the European IEC design and efficiency standard and the NEMA standards are also widely followed. A revised Indian standard, IS 12615 is currently under circulation and finalization. This standard follows the worldwide practice of categorizing motors as improved efficiency 'Eff2' and high efficiency 'Eff1', with the efficiency values specified in IS 8789:1996 being the frame of reference. Table E-6 gives the comparative efficiency values for motors in India, as given in the proposed standard IS 12615.

Table E-6: Comparison Values for Energy-Efficient Motors

Power (KW)	Efficiency Value (%)					
	2 poles		4 poles		6 poles	
	Eff2	Eff1	Eff2	Eff1	Eff2	Eff1
0.37	66	70.2	66	73	65	69.4
0.55	70	74	70	78	68	72
0.75	73	77	73	82.5	71	74.6
1.1	76.2	82.8	76.2	83.8	74	77.3
1.5	78.5	84.1	78.5	85	76	79.6
2.2	81	85.6	81	86.4	79	82.2
3.7	84	87.5	84	88.3	82.5	85.1
5.5	85.7	88.6	85.7	89.2	84.5	86.8
7.5	87	89.5	87	90.1	86	88.1

9.3	87.7	90	87.7	90.5	87	89.3
11	88.4	90.5	88.4	91	87.5	89.7
15	89.4	91.3	89.4	91.8	88.5	90.5
18.5	90	91.8	90	92.2	89.5	91.3
22	90.5	92.2	90.5	92.6	90	91.8
30	91.4	92.9	91.4	93.2	91	92.6
37	92	93.3	92	93.6	91.5	93
45	92.5	93.7	92.5	93.9	92	93.4
55	93	94	93	94.2	92.5	93.8
75	93.6	94.6	93.6	94.7	93	94.2
90	93.9	95	93.9	95	93.3	94.5
110	94	95	94.4	95.2	93.5	94.6
125	94.5	95.3	94.7	95.5		
132	94.5	95.3	94.7	95.5	93.8	94.9
160	94.8	95.5	95	95.8	94	95.1

Due to the wide-spread and varied usage of motors, improving the efficiency of motors has been long-identified as a priority. Various initiatives have been promoted and implemented by the public and private sectors. Under the Energy Conservation Act 2001, the Bureau of Energy Efficiency (BEE) has been established to undertaken specific initiatives targeted at energy intensive industries and activities. One of the key activities being undertaken by BEE is the formalization of the motor energy efficiency standards to raise the overall efficiency of electricity use in the country.

References:

1. [1]IEEMA Production data, 2004-05
2. [1] International Copper Promotion Council of India (ICPCI), The Complete Guide to Energy Efficient Motor, 2003
3. [1] IIEC, Market and Technology Survey of Electric Motors, 1999
4. [1] Director General Commercial Intelligence & Statistics (DGCIS) website, Motor Import-Export data sourced and collated by IEEMA, May 2005

APPENDIX F: MALAYSIA MARKET OVERVIEW

Market Overview

Sales of Motors in Malaysia

Table F-1. Direct Investments and Manufacturing Output (RM billion)

	1999	2000	2001	2002	2003
Approved Application for Investments	14.0	42.2	16.5	18.8	25.6
Manufacturing Output	56.8	67.3	63.3	65.9	70.2

Source: Malaysian Industrial Development Authority

From industry sources, overall sales of motors improved marginally in 1999 after declining sales in 1998 due to the Asian regional economic and financial crisis affecting Malaysia. Motors sales improved further in 2000 due to an increase in direct investments and manufacturing output with improvements in the regional economies. However sales remained stagnant in 2001 as a result of the global economic slowdown but improved marginally again in 2002 as Malaysia recorded a GDP growth of 4.2% and further in 2003 with a GDP growth of 5.3%.

Table F-2. Estimated Sales of Motors 1999-2003 (units)

Motor	1999	2000	2001	2002	2003
EFF1	900	1,300	1,300	1,100	1,150
EFF2	38,000	41,100	41,300	43,700	46,500
EFF3	19,100	19,900	19,700	20,100	25,000
Total	58,000	62,300	62,300	64,900	72,650

Source: Estimates based on PTM Motor Database V. 3 and Spire's interviews

Based on estimates from various industry sources, the average estimated total sale of motors in Malaysia in 2002 was 64,900 units. Spire's analysis takes into account industry estimates that:

- Nearly 10% of the total imports or motors are parallel imports and
- Nearly 30% of the imports are for EFF3 motors imported mainly from China.

However estimates from some industry sources mentions sales of EFF3 motors in 2002 may be as high as 30,000 units and subsequently total sale of motors may be as high as 75,000 units during that year.

Total sale of motors in 2003 is estimated to have increased by 11.9% from 64,900 units in 2002 to 72,650 units in 2003. From 2002 to 2003 estimated sales of:

- EFF1 motors increased by 4.5% from 1,100 units to 1,150 units;
- EFF2 motors increased by 6.4% from 43,700 units to 46,500 units; and
- EFF3 motors increased by 24.3% from 20,100 units to 25,000 units.

Industry sources indicate a continued prevalence of cheaper EFF3 motor imports from China in 2003. As in 2002, some industry estimates also mention EFF3 motor sales may be as high as 30,000 units or more and therefore total sales of motors could be in excess of 77,000 units in 2003.

Table F-3. Proportion of Sales of Motors 1999-2003 (%)

Motor	1999	2000	2001	2002	2003
EFF1	1.5%	2.1%	2.1%	1.7%	1.6%
EFF2	65.5%	66.0%	67.4%	67.3%	64.0%
EFF3	33.0%	31.9%	30.5%	31.0%	34.4%
Total	100%	100%	100%	100%	100%

Source: Estimates based on PTM Motor Database V. 3 and Spire's analysis

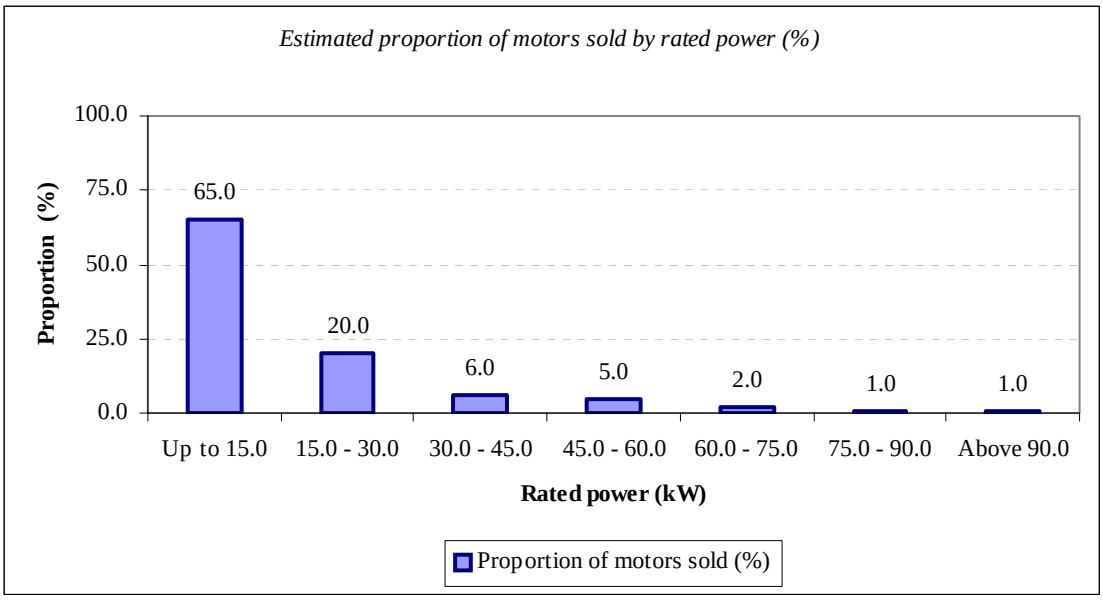
The majority of the motors sold in Malaysia are for EFF2 followed by EEF3 motors. The estimated market share of:

- EFF2 motors increased from 65.5% in 1998 to 67.3% in 2002 before settling to 64.0% in 2003.
- EFF3 motors declined from 33.0% in 1999 to 31.0% in 2002 but increased to 34.4% 2003.
- EFF1 increased from 1.5% in 1999 to 1.7% in 2002 before declining marginally to 1.6% in 2003.

Major decline in unit sales of EFF1 motors in 2003 were mainly for motors with a power rating of 10.0kW and below. There is a wide price difference between higher price EEF1 motors and lower price EFF2 and EFF3 motors in this power rating range. Thus many users are in the opinion that there would not be any cost savings through energy consumption by using EFF1 motors.

However sales of EFF1 motors with a power rating of 20.1kW and above was not adversely affected in 2003. The price difference between EFF1 motors and EFF2 and EFF3 motors in this power rating range is narrower. Furthermore there are fewer competitors or models of EFF2 and EFF3 motors in this power rating range to create strong price competition.

Figure F-1. Sales of Motors According to Rated Power



Unit sales of motors decrease as the power rating of the motor increases. Feedbacks from the industry indicate that motors sold in Malaysia in 2003 with a power rating of

- 0.18kW to 15.0kW account for an estimated 65.0% of total motors sold
- 15.0-30.0kW account for an estimated 20.0% of the total motor sales
- above 90.0kW account for only 1.0%.

National Production of Motors

Table F-4. Estimated National Production of Motors and Number of Manufacturers/Distributors

	1999	2000	2001	2002	2003
Production of motors (units)	42,649	46000	46,000	48,000	53,500
No. of manufacturers/importers	13	15	15	14	17

Source: Department of Statistics (1999 only), Spire's interviews and analysis

The Malaysian Statistic Department recorded 42,649 units of motors were manufactured in Malaysia in 1999. Local production increased to an estimated 46,000 units in 2000 and remained at the level in 2001. Local production increased further to an estimated 48,000 units in 2002 before reaching 53,500 units by 2003.

The Malaysian Statistic Department recorded 8 motor manufacturers in 1999 and together with importers of motors there were an estimated total of 13. Their numbers increased incrementally (mainly importers) over the years but general industry opinion is that the number of importers either remained stagnant or decreased slightly during the economic slowdown of 2001-2002. Feedbacks from the industry indicate there were 15-20 motor manufacturers and importers of motors in 2003.

Leading Brands and Their Market Share

The leading brands mentioned in the following table together account for more than 75% of the total sales of motors in 2003.

Table F-5. Market Share of Brands by Volume (2003)

Manufacturer / Distributor	Brand	EFF	Market Share of Total Motor Sales
TECO	TECO	2	41.3%
Jasa Kita Engineering	Brook Crompton	1	0.3%
		2	11.0%
	Excel	3	11.0%%
T.E.M. Engineering	Tatung	1	0.1%
		2	2.7%
	Branco	2	1.7%
	TEC	3	5.5%
Siemens	Siemens	1	0.01%
		2	1.4%
Asea Brown Boveri	ABB	1	0.1%
		2	0.8%
GEF Precision	GEF	2	0.4%
Elektrim Motors	EMM	2	0.3%
Kiloskar Electric	Kilorskar	1	0.03%
		2	0.2%
Various	Others	1	1.1%
		2	4.2%
		3	17.9%
		TOTAL	100.0%

Source: Spire's interviews and analysis

TECO (Malaysia) and Jasa Kita are leaders in the Malaysian market in terms of quantity sold in 2003. Together the TECO, Brook Crompton and Excel brands sold by these 2 companies make up nearly two-third or an estimated 63.6% of the total motors sold during the period. These brands are either manufactured or imported by TECO (Malaysia) and Jasa Kita Engineering Sdn Bhd and cover motors of all EFF motor ranges. In 2003:

- Brook Crompton EFF1 motors imported and sold by Jasa Kita accounted for just 0.3% of the total motor sales but 18.9% of the EFF1 motors sales.
- TECO EFF2 motors manufactured and sold by TECO (Malaysia) accounted for the largest market share for motors at 41.3% and 64.5% of the EFF2 motor sales.
- Brook Crompton EFF2 motors sold by Jasa Kita accounted for 11.0% of the total motor sales and 17.2% of the EFF2 motor sales.
- Excel EFF3 motors manufactured and sold by Jasa Kita accounted for 11.0% market share of the motor sales and 32.0% of the EFF3 motor sales.

T.E.M. Engineering markets Tatung (EFF1 and EFF2), Branco (EFF2) and TEC (EFF3) brands and their combined sales account for 10.0% of the total sales in 2003.

Together with TECO, Brook Crompton and Excel, these brands account for nearly three-quarter or 73.6% of the total motor sales in 2003.

Primary Distribution Channel for Motors

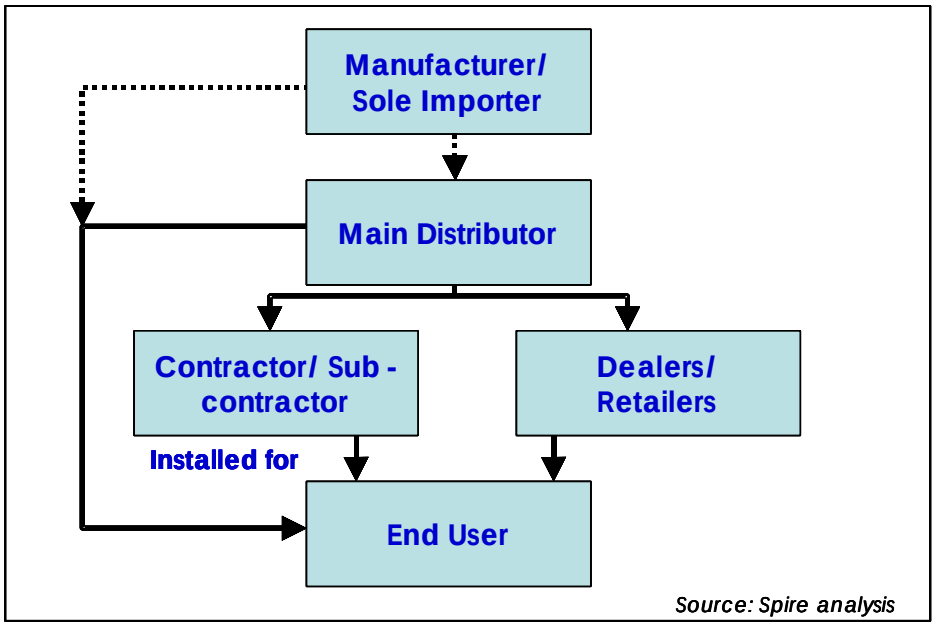


Figure F-2. Distribution Channels for EFF1 Motors (Standalone Only)

The distribution channel for motors includes suppliers (manufacturers or importers), contractors, distributors and dealers:

- Suppliers include manufacturers that manufacture motors in Malaysia or import from their manufacturing plants in other countries.
- Suppliers also include sole importers appointed by an overseas principal or manufacturer to import and distribute motors in Malaysia.
- Main distributors obtain motors from the sole importer or manufacturer and then resell to the contractors, dealers or directly to the users.
- Contractors purchase from the main distributors and installs motors on the users premises.
- Dealers purchase from the distributors and sells directly to the users but do not install the motors.

Table F-6. Major Distribution Channel for Purchase of Motors by Users (Stand alone Motors Only)

Channel	EFF1	EFF2 and EFF3
Suppliers	44%	15%
Contractors	33%	27%
Distributors	15%	20%
Dealers	7%	38%
Total	**100%**	**100%**

Source: Analysis based on feedbacks from suppliers and distributors

Distribution and marketing of EFF2 and EFF3 motors is extensively covered by contractors, distributors and dealers which together accounts for 85% of the distribution of these motors to the users. However distribution and marketing of EFF1 motors is mainly conducted by the suppliers followed by contractors who are fewer in numbers compared to the 500 distributors and dealers located throughout the country for EFF2 and EFF3 motors. Thus EFF2 and EFF3 motors have a competitive advantage over EFF1 motors with regards to distribution.

Prices of Motors in Malaysia

Table F-7. Prices of Motors at User Value (standalone units only)

Motor Power Rating	Price Range EFF1 (RM/Unit)	Price Range EFF2 and EFF3 (RM/Unit)	Mean Price Difference between EFF1 and Conventional Motors
< 5kW	950 to 3,940	141 to 977	5.4 times
5.1kW to 10kW	558 to 7,600	206 to 1,388	4.1 times
10.1kW to 20kW	2,830 to 5,280	763 to 4,476	2.4 times
20.1kW to 50kW	1,980 to 15,436	1,661 to 10,307	1.3 times
50.1kW to 90kW	6,450 to 19,110	5,945 to 18,584	1.1 times
> 90kW	Not available	22,790 to 42,250	Not available

Source: Spire's interviews and analysis

Overall prices of EFF1 motors have declined from 1999 to 2003 by nearly 30% but overall prices of EFF2 and EFF3 motors have also declined by the same level during the period. There is strong price competition between EFF2 and EFF3 motors due to the larger demand for these motors coupled with cheap imports from China.

The price differences between higher price EFF1 and lower price EFF2 and EFF3 motors with a power rating of 10.0kW and below is as much as 5 times. This market segment is the largest market by volume sales and represented by greater number of brands and models of EFF2 and EFF3 motors that compete on price. Thus prices of these motors with a power rating of up to 10.0kW have declined by 20-40% between 1999 and 2003.

As the power rating of the motors increases, the price difference between higher price EFF1 and lower price EFF2 and EFF3 motors narrows. Furthermore there is lower demand for higher power rating motors compared to motors with a power rating of 10.0kW and less and therefore price competition is less intense. Thus EFF1 motors with a power rating of 50.1kW to 90.0kW generally cost only 10% more than EFF2

and EFF3 motors. Prices of motors in this market segment have declined by 10-30% between 1999 and 2003.

Efficiency Level Requirements and Standards for Determining Performance

There are currently no minimum efficiency level requirements for industrial motors in Malaysia. Furthermore there is no national standard for determining motor performance in Malaysia. The introduction of a Minimum Efficiency Performance Standards (MEPS) for electric motors is not expected in the immediate term but possibly in the longer term (5 to 10 years). From various manufacturers' motor catalogues available in Malaysia:

- The most common energy efficiency standards used are the International Electrotechnical Commission (IEC) Standard.
- Others used but to a lesser extent are The Institute of Electrical and Electronics Engineers (IEEE) Standard, British Standard (BS) and Australian Standard (AS).

Currently there is no authoritative or independent testing facility to test and assess the energy efficiency levels of motors from various brands. The Standards and Industrial Research Institute of Malaysia (SIRIM) plans to acquire the necessary testing equipments to carry out independent testing on the energy efficiency of motors in the foreseeable future.

The government encourages the use of higher efficiency motors but current compliance is on a voluntary basis. Through the Malaysian Energy Commission, the government is engaging in an advertising and promotion (A&P) campaign in 2005 to encourage purchase and use of EFF1 motors or at least EFF2 motors among industries.

Trade Flow Review

Export and Import of Motors in Malaysia

Malaysian Motor Exports

Table F-8. Motor Exports from Malaysia

	2001	2002	2003
Total Number of Units Exported	65,682	62,015	77,577
Total Value of Units Exported (RM)	45,522,921	51,141,882	55,942,623

Source: Malaysian External Trade Development Corporation (MATRADE)

Total export volume of motors from Malaysia declined by 5.6% from 65,682 units in 2001 to 62,015 units in 2002 but increased the following year by 25.1% to 77,577 units in 2003. However, in terms of value Malaysia's total value of motors exported increased by 12.3% from RM45.5 million in 2001 to RM51.1 million in 2002 before increasing further by 9.4% to RM55.9 million in 2003. Thus the average value of

motors exported was RM693 per unit in 2001, higher at RM825 per unit in 2002 and RM721 in 2003.

The United States, Singapore and Thailand were the 3 major markets for Malaysia's exports of motors in 2001and 2002. By 2003, the United Kingdom replaced Thailand as among the 3 major export markets for motors from Malaysia. Major country of destination and units exported from Malaysia are as follows:

- 2001 - United States (25,032), Singapore (15,833) and Thailand (10,973) accounting for 78.9% of Malaysia's exports.
- 2002 - United States (21,618), Singapore (12,167) and Thailand (6,747) accounting for 66.1% of Malaysia's exports.
- 2003 - United States (19,596), Singapore (13,738) and United Kingdom (11,997) accounting for 58.4% of Malaysia's exports.

Much of the motors exported to Singapore are re-exported or transhipped to other countries and Singapore is known as a regional hub in the re-export trade.

Malaysian Motor Imports

Table F-9. Motor Imports into Malaysia

	2001	2002	2003
Total Number of Units Imported	41,777	43,617	949,578
Total Value of Units Imported (RM)	53,975,982	57,968,786	118,511,107

Source: Malaysian External Trade Development Corporation (MATRADE)

Malaysia's imports of motors by volume increased by 4.4% from 41,777 units in 2001 to 43,617 units in 2002 and increased significantly by nearly 22-fold to 949,578 units in 2003. However, the upsurge in imports in 2003 was for motors with a power rating of less than 0.75kW. In value terms, Malaysia's import off motor increased by 7.4% from RM54.0 million in 2001 to RM58.0 million in 2002 before increasing further by 2-fold to RM118.5 million in 2003 mainly due to imports of motors with a power rating of less than 0.75kW. The average import price of motors into Malaysia was RM1,292 per unit in 2001, RM1,329 per unit in 2002 but just RM125 in 2003 due to the upsurge in imports of motors with a power rating of less than 0.75kW.

China has been among the top 3 major supplier of motors to Malaysia between 2001 and 2003. Taiwan was among the top 3 major supplier in 2001 and 2002 while Japan was among the top 3 supplier in 2002 and 2003. Major country of origin and units of motors imported into Malaysia are as follows:

- 2001 - China (10,325), Taiwan (6,785) and United Kingdom (5,713) accounting for 54.6% of Malaysia's import.
- 2002 - Japan (9,803), China (8,218) and Taiwan (6,549) accounting for 56.3% of Malaysia's import.
- 2003 - Singapore (457,658), China (181,698) and Japan (116,857) accounting for 79.6% of Malaysia's import.

Much of the motors imported from Singapore are re-exports or transhipments from other countries.

Malaysia's Motor Trade with Australia, Thailand, China and India

Summation of Trade with Australia, Thailand, China and India

Table F-10. Motor Exports to Australia, Thailand, China and India

	2001	2002	2003
0.0 – 0.75kW	6,931	78	171
0.75 - 75.0kW	12,937	12,516	19,837
Above 75.0 kW	1	1	2
Total	19,869	12,595	20,010

Source: Malaysian External Trade Development Corporation (MATRADE)

Malaysia's motor exports to Australia, Thailand, China and India are mainly for motors in the range of 0.75kW to 75.00kW and volume exported increased by 53.3% from 12,937 units in 2001 to 19,837 units in 2003. Conversely the volume exported for motors of less than 0.75kW to these countries decreased and for motors above 75.0kW was minimal from 2001 to 2003. Together these countries accounted for 25.8% of Malaysia's exports in 2003.

Table F-11. Motor Imports from Australia, Thailand, China and India

	2001	2002	2003
0.0 – 0.75kW	10,783	8,188	237,821
0.75 - 75.0kW	0	0	21,641
Above 75.0 kW	331	599	7,440
Total	11,114	8,787	266,902

Source: Malaysian External Trade Development Corporation (MATRADE)

Malaysia's motor imports from Australia, Thailand, China and India between 2001 and 2003 have mainly been for motors with smaller power ratings of less than 0.75kW. Imports increased by 22-fold from 10,783 units in 2001 to 237,821 units in 2003. Imports of motors with power ratings above 0.75kW also increased during the same period especially for motors with a power rating between 0.75 and 75.0kW. Together these countries accounted for 28.1% of Malaysia's imports in 2003.

Australia

Table F-12. Motor Exports to Australia

	2001		2002		2003	
	Units	%	Units	%	Units	%
0.0 – 0.75kW	0	0.0%	62	1.1%	150	1.6%
0.75 - 75.0kW	8,126	100.0%	5,638	98.9%	9,288	98.4%
Above 75.0 kW	0	0.0%	0	0.0%	1	0.0%
Total	8,126	100.0%	5,700	100.0%	9,439	100.0%

Source: Malaysian External Trade Development Corporation (MATRADE)

Exports of motors to Australia accounted for 12.2% of Malaysia total exports of motors between 2001 and 2003. Motors in the range of 0.75kW to 75.00kW made up most of the motors exported to Australia during the period.

Table F-13. Motor Imports from Australia

	2001		2002		2003	
	Units	%	Units	%	Units	%
0.0 – 0.75kW	531	84.3%	108	76.1%	205	32.4%
0.75 - 75.0kW	0	0.0%	0	0.0%	428	67.6%
Above 75.0 kW	99	15.7%	34	23.9%	0	0.0%
Total	630	100.0%	142	100.0%	633	100.0%

Source: Malaysian External Trade Development Corporation (MATRADE)

Imports of motors from Australia accounted for only 0.1% of Malaysia's total imports of motors in 2003. There were no imports of motors between 0.75kW and 75.00kW from Australia in 2001 and 2002 but were the main imports from Australia in 2003. Others imported in 2003 were for 0.0-0.75 kW motors.

Thailand

Table F-14. Motor Exports to Thailand

	2001		2002		2003	
	Units	%	Units	%	Units	%
0.0 – 0.75kW	21	0.6%	16	0.2%	6,892	62.8%
0.75 - 75.0kW	3,426	99.4%	6,731	99.8%	4,081	37.2%
Above 75.0 kW	1	0.0%	1	0.0%	0	0.0%
Total	3,448	100.0%	6,747	100.0%	10,973	100.0%

Source: Malaysian External Trade Development Corporation (MATRADE)

Exports of motors to Thailand accounted for 16.7% of Malaysia's total exports of motors in 2003. Motors of less than 0.75kW made up most of the motor exports to Thailand in 2003 followed by 0.75-75.0kW motors.

Table F-15. Motor Imports from Thailand

	2001		2002		2003	
	Units	%	Units	%	Units	%
0.0 – 0.75kW	4	100.0%	2	0.5%	84,073	99.6%
0.75 - 75.0kW	0	0.0%	0	0.0%	339	0.4%
Above 75.0 kW	0	0.0%	415	99.5%	1	0.0%
Total	4	100.0%	417	100.0%	84,413	100.0%

Source: Malaysian External Trade Development Corporation (MATRADE)

Imports of motors from Thailand accounted for 8.9% of Malaysia's total imports of motors in 2003. However Thailand has traditionally not been a major exporter of motors to Malaysia and only small volumes were imported from Thailand in 2000 and 2001. However, in 2003 there was a sudden surge of imports from Thailand for 0.0-0.75kW motors.

China

Table F-16. Motor Exports to China

	2001		2002		2003	
	Units	%	Units	%	Units	%
0.0 – 0.75kW	0	0.0%	0	0.0%	1	0.0%
0.75 - 75.0kW	32	97.0%	4	100.0%	6,903	100.0%
Above 75.0 kW	1	3.0%	0	0.0%	0	0.0%
Total	33	100.0%	4	100.0%	6,904	100.0%

Source: Malaysian External Trade Development Corporation (MATRADE)

Exports to China in 2003 accounted for 8.9% of Malaysia's total export of motors in 2003. The number of motors exported to China was relatively small in 2001 and 2002 but increased to 6,904 units in 2003. Main category exported was for 0.75-75.00kW motors.

Table F-17. Motor Imported from China

	2001		2002		2003	
	Units	%	Units	%	Units	%
0.0 – 0.75kW	10,119	98.0%	8,078	98.3%	153,455	84.5%
0.75 - 75.0kW	0	0.0%	0	0.0%	20,812	11.5%
Above 75.0 kW	206	2.0%	140	1.7%	7,431	4.1%
Total	10,325	100.0%	8,218	100.0%	181,698	100.0%

Source: Malaysian External Trade Development Corporation (MATRADE)

Imports from China accounted for 19.3% of Malaysia's import in 2003, 24.7% in 2001 and 18.8% in 2002. Imports in 2001 and 2002 were mainly for 0.0-0.75kW motors. By 2003, major imports also included 0.75-75.0kW and 75.0kW and above motors.

India

Table F-18. Motor Exports to India

	2001		2002		2003	
	Units	%	Units	%	Units	%
0.0 – 0.75kW	38	5.2%	0	0.0%	0	0.0%
0.75 – 75.0kW	698	94.8%	143	100.0%	220	100.0%
Above 75.0 kW	0	0.0%	0	0.0%	0	0.0%
Total	736	100.0%	143	100.0%	220	100.0%

Source: Malaysian External Trade Development Corporation (MATRADE)

Exports of motors to India accounted for 0.3% of Malaysia's total motor exports in 2003. The majority of motors exported to India in 2001 and all exports in 2002 and 2003 were for 0.75-75.00kW motors. Lesser volume of motors with power ratings of less than 0.75kW range was also exported in 2001.

Table F-19. Motor Imports from India

	2001		2002		2003	
	Units	%	Units	%	Units	%
0.0 – 0.75kW	129	83.2%	0	0.0%	88	55.7%
0.75 – 75.0kW	0	0.0%	0	0.0%	62	39.2%
Above 75.0 kW	26	16.8%	10	100.0%	8	5.1%
Total	155	100.0%	10	100.0%	158	100.0%

Source: Malaysian External Trade Development Corporation (MATRADE)

Imports of motors from India accounted for 0.02% of Malaysia's total motor imports in 2003. This was a decline from 0.4% in 2001 but similar with the 0.02% in 2002. Motors imported from India in 2001 and 2003 were mostly less than 0.75kW. In 2002 however all motors imported were above 75.0kW.

Catalogue data

Motor catalogues were obtained from 8 motor manufacturers/distributors covering the most commonly sold models in 2003. These models encompass three-quarter or 76.8% of the estimated total number of motors sold in 2003. Percentage efficiencies at 100.0% load were available for all 519 motor models involved.

Based on catalogue data, out of the 519 models, 43.2% of the models had full-load efficiency levels of above 90.0%. Among the motors, EFF1 models had the highest proportion of models with full-load efficiency of above 90.0% followed by EFF2 and subsequently EFF3 motors.

Table F-20. No. of models by level of efficiency (%) and EFF rating

Efficiency (%) At Full-Load	No. of models							
	EFF1		EFF2		EFF3		Total	
	Units	%	Units	%	Units	%	Units	%
Above 90.0%	72	62.6%	117	38.7%	35	34.3%	224	43.2%
80.0 – 90.0	34	29.6%	117	38.7%	44	43.1%	195	37.6%
70.0 – 80.0	8	7.0%	53	17.5%	20	19.6%	81	15.6%
60.0 – 70.0	1	0.9%	14	4.6%	3	2.9%	18	3.5%
50.0 – 60.0	0	0.0%	1	0.3%	0	0.0%	1	0.2%
Total no. of models	115	100%	302	100.0%	102	100%	519	100.0%

Source: Motor catalogues from various motor manufacturers

Complete data collection is provided in Excel spreadsheet "Motor Manufacturer Data Collection Form" provided by the Dansk Management Group.

APPENDIX G: THAILAND MARKET OVERVIEW

Introduction

More than 80% of electrical energy used in industries is consumed by motors. In 2003, industrial sector consumed about 49,062 GWh or about 46% of total electricity consumption. This survey will look at market size of motors (number of units sold and value), market share, market breakdown by rated power, sale channel, relative efficiency levels, standard used for determining performance, and import and export statistics.

Total Number of Manufacturers, Assemblers, Importers and Distributors

There are a few major manufacturers, several importers and over 200 distributors. Table G-1 and G-2 show names of manufacturers and importers respectively.

Table G-1. List of Major Motor Manufacturers

Manufacturers	Brands	HP
Oriental Electric Industry Co., Ltd.	Mitsubishi	<1-75
Thai Toshiba Electric Industry Co., Ltd.	Toshiba	<1-15
Hitachi Industrial Technology Co., Ltd.	Hitachi	<1-10
TECO Electric & Machinery (Thai) Co., Ltd.	TECO	<1-75

Table G-2. List of Major Importers

Importers	Brand Name	Made In
ABB Ltd.	ABB	Germany&others
Accurate Engineering Co., Ltd.	VEM	Germany
Adisa System Co., Ltd.	AEG	Germany
Allied Motor Co., Ltd.	Baldor	USA.
B. Grimm Power Engineering Co., Ltd.	US. Motor	USA.
Cisco Engineering Co., Ltd.	Newman	UK
Crompton Electric Motor (Thailand) Ltd.	Crompton Greaves	India
Elektrim-Contoni Motor Co., Ltd.	Elektrim	Poland
Kentford Machinery Co., Ltd.	PEM, TEMBER	China
Muller Mechanic Co., Ltd.	Muller	China
RPM & C Co., Ltd.	SMIEC	China
S.T. Power Services Co., Ltd.	Reliance	USA.
Siemens Limited	Siemens	Yugoslavia, India
System Corp. Ltd.	Brook Hansen	Sweden, Germany
TECO Electric & Machinery (Thai) Co., Ltd.	TECO	Taiwan, Malaysia

Importers	Brand Name	Made In
T.N. Metal Works Co., Ltd.	Hascon	China
Uawithya Equipment Co., Ltd.	Brook Crompton	UK

Market Size

Based on the interviews with manufacturers, importers and distributors, it is estimated that a few million units were sold in 2003 with a sale value of about 3,500 million Baht. Based on the Custom Department data, an average price of a motor was about 718 Baht/unit (B.552 (CIF) x mark-up factor of 1.3). Therefore, number of motors sold would be around 4.87 million units (3,500 million Baht/Baht 718/unit). In 2003, total number of imported motors was about 4.37 million, therefore, the remaining was local made motors or about 10% of the total units.

Another indicator could be number of consumers. According to the Department of Industrial Works (MOI) and Department of Industrial Promotion (DIP), as of December, 2003, there were about 275,000 small, medium and large factories registered, excluding buildings.

Market Share

The survey and import statistics for years 2001-2003 indicated that market share of local motor manufacturers was about 12% and 88% was imported. Table G-3 shows estimate market share of local made and imported motors. Japanese motors were the leader for the local made market, about 62%, as well as for the overall market, about 25%. Japanese and Chinese imported motors had about the same market share, about 20%. Other leading imported motors were from Germany, Taiwan and Poland. These 5 countries accounted for about 62% of the total import value. An importer informed that Germany is used as a stock place for motors, which are made in several countries, so that, Germany can be used as a country of origin.

Since the economic crisis in 1997, some Thai manufacturers had to scale down their production and import from overseas branches or other cheaper sources, e.g., China. China makes both low efficiency motors for general market and standard ones for several leading brands.

Table G-3. Market Share of Local Manufacturers and Imported Motors

1) Local Manufacturers		Value (Mil. Baht)		% of Local	% of Total
1.1	Mitsubishi	170.02		40%	5%
1.2	Hitachi	51.01		12%	1%
1.3	Toshiba	42.50		10%	1%
1.4	TECO	63.76		15%	2%
1.5	Others	97.76		23%	3%
1.6	**Total**	425.05		100%	**12%**
2) Import		**Ave. Value 2001-3 (CIF-Baht)**	**Mark-up Factor 30%**	**% of Import**	
2.1	Japan	487.68	633.98	20.62%	18%
2.2	China	483.63	628.72	20.45%	18%
2.3	Germany	216.34	281.24	9.15%	8%
2.4	Taiwan	168.79	219.43	7.14%	6%
2.5	Poland	113.98	148.17	4.82%	4%
2.6	Sub-total	1470.42	1,911.55	62.17%	55%
2.7	Others	894.93	1,163.41	37.83%	33%
2.8	**Total**	2,365.35	3,074.96	100.00%	**88%**
2.9	**Grand Total**		3,500		100%

Note: Mark-up factor includes import duties and taxes, VAT and profit.

Market Breakdown According to Rated Power and Efficiency

From discussion with some distributors, it is estimated that more than 70% of motors sold are less than 10 kW. Based on the Customs Department, average total number of imported motors during 2001-2003 is shown in Table G-4.

Table G-4. Average No. of Imported Motors 2001-3

Size (kW)	No. (Mil. Unit)	%
< 0.75	4.16	83
0.75-75	0.80	16
> 75	0.04	1
Total	5.0	100

According to the above table, market breakdown by rated power can be estimated as shown in Table G-5.

Table G-5. Estimate Market Breakdown by Rated Power

Rated Output (kW)	Market Breakdown (%)	
	2003	1999*
<4	85	68
>4-15	10	22
>15-37	3	7
>37-90	1	2
>90-373	0.6	0.6
>373	0.4	0.4

*Source: Energy Efficiency Standard Regime Study, March, 1999, ERM-Siam Co., Ltd. (for only TEFC motors)

Most of motors sold in the market are below standard efficiency or Eff 3, about 50% of the total market share. There is no percentage of efficiency shown in catalogs and nameplates for Eff 3 motors. Most of them come from China with size less than 3.7 kW. These are low-cost motors, which mainly used for, such as, rice milling equipment, ventilation fans in poultry farms, conveyors, spinning machines in textile mills, etc.

Standard efficiency motors have about 45% market share, and 5% for high efficiency (HEM). The sale of HEM trends to increase when the economy is healthy.

Primary Sale Channels

Both local manufacturers and importers mainly sell motors through distributors. Some local manufacturers also import motors from their overseas branches and either sell directly to customers or through distributors. For export market, motors are sold directly by the local manufacturers.

Relative Efficiency Levels

There had been a study to develop energy efficiency standard in 1998 for several electrical appliances including motor for the Energy Policy and Planning Office (EPPO), former name was National Energy Planning Office (NEPO). The study recommended that the initial standard be set at the standard efficiency level (IEEE B) for 4-pole TEFC motors to take effect two years after the standard is finalized, set a second-tier standard at the medium efficiency level to take effect five years after the standard is finalized and then set a third-tier standard at the high efficiency level to take effect three years after the second-tier standard. The study also mentioned that all proposed standards are cost-effective to consumers and suggested the government to establish a strong program to support Thai manufacturers to produce high efficiency motors. However, the proposed program has not been implemented yet.

In 2003, the Department of Alternative Energy Development and Efficiency (DEDE) had issued a standard to be used as a draft Ministerial Order as shown in Table G-6.

This standard will be effective when the Thai Industrial Standard Institute (TISI) publishes in the government gazette. The work is in progress.

Table G-6. 3-Phase Motors Standard for Draft Ministerial Order

Size (kW)	Efficiency (%) at Full Load		
	2-Pole (3,000 RPM)	4-Pole (1,500 RPM)	6-Pole (1,000 RPM)
0.55	75.0	77.0	76.0
0.75	75.5	82.5	80
1.1	82.5	84.0	85.5
1.5	84.0	84.0	86.5
2.2	85.5	87.5	87.5
3.7	87.5	87.5	87.5
5.5	88.5	89.5	89.5
7.5	89.5	89.5	89.5
11	90.2	91.0	90.2
15	90.2	91.0	90.2
18.5	91.0	92.4	91.7
22	91.0	92.4	91.7
30	91.7	93.0	93.0
37	92.4	93.0	93.0
45	93.0	93.6	93.6
55	93.0	94.1	93.6
75	93.6	94.5	94.1
90	94.5	94.5	94.1
110	94.5	95.0	95.0

Standard Used for Determining Performance

Most of motors in the market use European Standard, IEC 34-2. Some use US. Standard, IEEE 112- Method B, and Japanese Standard, JEC-37.Thailand has two testing centers. One is the Industrial Metrology and Testing Service Centre (MTC) located at Bangpoo Industrial Estate. MTC was established under Thailand Institute of Scientific and Technological Research (TISTR) and another is Metropolitan Electricity Authority (MEA) at Samsen Branch.

MTC can test motors up to 37 kW using IEC or IEEE standards. However, so far they have not commercially tested any motor yet. MEA can test motors up to 30 kW and they have tested several motors from local manufacturers using mainly IEEE Standard.

Trade Flow Overview

The overview of the trade flows will show the value of motors being exported and imported to Thailand from four concerned countries (Australia, China, Malaysia, and India) as well as other countries of importance. According to the web site of Customs Department-Thailand, size of the motor has been categorized into three major groups: Not exceeding 0.75 kW, 0.75 kW - 75 kW, and Exceeding 75 kW.

For import statistic (Table G-7), Thailand has imported motor approximately not less than 2,000 million baht a year during 2001-2003. For type of motor that not exceeding 0.75 kW in 2003, the CIF value of imported motor to Thailand from four concerned countries is Baht178.33 million, decreased by Baht203.34 million compared to 2002. This was due to the significant increase in the imported motor proportion from Japan (increased by 83 percent).

For type of motor that ranged between 0.75 kW to 75 kW in 2003, the import value from China, and Malaysia has been increased by 61 percent and 23 percent respectively. While the import figure from India is minimal and fluctuates in small range, compared to other concerned countries. Rather than the decrease in import proportion from Australia, the import proportion from Germany and Japan has also been outstandingly increased. By the end of 2003, the total of imported amount has been increased from Baht 640.39 million in 2002 to Baht 809.58 million in 2003 (increased by 26 percent).

For type of motor that exceeding 75 kW in 2003, there is a fluctuation in term of imported value from four major countries. While the import proportion from China and India have increased (by Baht13.36million and Baht0.62million respectively), the import proportion from Australia was decreased by Baht0.86 million (16 percent). However, the significant import value from Japan and Germany has resulted in the increase of the total import amount from Baht234.58 million in 2002 to Baht350.88 million in 2003.

For export statistic (Table G-8), the average export percentage during 2001-2003 has shown that Thailand has exported 18.80 percent to four concerned countries. China and Australian are the top two largest markets among four concerned countries. Despite exporting to four concerned countries, Japan market is the far largest market for Thai motors. The average export percentage to Japan during 2001-2003 is 62.64 percent.

For type of exported motor that not exceeding 0.75 kW, export portion from Australia has been increased by Baht22.40 million to reach Baht56.48 million in 2003. While in 2003, the export portion from China, Malaysia, and India were decreased by 4.05, 2.97, and 0.002 (Baht/million) respectively.

For type of motor that ranged between 0.75 kW to 75 kW in 2003, the export value from China, Malaysia, Australia and India have increased by 2.78, 0.15, 0.14, and 0.05 (Baht/million) respectively.

For type of motor that exceeding 75 kW, China has been the major export market since 2001. There are slightly increases in export portion to both China and Malaysia in 2003. While, there is no record of export to India from 2001 to 2003.

Table G-7. Import Statistic of 4 concerned countries and other major countries

Country	CIF Value in million Baht									Total			Percentage		
	Not Exceeding 0.75 kW			0.75 KW - 75 kW			Exceeding 75 kW								
	2003	2002	2001	2003	2002	2001	2003	2002	2001	2003	2002	2001	2003	2002	2001
China	128.21	344.12	470.8	188.15	116.88	96.93	41.16	27.8	36.85	357.52	488.8	604.58	14.81	24.56	22.46
Australia	2.63	5.39	2.34	27.8	46.02	27.6	4.51	5.37	14.86	34.94	56.78	44.80	1.45	2.85	1.66
Malaysia	35.21	21.68	69.22	44.05	35.85	15.58	-	-	0.19	79.26	57.53	84.99	3.28	2.89	3.16
India	12.28	10.48	0.52	2.94	2.18	1.29	1.1	0.48	-	16.32	13.14	1.81	0.68	0.6602	0.07
Taiwan	56.96	38.66	43.49	107.77	63.06	111.39	34.18	25.81	25.05	198.91	127.53	179.93	8.24	6.41	6.68
Germany	87.06	60.65	55.29	131.63	79.12	89.78	62.61	43.31	39.56	281.3	183.08	184.63	11.65	9.20	6.86
Japan	487.65	266.82	247.60	179.87	120.61	77.34	60.95	14.35	7.84	728.47	401.78	332.78	30.18	20.19	12.36
Korea	54.09	118.91	256.91	6.49	5.15	2.35	0.47	4.02	1.94	61.05	128.08	261.20	2.53	6.44	26.19
Total	864.09	866.71	1146.17	688.7	468.87	422.26	205	121.14	126.29	1757.77	1456.72	1694.72	72.83	73.19	62.95
Others	261.62	120.86	679.34	248.3	299.33	255.36	145.9	113.44	62.69	655.82	533.63	997.39	27.17	26.81	37.05
Grand Total	1125.71	987.57	1825.51	937	768.2	677.62	350.9	234.58	188.98	2413.59	1990.35	2692.11	100.00	100.00	100.00
Grand Total (Mil. Units)	3.54	3.48	5.45	0.82	0.80	0.77	0.01	0.001	0.12	4.37	4.28	6.34			
% of Total Value (4 concerned countries and other major countries)	46.64	49.618	67.8096	38.8218	38.5962	25.171	14.54	11.786	7.0198						

Source:http://www.customs.go.th/__accessed November 30 2004

Table G-8. Export Statistic of Australia, China, Malaysia, India, Japan and Taiwan

Country	FOB Value in million Baht									Total			Percentage		
	Not Exceeding 0.75 kW			0.75 kW - 75 kW			Exceeding 75 kW								
	2003	2002	2001	2003	2002	2001	2003	2002	2001	2003	2002	2001	2003	2002	2001
Australia	56.48	34.08	36.55	0.50	0.36	0.27	-	-	-	56.48	34.44	36.82	10.28	6.92	8.23
China	0.58	4.63	4.64	15.05	12.27	0.28	31.64	29.90	20.26	47.27	46.8	25.18	8.60	9.40	5.63
Malaysia	6.13	9.10	8.93	0.55	0.40	0.52	3.85	2.54	6.31	10.53	9.5	15.76	1.92	1.91	3.52
India	-	0.002		0.06	0.01	-	-	-	-	0.006	0.012	-	0.0011	0.002	0
Japan	199.10	191.23	181.47	139.17	142.20	83.91	-	0.31	-	338.27	333.74	265.38	61.56	67.03	59.34
Taiwan	0.29	0.70	33.19	10.74	3.38	2.63	-	-	0.21	11.03	4.08	36.03	2.01	0.82	8.06
Total	262.58	239.74	264.78	166.07	158.62	87.61	35.49	32.75	26.78	463.59	428.57	379.17	84.37	86.08	84.79
Others	57.00	46.33	51.36	20.98	16.46	14.60	7.36	3.97	2.09	85.894	69.298	68.04	15.63	13.92	15.21
Grand Total	319.58	286.07	316.14	187.05	175.08	102.21	42.85	36.72	28.87	549.48	497.87	447.21	100.00	100.00	100.00
Grand Total (Mil.Units)	0.74	1.07	0.63	0.08	0.07	0.05	0.42	0.36	0.21	1.24	1.50	0.89			
% of Total Value (four concerned countries and Japan)	56.64	55.94	69.83	35.82	37.01	23.11	7.66	7.64	7.06						

Source:http://www.customs.go.th/__accessed November 30 2004

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APPENDIX H: MODEL DATA COLLECTED

Cf. separate Excel spreadsheet.