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Cold Hard Facts

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The Refrigeration and Air Conditioning Industry in Australia

Funded by the Australian Department of Environment and Water Resources and Refrigerants Australia

Prepared by
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Executive Summary

A substantial survey of all available published data, combined with extensive interviews with industry, have resulted in a range of robust metrics on the Refrigeration and Air conditioning industry in Australia.

A significant database was compiled to facilitate the collation, analysis and testing of data.

The main results from the study indicate that the Refrigeration and Air conditioning industry:

- Involved direct spending of at least $15.96 billion in 2006, slightly more than 1.7% of GDP;
- Involves machinery that consumed possibly 45,000 GWh, or 21.9% of all electricity sent out in Australia in 2006;
- Resulted in as much as 7% of all greenhouse gas emission in Australia in that year, or 40Mt of CO_2e[1].
- Employs at least 163,000 people.

In the process of arriving at these values the research concluded that:

- $3.87 billion was spent buying and installing domestic and small commercial air conditioning equipment in Australia in calendar 2006;
- There were at least 5.63 million installed air conditioners in 2006 - about 0.7 units per household;
- There is 9.46 million cubic metres of cold room storage capacity in Australia with possibly 70% of that space using ammonia as refrigerant;
- 1438 chiller units were sold in 2006 and there is an installed base of 22,450 of these large devices.

[1] Based on Energy Strategies Prompt Indicator value of 571.9 Mt of CO_2e for Australian emissions 2005/06

1. Introduction

It is a little known fact that one of the earliest pioneers of modern refrigeration was an Australian. James Harrison demonstrated and patented a commercial ice-making machine in Geelong, Victoria in 1851. His insights and the principles he demonstrated with his early vapour-compression systems still underpins much of the refrigeration technology that the world relies on today.

A century and a half later, every Australian old enough to walk is likely to retrieve something from a domestic fridge almost every day of their life. However, the extent of the services provided by refrigeration and air conditioning extend far beyond the highly developed and efficient food storage device that is found in every home in the country.

Refrigeration in various guises is central to modern food production, distribution and storage, critical to the occupation of large non-residential buildings, essential to the operation of large hospitals and labs and vital to the operation of large communication and computing centres, just to name few applications that we would sorely miss.

Refrigeration technology is so integral to modern life that understanding the role, scale, value and economic relevance of refrigeration to Australia is no small task. However there has not been a great deal of attention paid by policy makers to the scale of the physical installations of refrigerating devices. It is only in recent years, spurred by an interest in management of refrigerant gases, energy use and residential appliance ownership, that there has been any need to understand the scale of the installed base.

This report has attempted to calculate the extent of the installed base of refrigerating systems, across a great many applications and sectors, through a 'bottom up' process. Primary sources of information used includes commercially prepared market reports compiled by reference to individual firms sales figures, import statistics compiled by the Australia Bureau of Statistics and the Department of Environment and Water Resources, and interviews with leading industry participants. Secondary sources of information include previous estimates made by consultants to the Equipment Energy Efficiency committees MEPS programs.

2. Background and Process

The Federal Department of the Environment and Water Resources, and Refrigerants Australia[2], commissioned[3] Michael McCann of Energy Strategies to, "*prepare a description of the industry in Australia, including an estimate of the number of people and businesses working in each major industry sector, as well as attempting to derive a meaningful figure for the overall economic value to the economy of the refrigeration and air conditioning industry across all sectors*."

Previous attempts at 'surveying' the industry had foundered in the face of significant data gaps, a degree of opacity in the data that is available, a lack of industry informants and insufficient understanding of the range of applications and specialist industry niches, ie a lack of understanding of 'how the industry fits together.'

To overcome this, Energy Strategies sub-contracted research services from Peter Brodribb of Expert Air, in the first instance to assist in interpreting available data on equipment imports, and also to conduct interviews and investigations into some sectors of the industry.

The active participation of a long standing industry professional in the research proved to be extremely productive in terms of getting willing participation from various industry members in providing market activity and data, and in analysing and interpreting data.

In some areas there is still effectively zero useful data. However as it turns out, the terms of reference were ambitious, not as we had expected because of a paucity of data. The task was ambitious because once the process of reviewing industry market intelligence and conducting interviews with industry commenced, it became apparent that in some areas there was going to be a great deal of data to sort and analyse.

The main sources of data not derived directly from industry participants included:

- import statistics from the Australian Bureau of Statistics for the past decade;
- data on imports of 'precharged' equipment collected by the Ozone and Synthetic Gas team;
- a study by CSIRO into the energy consumed in the cold chain; and
- estimates of numbers of various types of machines already in the community prepared by consultants to the Equipment Energy Efficiency committee in the process of establishing MEPS levels.

Considerable effort has been expended to assess and test the data collected. Nonetheless there are areas that would still benefit from further study, including the estimates of workforce employed, as there is a great deal of overlap across trades and with other industries.

[2] The industry association of representing importers and distributors of refrigerant gases in Australia.
[3] The terms of the scope of work for the project is included at Appendix 1

An extensive database was built comprising all available and discovered data, to allow various methods of analysing and validating data. This database, in an Excel spreadsheet file called "HVAC-R Industry Statistics – Chilling Insights June 07", was provided with this report. At the time of publication plans were in place to conduct seminars with leading market participants to further refine and validate the data. These meetings, scheduled for June 2007 may result in a later amendment to this report.

3. A Taxonomy of the Industry

In the first stage of this project, in an effort to better understand how refrigeration and air conditioning services were integrated into the Australian economy, a 'taxonomy' of the industry was prepared and circulated to industry members.

Several drafts of this long list of technology applications were ultimately circulated. The last version, that is thought to record all of the major applications in a reasonably coherent framework, is attached at Appendix 2.

This 'taxonomy' proved useful as a reference throughout the rest of the project, and is used later in this report in describing the extent of data gaps and to propose areas that may be the focus of future research.

What is apparent from the final taxonomy is that refrigeration and air conditioning are truly cross cutting technologies, deployed in every sector of the economy for many purposes.

The widespread integration into the economy is not necessarily a recent phenomenon, as for instance the adoption of computers is. Refrigeration systems have been expanding their central role in economic activity for more than a century, and accelerating in the last 50 years.

In the last 25 years the almost universal adoption of air conditioning, firstly in non-residential buildings and, during the last decade, in homes, has produced a huge installed base of air conditioning machinery and systems.

Coupled with massively increased use of close control systems to maintain operating temperatures in critical telecomputing centres and other sensitive facilities, the continued operation of air conditioning systems is now as vital to the modern world as the cold chain, refrigerated transport and home fridges are to delivery of fresh foods and human nutrition in modern cities.

4. The Results

4.1. Total Employment

It is estimated that at least 163,000 people are directly employed in the refrigeration and air conditioning industry. This workforce is comprised of:

HVAC in Non-residential Buildings*	> 95,000
Domestic Air-conditioning^	> 15,990
Cold Storage**	~ 5620
Drivers of Refrigerated Transport^^	~ 16,400
Auto Air#	> 24,000
Adjustment for Specialists and Ancillary Services##	~ 6,200

*In 2006 Energy Strategies estimated a workforce of at least 95,000 people along the entire supply chain for HVAC services in non-residential building, including maintenance personnel, but not including facilities managers. This estimate was intended to cover specialist close control operators and employees of large chiller enterprises. This estimate was extensively industry tested and is thought to be a robust number.

^This estimate of employment in the installation and servicing of smaller domestic air conditioning is almost certainly an underestimate. However based on the data available for sales of domestic and small commercial air conditioning systems of more than 1.25 million in 2006, it was estimated that at minimum of 10,664 people were required to work fulltime to install those devices. It was then assumed that for every person directly employed installing systems there is at least another .5 of a person employed in admin, sales, maintenance and ancillary services in the domestic air conditioning industry that is not involved in the non-residential industry and thus not counted in the number estimated for the non-residential HVAC supply chain. While the factor of .5 is only a very modest multiplier this section of the industry is characterized by small companies and independent contractors who would generally use casual workers to deal with higher than ordinary demand, and who would have low overheads.

**This estimate is based on the ratio between employment numbers and volume of storage at the largest operator of commercial cold storage, and multiplying by the total volume of cold storage estimated to be operating in Australia.

^^Estimates of drivers for refrigerated vehicles are based on one full time driver for every refrigerated vehicle estimated to be on the nations roads (see Section 4.3). While these workers are clearly transport industry workers, their central role in the Cold Chain, and the reliance of their employment on refrigeration systems warrants their inclusion as part of the Refrigeration and Air conditioning industry.

#This number is almost certainly an underestimate. However approximately 16,000 individuals have been licensed under the Australian Refrigeration Council licensing scheme to work on mobile systems. Approximately 14,000 businesses have applied for Trading Authorisations to purchase and handle bulk refrigerant gases. The estimate of employment assumes that for every licensed technician working on automotive air conditioning systems there is another .5 of a person employed directly in admin, sales and ancillary services in the vehicle air conditioning industry. While the factor of .5 is only a very modest multiplier this section of the industry has a large proportion of smaller companies and independent operators who would not necessarily be working full time on mobile air conditioning systems.

It is felt that, while the major areas of employment and expenditure are captured previously, there are significant specialist areas for which insufficient data is presently available and which could add materially to these conclusions.

Major specialist areas for employment, sales of technology, engineering services and economic activity for which we presently have little accurate data includes:

- Sales, service and installation of small cool rooms - not in the cold chain and supermarkets;
- Commercial Aviation - domestic and international flights serviced here;
- Mining and in mine machinery;
- Marine Systems - domestic, international, commercial and private vessels equipped and serviced here;
- Ancillary sales and service for control systems, sensors, filters, chemicals, specialist cleaning;
- Military vehicles, equipment and systems.

There are also lower skilled jobs that are not easily accounted for, such as labourers and builders engaged in the construction of new coolrooms, , repair, and sales of second hand reconditioned fridges etc.

To capture some of these jobs a conservative adjustment figure has been added to the employment numbers equivalent to 10% of all jobs identified but not including employment in HVAC for non-residential buildings.

4.2. Total Economic Value

We estimate that direct spending in the refrigeration and air conditioning industry in Australia is equivalent to at least $15.96 billion in 2006.

This value is approximate to 1.7 % of Australia's GDP in 2006 and is made up of

The Climate Control Industry - HVAC in non-residential Buildings*	~$7. 1 billion
Installed cost of air conditioning equipment^ (excluding gas ducted heating) Exl GST	~ $3.66 billion
Estimated Expenditure on Domestic Refrigerators and Freezers**	~ $0.75 billion
Wages for employees other than in HVAC for non-residential buildings^^	~ $3.2 billion
Energy Spend (excluding non-residential HVAC)#	~ $1.25 billion

*Value for the 'Climate Control' industry delivering HVAC in non-residential buildings estimated by Energy Strategies in November 2006 for the HVAC High Efficiency Systems Strategy. This includes the 'energy spend', cost of new systems, maintenance and replacement parts on existing systems and engineering consulting.

^See Worksheet, 'AC Summary' in the 'Chilling Insights' database.

**See Worksheet, 'Domestic Appliances' in the 'Chilling Insights' database.

^^Based on total estimated employment multiplied by the average adult wage in 2006 of $51,637.00

Based on an electricity cost of $0.08c/kWh. Some commercial applications caught up here pay as little as $0.045c/kWh but residential and others will pay as high as $0.14c/kWh. This figure excludes energy consumed in HVAC systems in non-residential buildings as that value is already captured in the value of the Climate Control industry.

4.3. Estimates of Installed Base of Various Refrigeration and Air conditioning Machinery

In the process of conducting this research a number of what we believe to be quite robust estimates of installed equipment were derived from the data. Some of these values are of particular interest to stakeholders involved in network planning, energy efficiency policy or in the dynamics of the market. The main values of interest are as follows:

Estimates of Installed Base of Various Machinery by Segment, 2006	
Domestic Refrigerators and Freezers	13,000,000
Domestic and Small Commercial Air conditioning	5,638,669
Chillers	22,450
Volume of Cold Storage	9,460,000 m^3
Number of Supermarket Cold Store installations	3,675
Farm, Catering and Shop Coolrooms	22,853
Self Contained Commercial Refrigeration Equipment	821,500
Refrigerated Vehicles	16,418
Passenger Vehicles with Air conditioning	~ 10,000,000

Appendix 1 – Scope of Work

Scope of Work
The study will provide a description of the industry in Australia, including an estimate of the number of people and businesses working in each major industry sector, as well as attempting to derive a meaningful figure for the overall economic value to the economy of the refrigeration and air conditioning industry across all sectors. Sector levels for particular focus are:

- the cold chain as it relates to food and agriculture, including food transport and food processing,
- large scale retail across both display units and storage units, and
- small retail across both display units and storage units,
- automotive and mobile air conditioning including in the commercial and public bus fleets, trains and in commercial aviation, and
- domestic air conditioning.

Other areas and sub-sectors where air conditioning and refrigeration technology is critical to viable operation should be examined where data sources allow. Particular attention should be paid to seeking any available data for:

- pharmaceutical manufacturing, distribution, storage and supply/retail,
- health and medical facilities, hospitals and medical procedures facilities,
- close control of computing and telecommunications nodes,
- industrial refrigeration and air conditioning, including air chilling for mine sites and chilling or refrigeration required for manufacturing and in processes

Other critical functions and instances that become apparent would be noted and analysed as discovered.

All potential sources of data should be assessed for relevance, and sources and collections compared to provide means of calculating and verifying confidence levels in various collections. The study will report on notable data gaps and make recommendations regarding possible remedies to significant data gaps identified.

The collected data will be used to estimate total direct employment and wages costs, total direct spending and attempt to define a level of economic 'penetration' of these classes of technology; i.e. how much economic activity in the broader economy is dependent on the effective operation of refrigeration and air conditioning technologies.

Appendix 2 – Taxonomy of an Industry

Sub-Sectors and Significant Applications

Discussion: The construction of this 'taxonomy' of the industry is for the purpose of identifying all of the significant applications of refrigeration and air conditioning equipment. Because of the ubiquitous nature of refrigerant cooling, employed as it is in applications across every sector of a modern economy, there will undoubtedly be individual applications and devices that are missed off this list.

However the main aim is not necessarily to comprehensively list every niche application, but to create a broad brush description of the major applications which can be used as the basis of a broad study into the economic value of the refrigeration and air conditioning industry.

KEY: Black = Good specific data, application areas certainly captured in survey.
Green = Limited or no specific data, some applications or parts of application areas likely to be included in data collected so far. No great challenge in improving data collection and data resolution.
Blue = Unsure or almost certain that no useful data has been captured. Unsure about availability of data for some of these applications.

Mobile systems

- Air conditioned and Refrigerated Transport
  - Passenger Vehicle Air Conditioning
  - Light Commercial
  - Refrigerated Trucks & Trailers
  - Buses
  - Recreational Vehicles, Mobile Homes and Caravans
  - Mining & Construction
  - Trains
  - Agricultural (inc. tractors)
- Aviation
- Maritime Systems
- Defence Field Systems and Emergency Services

Stationary Systems

- Non-residential Buildings Ventilation and Air Conditioning Systems
  - Commercial, Government, Education, Transport and Community Hospitals and Health Facilities
  - Hotels and Accommodation
  - Industrial
  - Convention Centres, Retail Malls and Food Courts
  - Entertainment, Restaurants, Swimming pools, Gyms

Residential/Domestic Technology
- High density multiple dwelling
- Semi-detached and Houses
- Domestic Refrigeration

Close Control facilities
- Computing, Server Farms and UPS
- Telecommunications switching, PABX and UPS
- Museums, galleries, archives and specialized storage
- Pharmaceutical
- Labs & testing

Cold Chain
- Food Storage
- Retail Display
- Supermarkets
- Pharmaceuticals

Process Chillers & Industrial Refrigeration
- Brewing and Winemaking
- Dairy Industry
  - Milk Harvesting and Storage
  - Milk Processing
  - Cream Cheese Industry
- Food processing (Confectionary, Frozen Foods, Drinks, Fruit Juice, Chilled Water as additive)
- Aqua Culture & Seafood
- Ice Making

Industrial Chiller Applications
- Plastics/die cooling
- Electronic Plating
- Printing machines & associated equipment
- Dry Cleaning
- Construction
- Laser cutting equipment
- Chilling of water for industrial processes

Other Large Chiller Deep Freeze Applications
- Water cooling for medical or chemical equipment such as SEM, MRI and X-Ray units
- Petro-chemical/gas & chemical
- Medical/Pharmaceutical/Serum/Plasma
- Co-generation/Tri-generation
- Mining and Tunnels
- Liquifaction and Cryogenics

Power Generation Industry
- Mobile Plant

Miscellaneous/Niche
- Water coolers
- Heat Pump Pool Heaters