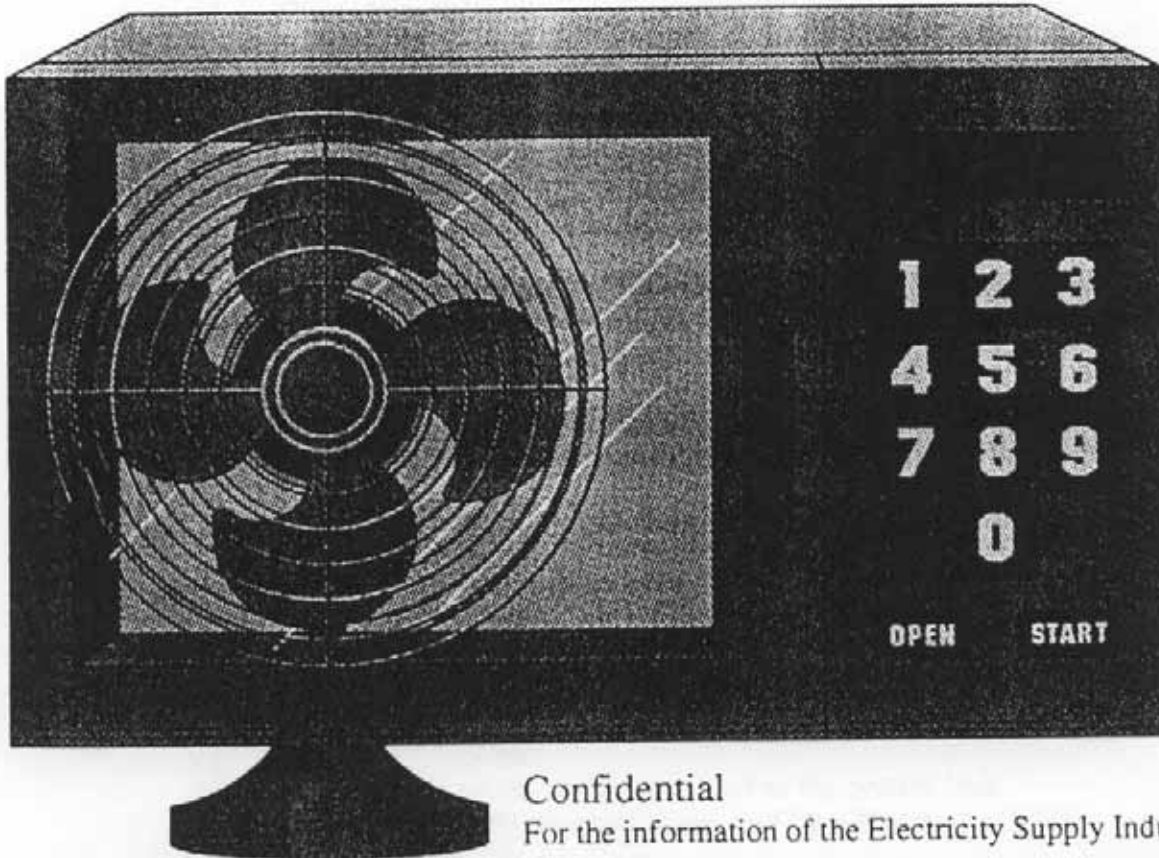


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# The Residential End-Use Study

A detailed study of how and when electricity is consumed by the residential class customers in New South Wales and the Australian Capital Territory.

Undertaken by Pacific Power and the Electricity Distributors of New South Wales and the Australian Capital Territory.



**Confidential**  
For the information of the Electricity Supply Industry only.

# The Residential End-Use Study

## Executive Summary

### 1. General Description of the Study

Pacific Power together with the former 26 distribution authorities in New South Wales and the Australian Capital Territory has completed successfully the first large-scale survey of electricity use in local households. The survey, called the Residential End-Use Study (RES), directly measured the energy used by a wide range of electrical appliances in households over a one year period. The objectives of the RES were to gain knowledge on the pattern of electricity use by major household appliances, and to determine how each contributes to the total domestic and state system load profiles.

The results the of Study can provide a valuable input into future Electricity Industry planning including the development of marketing plans and demand side management strategies, and in the preparation of forecasts of electricity consumption in the residential sector.

A smaller study was undertaken by the Electricity Industry in 1986/87. This study, the Domestic End-Use Study (DES), was limited in the number of appliances that could be monitored and relied on estimating the consumption of most appliances.

The availability of new, sophisticated data logging equipment made the latest study possible. The equipment was specially designed and manufactured for this study by two Australian companies, Test and Certification Australia and Electronic Design and Manufacturing International Pty Ltd. The equipment is now being sold successfully in Australia and overseas.

Between March 1993 and June 1993, data logging equipment was installed in 290 households in NSW and ACT, selected from this customer class using a stratified sample design. The total domestic load and the individual loads of as many as seven major household appliances at each house were recorded at 30 minute intervals from August 1993 to August 1994. A total of 1,670 household electrical appliances were metered.

This report details the process of designing the study and analysing the data, and presents the results and conclusions. Annexures provide additional details and analysis of results which are summarised in the report.

### 2. Key Results

#### 2.1 Summary of Results

- The winter system peak is largely driven by the residential class load; it is estimated that about 2,000 MW, out of a total peak of 9815 MW, is attributed to the residential class.
- In winter, space heating, cooking, lighting and non off-peak water heating contribute the most to the peak.
- In summer, space cooling and refrigeration contribute the most to the peak.
- Water heating (35.7%), refrigeration (16%), lighting (9%), and space heating and cooling (6.7%) account for about two thirds of electricity consumption in the residential market.
- An increase in system diversity was found between the system and the residential class load profiles.

#### 2.2 Residential Class Contribution to System Peak

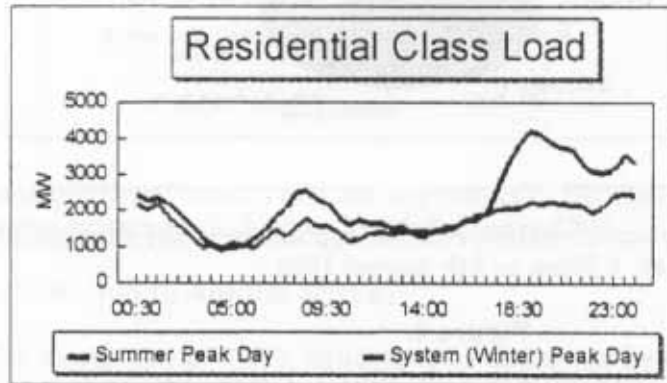
The winter system peak was largely driven by the residential class load. The study indicates that about 2,000 MW of additional residential load contributed to the system peak demand that

occurred at 6.30pm, on 8th August 1994. Winter's seasonal requirements for heating, a longer lighting period and non offpeak water heating mainly contributed to the additional load.

The system peak in summer occurred on 9th February 1994 at 3.30pm and was the result of a high commercial air conditioning load. The residential load did not significantly contribute to the summer system peak. The residential class load summer peaks occurred at 11.30pm with monthly peak days coinciding with system peak day in December only. At the time of residential class load summer peaks, off-peak water heating and refrigeration consuming the major proportion of electricity.

Figure 1 shows the estimated residential class load profiles on the system winter peak day and the summer peak day.

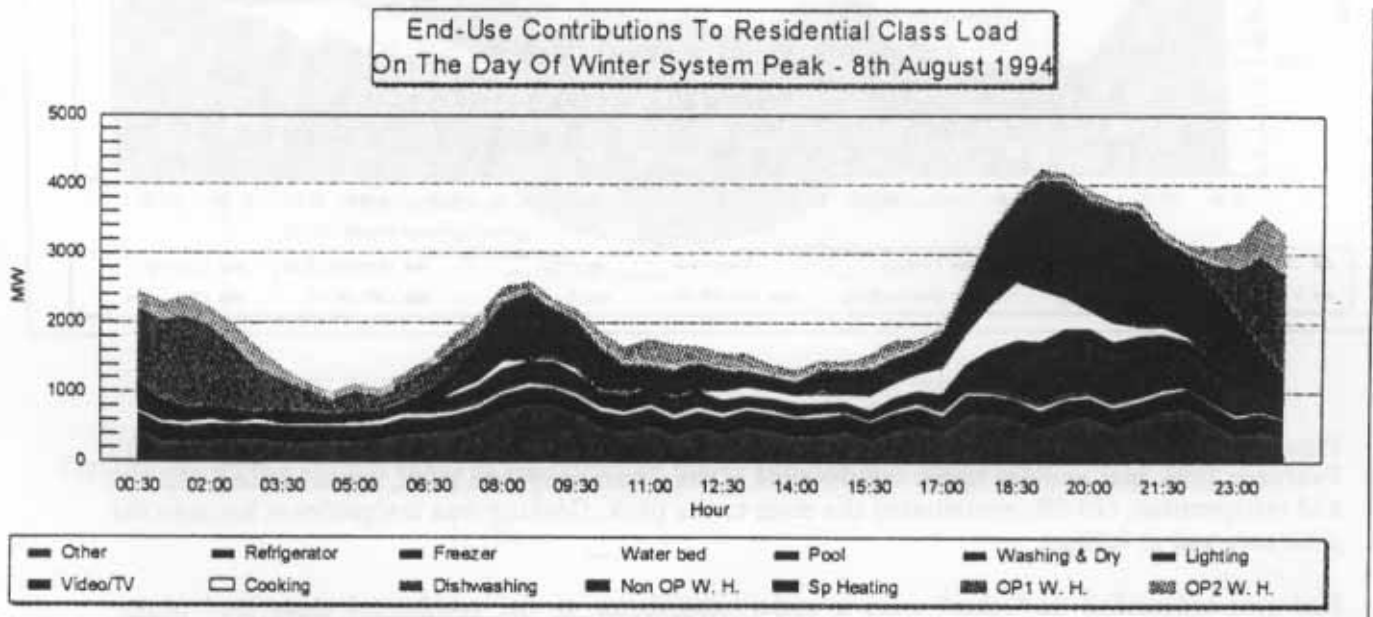
Figure 1.



### 2.3 End-Use contribution to the peak load

Figure 2 shows the breakdown of the residential class load profile for the system peak (winter) day, 8th August 1994, into end-use loads

Figure 2.



At the time of the system winter peak, space heating, (24.2%), cooking, (21.9%), lighting (14.7%) and non off-peak water heating, (6.8%) contributed the most to the peak. Refrigeration, (5.6%), video/tv, (3.4%), and pool pumps, (2.9%) were also significant.

Figure 3.

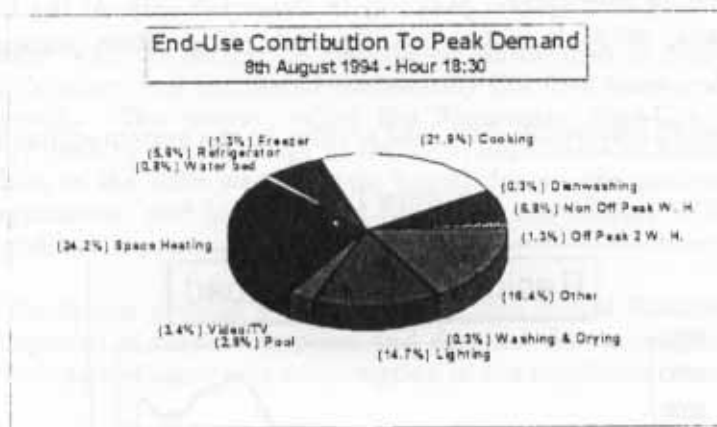


Figure 3 shows the contribution of various end-use appliances to the residential class load profile at the time of the system peak, 6.30pm on 8th August 1994.

Figure 4.

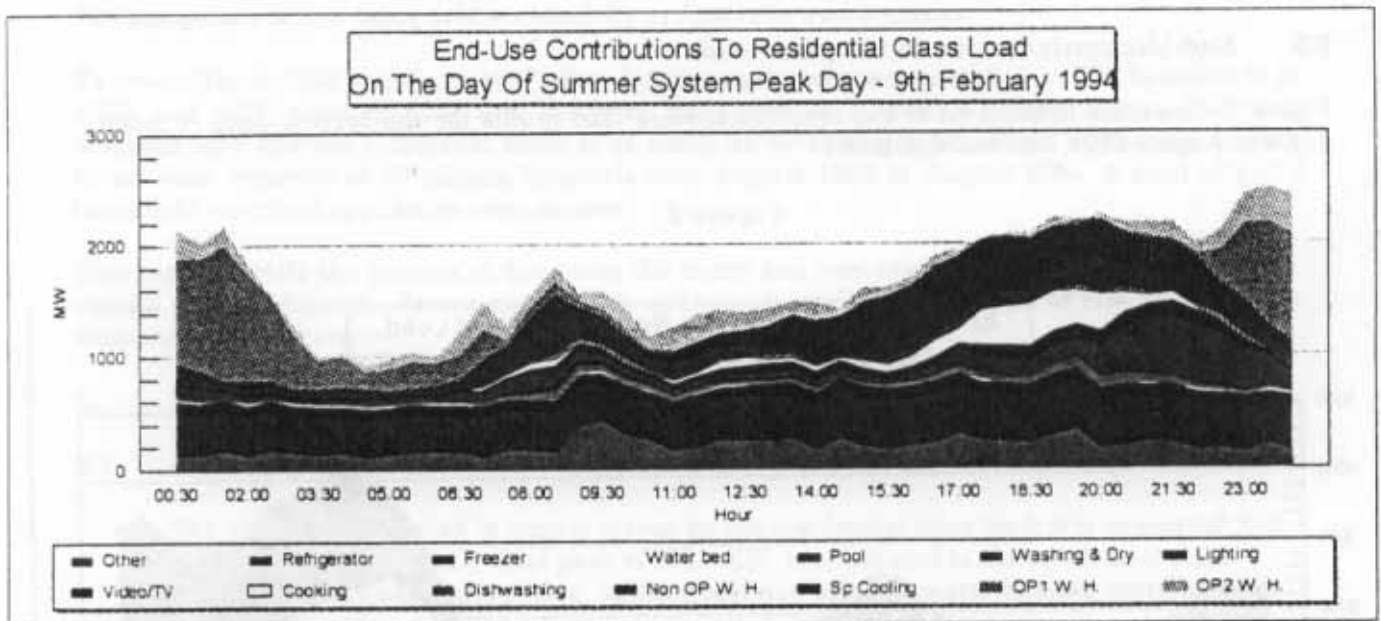


Figure 4 shows the breakdown of the residential class load profile for the summer peak day, 9th February 1994, into end-use loads. At the time of the summer system peak, space cooling, (33.5%) and refrigeration, (26.6%) contributed the most to the peak. Cooking was insignificant because the peak occurred at 3:30pm.

End-uses identified as "other" were a major contributor to the residential class load peaks, particularly during the morning peak. "Other's" contribution to the morning peak would indicate the inclusion of loads such as bench mounted cooking appliances (electric kettles and toasters), bathroom heaters and hair dryers.

Figure 5.

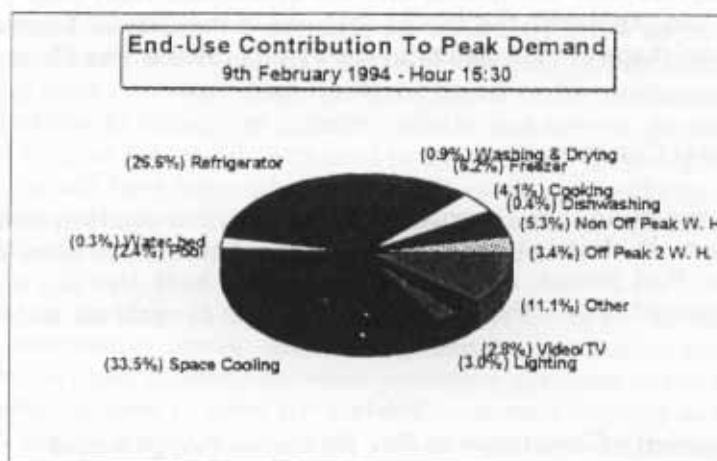


Figure 5 shows the contribution of various end-use appliances to the residential class load profile at the time of the summer system peak, 3.30pm on 9th February 1994.

#### 2.4 End-Use Contribution to Annual Energy

Water heating (35.7%), refrigeration (16%), lighting (9%) and space heating and cooling (6.7%) collectively account for about two thirds of electricity consumption in the residential market.

Figure 6.

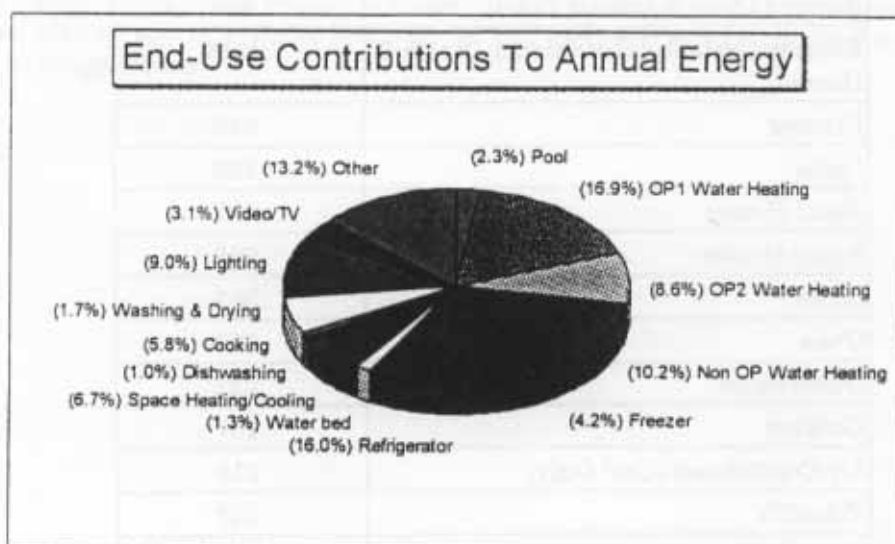


Figure 6 shows the annual share of electricity by major end-use and appliances.

## 2.5 Increased system diversity

There is more diversity between the system and the residential class load profiles in the NSW electricity system now compared with the results obtained in the 1986/87 Domestic End-Use Study. The study found that the shape of the residential class load profile is less likely to coincide with the system profile.

## 2.6 Average Annual Consumption

Table 1 shows the average annual electricity consumption for common household appliances. Water heaters use the most electricity and off-peak water heaters use more electricity than non off-peak water heaters. Pool pumps, refrigerators and water beds also use more electricity than other household appliances because these appliances are left to cycle on and off under their own controls.

**Table 1**  
**Average Annual Electricity Consumption For Household Appliances**

Appliance	Annual kWh
Off-Peak 2 Water Heater	3,578
Off-Peak 1 Water Heater	3,229
Non Off-Peak Water Heater	2,918
Pool Pump	1,353
Refrigerator	944
Refrigerator (2nd)	828
Waterbed	773
Reverse Cycle Room Air Conditioner	698
Reverse Cycle Air Conditioner (Room & Ducted)	1,026
Freezer	648
Light	566
Room Heater	427
Space Heater	996
Stove	363
Oven	233
Dishwasher	227
Cooktop	187
Air Conditioner (Cool Only)	216
Video/TV	157
Clothes Dryer	123
Microwave	67
Washing Machine	55

### 3. Conclusion

The Residential End-Use Study has provided an accurate picture on the electricity consumption patterns of households in NSW. It has provided detailed information on how and when the electricity is being used. Average usage patterns for all major appliances have been determined and their contributions to maximum summer, winter and system demand have been estimated. The results could even be reasonably extended to indicate how all energy is used in a household. The results of the study have been achieved in most cases with sufficient precision for the ESI to use the information with great confidence. Levels of precision are provided with the results to indicate the confidence with which the values may be used.

The energy sector in Australia is undergoing a period of change. The electricity industry is now being subject to competitive forces. Both the generating companies and the retail distributors must remain commercially competitive while providing optimum customer service. At the same time they are being required to meet stricter environmental controls and participate in a nation wide strategy to reduce green house gases. Each will have to manage more efficiently their capital assets such as generating plant, substations, transformers and transmission lines to obtain the best possible return. The ESI will now be better able to identify which end-uses are placing a large demand of the system at peak time. Where the end-uses are not large users of electricity they are not making the most efficient use of supply assets and the house holder could be encouraged not to operate the appliances at the peak times. Appliances which are large users of electricity can be targeted for energy efficiency programs.

The knowledge of detailed usage patterns provided by the RES will become more important to electricity retailers in a competitive market as they restructure their domestic tariffs.

The study has indicated that significant changes have occurred in usage patterns between 1986/87 when the DES and 1993/94 when the RES was carried out. The study has provided very good data from which to set benchmarks for further studies and it is recommended that surveys should be carried out at regular intervals to add to the existing information and pick up any changes in usage trends.