SUSTAINABLE ENERGY AUTHORITY OF VICTORIA

The IMPACT of COMMERCIAL AND RESIDENTIAL SECTORS' EEIs on ELECTRICITY DEMAND

Prepared by

EMET Consultants Pty Limited

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1 Introduction

In November 2002, the Ministerial Council on Energy (MCE), comprising commonwealth, state and territory energy ministers, endorsed a proposal for development of a National Framework for Energy Efficiency (NFEE or National Framework) to define future directions for energy efficiency policy and programs in Australia. The objective of the National Framework is to unlock the significant economic potential associated with increased implementation of energy efficient technologies and processes, to deliver a least cost approach to energy provision in Australia.

As part of the work on the National Framework, the Sustainable Energy Authority, in conjunction with the consultant Graham Armstrong, undertook a project to assess the demand-side energy efficiency improvement potential and costs for the residential, commercial and industrial sectors[5]. Recent projects are providing more refined estimates of energy efficiency improvement (EEI) potential for selected case studies in both the commercial and industrial sectors, including work by EMET consultants for the commercial sector.

In addition to work on modelling the economy wide impacts of the NFEE (Allen Consulting with CoPS-Monash), based on the identified EEI potential, McLennan Magasanik Associates (MMA) is undertaking some work to estimate the energy system impacts - avoided investment in electricity generation plants, network upgrades, etc - for implementing the identified EEI potentials over a certain time period.

As part of this work, in preliminary modelling, MMA have made some assumptions about the relationship between the energy efficiency measures and their likely impact on electricity peak demand in the residential, commercial and industrial.

In January 2004, SEAV commissioned EMET Consultants Pty Ltd to undertake some additional work to get a better idea of the relationship between energy end-use and electricity peak demand in the residential and commercial sectors.

The original aim of the project was to assist with the on-going development of the NFEE by provide information on the relationship between energy end use and electricity peak demand in the residential, commercial and industrial sectors. However due to time constraints the scope was reduced to cover only the energy efficiency initiatives related to the residential and commercial sectors.

More specifically, the objectives of the project were to produce:

Output 1 – General load patterns

1. Description of the typical summer electricity load pattern, including graph broken down into residential, commercial and industrial sectors, and table showing major components of the peak summer load;

2. Description of the typical winter electricity load pattern, including graph broken down into residential, commercial and industrial sectors, and table showing major components of the peak summer load;

Output 2 – Most appropriate LFA[1] for MMA modelling

3. For the commercial sector:
   - Graphical representation of the typical summer and winter electricity load pattern, and table showing major components of summer and winter peak load;
   - Identify the most appropriate LFA option[2] for both the summer and winter electricity load pattern, and estimate % reduction to both summer and winter peak load from implementing identified EEI potential;
4. For the residential sector:
   - Graphical representation of the typical summer and winter electricity load pattern, and table showing major components of summer and winter peak load;
   - Identify the most appropriate LFA option for both the summer and winter electricity load pattern, and estimate % reduction to both summer and winter peak load from implementing identified EEI potential;
5. Brief report setting our results of this work – items 1 to 4.

1.1 Analysis Methodology

This analysis follows on from the work undertaken by EMET[2 & 3] and GWA[4] in identifying and quantifying the electricity savings available within the Australian Commercial and Residential sectors and uses these results to estimate the impact that they may achieve on reducing electricity demand levels during the peak summer and winter system load periods.

The impact is estimated by building a relationship between electricity consumption and peak demand levels through the analysis of relevant appliance usage and load patterns.

Due to the shortness of time available for this process, electricity consumption and peak demand models previously produced by EMET[1] for the New South Wales Commercial and Residential sectors were extrapolated to represent the corresponding Australian sectors. This assumption is reasonable as the shape of the total electricity system curve is not used specifically, but only the usage patterns for different types of equipment are used in the analysis. Variations will be most evident in systems which are beyond typical user patterns (eg. the amount of Off-peak to on-demand Hot Water use and their control by the authorities) and in all States based on the specific time of peak demand levels, based on the specific mix of users in each system. To provide more definitive results, the work carried out by EMET[1] should be repeated for each State.

The following sources of data were used in this analysis. Refer to the relevant reports for a list of assumptions used in developing the estimates and models used in each case:

- Electricity appliance usage patterns (peak summer and winter electricity demand patterns and relationships to annual consumption) – *NSW Electricity Demand Study 2003[1]*, EMET for the NSW Ministry of Utilities and Energy, October 2003

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1 Load Forecast Adjustment Model – See Attachment 1 for a description of the MMA modelling process.

2 The results of this Demand Impact Study provide an alternative calculation of the impact of EEIs on peak demand levels as well as providing factors which may be applied to modified MMA models. No specific LFA Option is recommended in this report.

- Commercial Sector Energy Efficiency Initiatives and Electricity Savings potential (potential savings in electricity consumption through the use of cost-effective energy efficiency initiatives beyond Business as Usual) – *Energy Efficiency Improvement in the Commercial Sub-Sectors*[2], EMET for the SEAV, February 2004
- Residential Sector – Energy Efficiency Initiatives (excluding water heating) and Electricity Savings potential (potential savings in electricity consumption through the use of cost-effective energy efficiency initiatives beyond Business as Usual) – *Energy Efficiency Improvement in the Residential Sector*[3], EMET for the SEAV, February 2004
- Residential Sector - Water heating Energy Efficiency Initiatives and Electricity Savings potential (potential savings in electricity consumption through the use of cost-effective energy efficiency initiatives beyond Business as Usual) – *NFEE – Energy Efficiency Improvement Potential case studies, Residential Water Heating*[4], GWA for the SEAV, February 2004

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2 Typical Summer and Winter Peak Demand Load Patterns

Figures 2.1 and 2.2 show the electricity demand patterns derived by EMET/MEU[1] for the New South Electricity grid system for the days of peak demand in 2002 Winter and 2003 Summer. Each of these has been indexed to represent a generic pattern of consumption for these peak days.

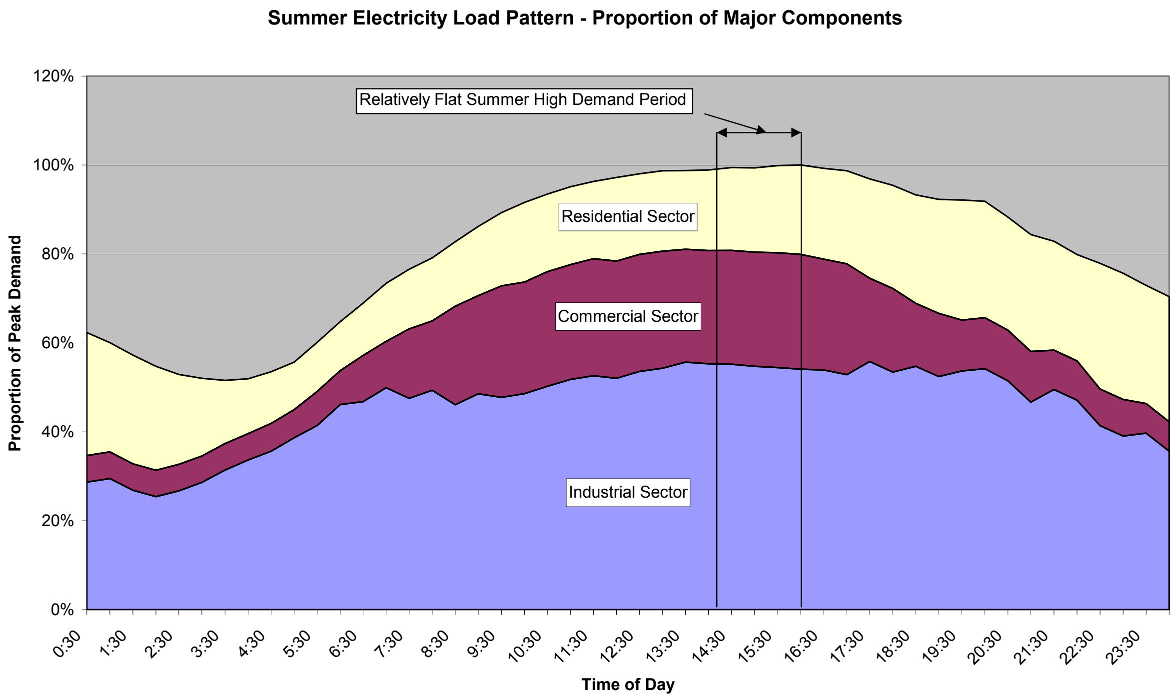

Figure 2.1 – Summer Electricity Load Pattern – Proportion of Major Components

The peak summer demand level was found to be sustained for a number of hours around the mid-afternoon period, with the highest load occurring at 1600 hours. At this time the peak load consisted of the Industrial Sector at 54.1% of the total, the Commercial Sector at 25.8% and the Residential Sector at 20.1% (refer to Table 2.1).

The peak winter demand pattern comprises one distinctive peak at approximately 1800 hours and a lower morning peak at approximately 0830 hours. At the time of the major peak the Industrial Sector contributes 53.0% of the total. The Residential Sector is second largest at this time with 30.3% and the Commercial Sector has the smallest contribution at 16.6% (Refer to Table 2.1).

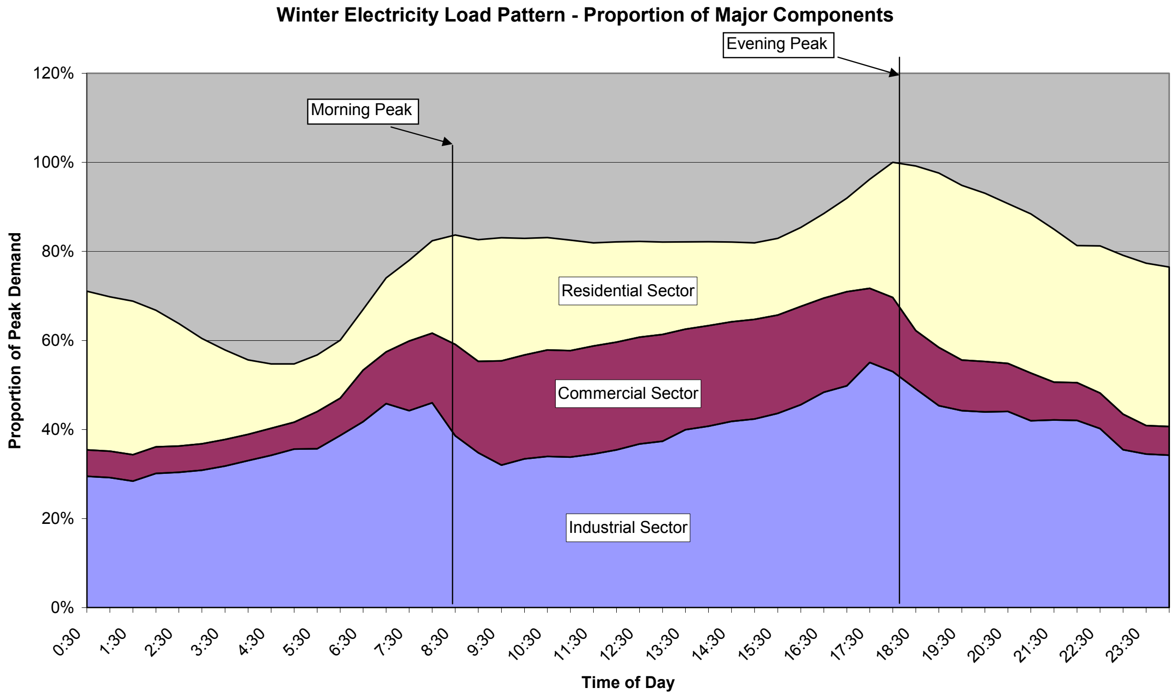

Figure 2.2 – Winter Electricity Load Pattern – Proportion of Major Components

Table 2.1 – Proportions of the Major Sectors at the time of Peak Summer and Winter System Demand Levels

Sector	PEAK SUMMER SCENARIO		PEAK WINTER SCENARIO	
	Proportion of System Demand at 14:00 hrs	*Proportion of System Demand at 16:00 hrs*	*Proportion of System Demand at 08:30 hrs*	*Proportion of System Demand at 18:00 hrs*
Industrial	*56.0%*	*54.1%*	*46.1%*	*53.0%*
Residential	*18.3%*	*20.1%*	*29.4%*	*30.3%*
Commercial	*25.7%*	*25.8%*	*25.4%*	*16.6%*

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3 Commercial Sector

The EMET/MEU[1] study for the NSW electricity demand determined that the Summer and Winter electricity demand patterns for the Commercial Sector were similar in shape and within 10% of each other in peak value. The Summer condition peaked at 3,028 MW at 1200 hours, while the Winter condition peaks at 2,719 MW at the same time. Their total demand pattern was found to be relatively flat during the middle of the day, with the peak occurring largely as a result of increased cooking equipment being in operation at lunch time. The Winter morning pattern is higher than the Summer reflecting the electric heating load occurring in the early part of the working day. The Summer afternoon load remains at a higher level compared to Winter, due to the increasing cooling load as the building continues to be subjected to higher temperature conditions.

The patterns for NSW Commercial Sector at times of Peak Summer and Winter demand are shown in Figures 3.1 and 3.2 respectively.

Some heating plant remains in operation even on the hottest of days, due to the need to balance some cooling loads within some buildings (due to system design, poor efficiency or strict humidity/temperature requirements). Conversely, cooling equipment continues to operate in many commercial sector buildings on the coldest of days as noted on the charts.

The proportion of demand applicable to individual Commercial Sector appliances/applications is shown in Table 3.1.

As the sector takes up an increased proportion of reverse cycle plant in comparison to the more traditional central chillers (for cooling) and gas fired boilers (for heating), the Winter load patterns will be expected to increase (due to the larger penetration of electrical heating) as will also the Summer patterns (due to poorer efficiency of these systems particularly at peak load conditions).

Table 3.1: Components of the NSW Commercial Sector Electricity Demand at the Peak Summer and Winter System Demand levels (Source EMET/MEU[1])

	Peak Winter Day - 18th June 2002				*Peak Summer Day - 30th January 2003*			
Component	*Load at 8:30 (MW)*	*Proportion of System Demand*	*Load at 18:00 (MW)*	*Proportion of System Demand*	*Load at 14:00 (MW)*	*Proportion of System Demand*	*Load at 16:00 (MW)*	*Proportion of System Demand*
System Peak	10,174	100.0%	12,156	100.0%	12,316	100.0%	12,456	100.0%
Cooling	114	1.1%	72	0.6%	1,007	8.2%	1,017	8.2%
Lighting: Interior	542	5.3%	676	5.6%	844	6.9%	842	6.8%
Air Handling Systems	335	3.3%	184	1.5%	343	2.8%	332	2.7%
Office Equipment	206	2.0%	160	1.3%	250	2.0%	250	2.0%
Hot Water	139	1.4%	113	0.9%	196	1.6%	196	1.6%
Cooking Equipment	338	3.3%	326	2.7%	164	1.3%	176	1.4%
Miscell Equipment	100	1.0%	111	0.9%	135	1.1%	134	1.1%
Process Motors	55	0.5%	114	0.9%	114	0.9%	114	0.9%
Heating	582	5.7%	49	0.4%	27	0.2%	72	0.6%
Pumping Systems	69	0.7%	44	0.4%	69	0.6%	69	0.6%
Lighting: Carpark	8	0.1%	8	0.1%	8	0.1%	8	0.1%
Lighting: Exterior	7	0.1%	167	1.4%	7	0.1%	6	0.1%
TOTALS	***2,495***	***24.5%***	***2,023***	***16.6%***	***3,165***	***25.7%***	***3,217***	***25.8%***

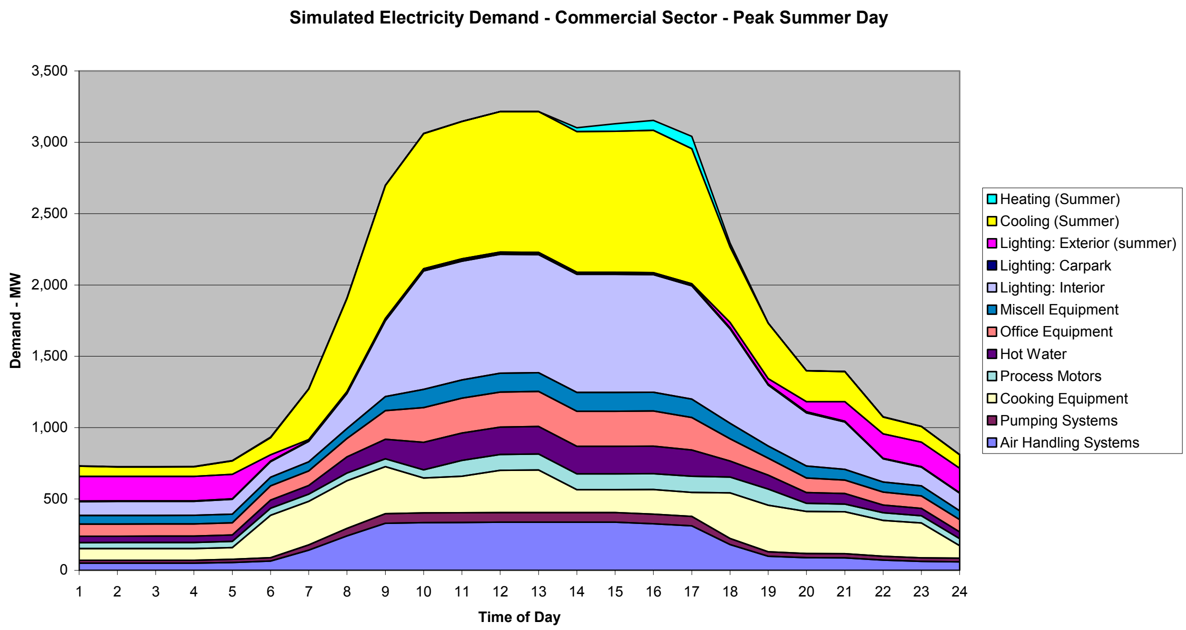

Figure 3.1 – NSW Commercial Sector – Breakdown of Peak Summer Demand Pattern by Application (Source EMET/MEU[1])

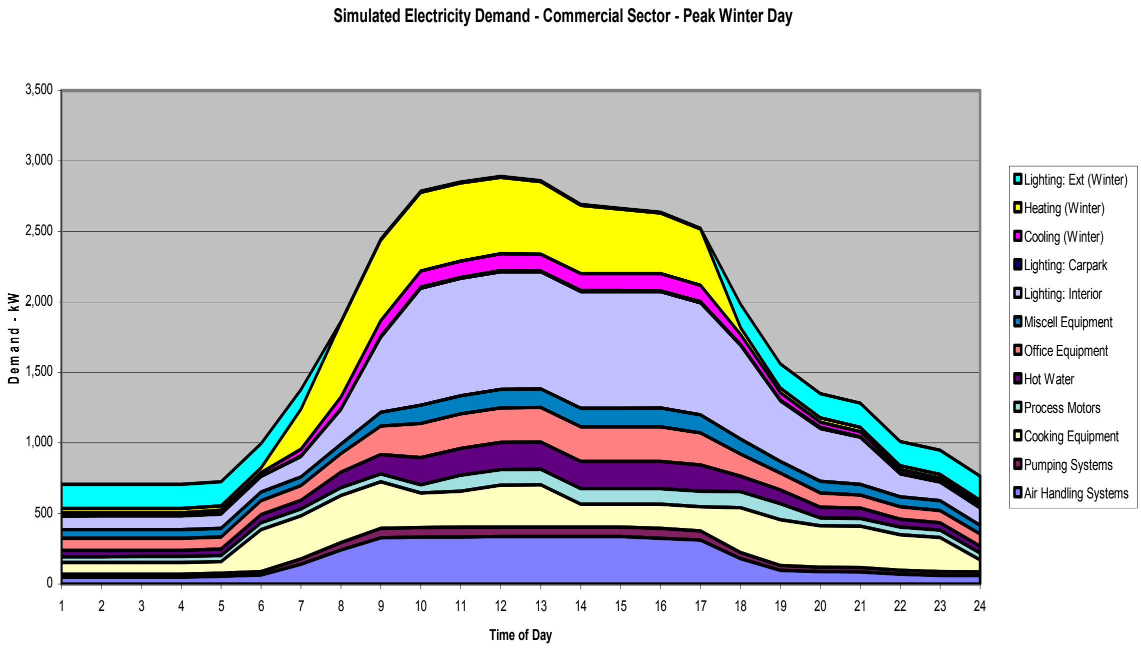

Figure 3.2: NSW Commercial Sector – Breakdown of Peak Winter Demand Pattern by Application (Source EMET/MEU[1])

3.1 Impact of Commercial Sector EEI's on the Peak Electricity Demand Levels for Summer and Winter

Using the electricity usage patterns derived for the NSW Commercial Sector appliances and systems a relationship was derived between electricity consumption and demand for each of the Summer and Winter Demand peaks. These are expressed in MW of peak demand (Summer & Winter) per PJ of annual electricity consumption and represent the result of the integration of the electricity consumption patterns for each type of appliance across a full 12 months. The results of this analysis are shown in Table 3.2.

Table 3.2: Commercial Sector Electricity Demand/Consumption Factors

	Electricity Demand Factor MW/PJ	
Application	**Winter**	**Summer**
Air Handling Systems	34.3	61.9
Pumping Systems	34.0	53.7
Cooking Equipment	48.9	26.4
Process Motors	73.9	73.9
Hot Water	34.0	59.0
Office Equipment	36.1	56.6
Miscell Equipment	39.7	48.3
Lighting: Interior	51.8	64.5
Lighting: Carpark	44.2	44.2
Lighting: Exterior	64.4	2.5
Cooling	10.1	142.0
Heating	22.9	33.1
Air Conditioning Average	25.3	72.7

As may be expected, the application with the highest sensitivity is for Cooling during the summer peak, with a factor of 142 MW reduction per PJ of electricity saved. Other applications of high sensitivity include Process Motors, Interior Lighting and Air Handling Systems during the summer peak and Process Motors and Exterior lighting during the winter peak.

Figure 3.3 illustrates the difference in impact made by each major application of electricity on the Summer and Winter demand levels compared to the annual proportion of electricity consumption for the Commercial Sector. For example, the proportion of the Cooling Systems demand during Summer (32% of total Sector contribution) is much higher than its Winter peak contribution (4%) and its share of electricity consumption (14%) reflecting the intensity of these systems operations during the Summer peak period. Lighting retains a high level of impact on demand across the seasons, while heating makes little impact even on the Winter peak due to its time of day.

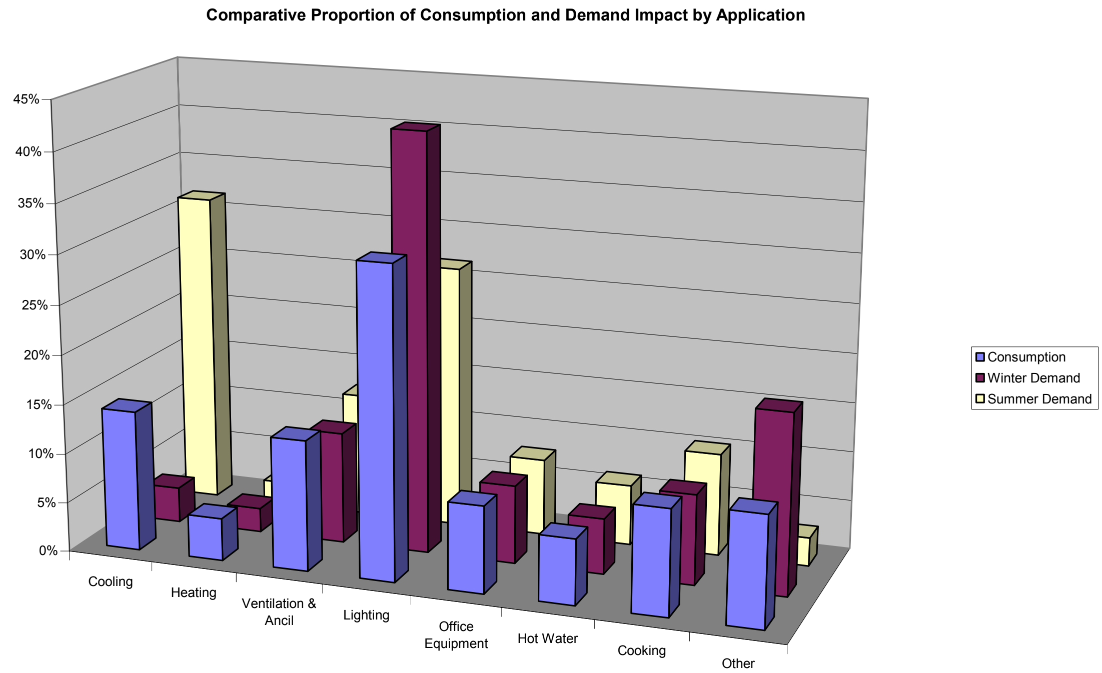

Figure 3.3 – Commercial Sector – Comparative Proportions of Consumption and Demand Impact by Application

Each of the demand impact factors (refer to Table 3.2) was applied to the EEIs identified in the EMET/SEAV[2] study for the commercial sector and an estimate of the electricity demand reduction potential was made for each case. The detailed results are shown in Figure 3.4 and are tabulated in Appendix 1 (The initiatives are shown in decreasing order of cost-effectiveness). Table 3.3 provides a summary of the data presented in Figure 3.4, showing the demand reduction achieved by different types of EEI measures. Refer to Appendix 1 for an explanation of the codes used to identify each EEI and for tabulations of the impact of each initiative within each of the Commercial Sector sub-sectors analysed in the EMET/SEAV[2] study.

The most significant impact is noted in Processes Option-3.3[3] (Winter) and Lighting Option-1.1a[2] (Summer), although the latter is of much lower cost-effectiveness and less likely to impact the sector than the HVAC Option-3.1[2] shown.

Combining the results of the above analysis, it is estimated that the Summer electricity demand levels across Australia in 2010 would be reduced by 2,781 MW by the application of all EEIs of 4 year payback or less, comprising 980 MW due to Business As Usual initiatives. Excluding the expected BAU take up of this energy efficiency improvement potential, it is estimated that the application of all EEIs of 4-year payback or less would reduce Summer peak demand Across Australia by 1,800 MW in 2010.

For the peak Winter demand, the estimated total demand reduction potential is 1,950 MW in 2010 by the application of all EEIs of 4-year payback or less, comprising 666 MW due to Business As Usual

[3] Refer to Appendix 1 and the EMET/SEAV[2] study report for an explanation of the EEI codes

initiatives. The beyond-BAU demand reduction potential is 1,284 MW. These results are shown in Table 3.4.

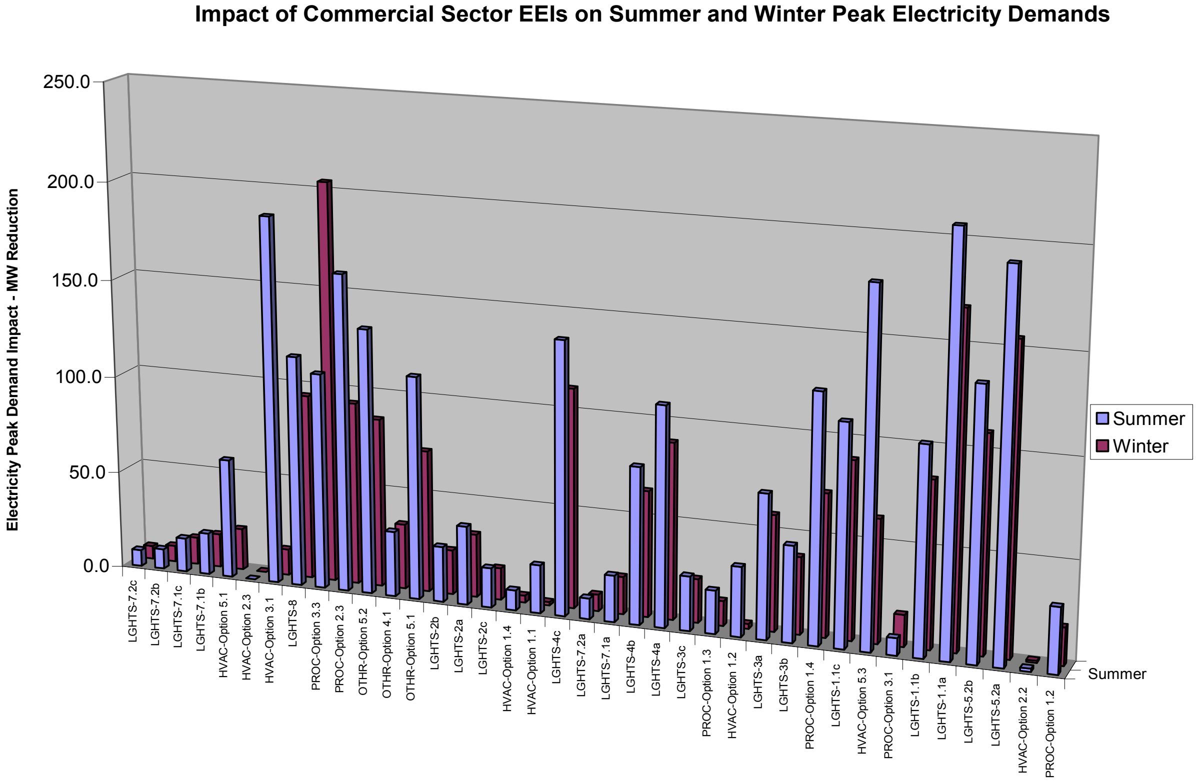

Figure 3.4 – Estimated Impact of Commercial Sector EEIs on Peak Summer and Winter Electricity Demand Levels

Type of EEI Initiative	Summer Peak Demand Reduction - MW	Winter Peak Demand Reduction - MW
Lighting	1,535.1	1,233.3
HVAC	500.8	106.0
Processes	462.2	418.4
Other	282.8	192.4
Total	**2,781**	**1,950**

Table 3.3: Commercial Sector – Estimated (Raw) Reduction in Peak Electricity Demand by Type of EEI Initiative

Sector Totals	Electricity Saving - PJ pa	Summer Peak Demand Reduction - MW	Winter Peak Demand Reduction - MW
BAU Reduction	16.7	980	666
4 year Payback (ex BAU)	27.5	1,800	1,284
Total Potential	44.2	2,781	1,950

Table 3.4: Commercial Sector – Estimated Reduction in Peak Electricity Demand Levels by the Application of Cost-effective EEIs

4 Residential Sector

The EMET/MEU[1] study noted that the electricity demand pattern for the New South Wales Residential Sector is highly sensitive to weather conditions and therefore varies substantially between Summer and Winter. Both patterns have high demand levels at around midnight due to the concentration of off-peak water heating at this time plus space heating in Winter.

The patterns for NSW Residential Sector at times of Peak Summer and Winter demand are shown in Figures 4.1 and 4.2 respectively (Refer to the Methodology on factors affecting the validity of this assumption).

The highest peak in Winter occurs at approximately 1900 hours at a level of approximately 4,750 MW (NSW system only). The morning Winter peak occurs at approximately 0830 hours at a level of approximately 3,300 MW (NSW system only).

During Summer, the peak of approximately 3,500 MW (NSW system only) occurs at midnight as noted above. The next significant peak occurs at approximately 1900 hours at a level of approximately 3,300 MW (NSW system only). It should be noted that the midnight peak is largely due to the activation of off-peak water systems and may be readily shifted if necessary by the Supply Industry.

4.1 Typical Summer and Winter Electricity Load Patterns for the Residential Sector

The characteristics of the NSW Residential Sector demand pattern during the periods of peak system demand are summarised in Table 4.1. At times of peak Winter demand (1800 hours) the major component of demand is space heating and air conditioning (reverse cycle heating) combined at 758 MW. The next largest users at this time are cooking appliances (Range and Microwave) at 576 MW, hot water heating at 808 MW and lighting at 518 MW.

During the minor Winter peak (0830 hours), the on-demand water heating is most significant at 1,085 MW followed by space heating at 679 MW (includes reverse-cycle air conditioning).

At the time of peak Summer demand the Residential the major contributors to the load are Air Conditioners (988 MW); Refrigerators, with a total load of 572 MW; and the combined hot water heating load (344 MW).

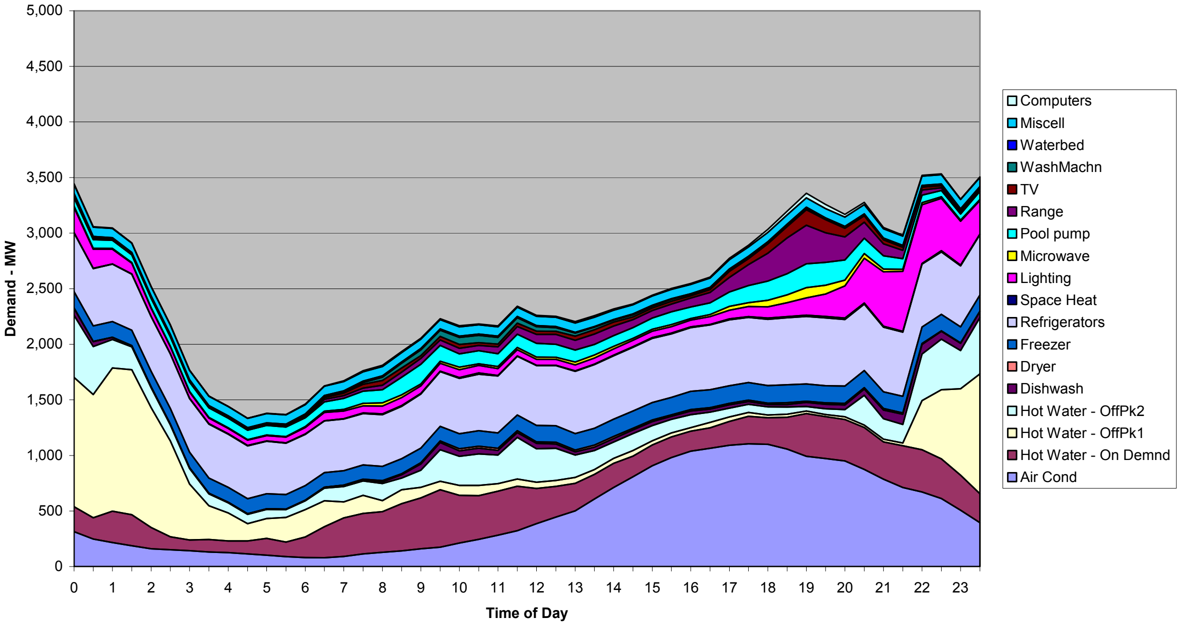

Figure 4.1 – NSW Residential Sector – Breakdown of Peak Summer Demand Pattern by Application (Source EMET/MEU[1])

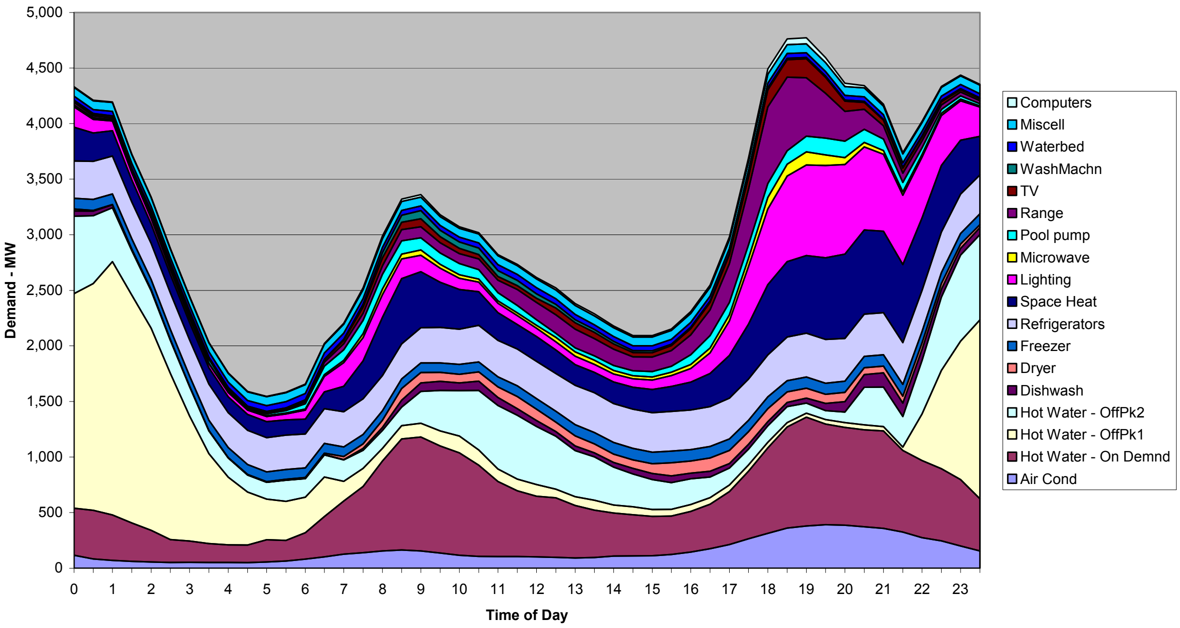

Figure 4.2 – NSW Residential Sector – Breakdown of Peak Winter Demand Pattern by Application (Source EMET/MEU[1])

Table 4.1: Components of the NSW Residential Sector Electricity Demand at the Peak Summer and Winter System Demand levels (Source EMET/MEU[1])

Component	Peak Winter Day - 18th June 2002				Peak Summer Day - 30th January 2003			
	Load at 8:30 (MW)	Proportion of System Demand	Load at 18:00 (MW)	Proportion of System Demand	Load at 14:00 (MW)	Proportion of System Demand	Load at 16:00 (MW)	Proportion of System Demand
System Peak	10,174	100.0%	12,156	100.0%	12,316	100.0%	12,456	100.0%
Refrigerators	317	3.1%	370	3.0%	573	4.7%	572	4.6%
Air Cond	155	1.5%	264	2.2%	607	4.9%	980	7.9%
Hot Water - On Demnd	808	7.9%	607	5.0%	223	1.8%	186	1.5%
Hot Water - OffPk2	162	1.6%	143	1.2%	171	1.4%	122	1.0%
Freezer	85	0.8%	104	0.9%	152	1.2%	157	1.3%
Range	76	0.7%	502	4.1%	93	0.8%	68	0.5%
Pool pump	134	1.3%	119	1.0%	96	0.8%	115	0.9%
Lighting	205	2.0%	518	4.3%	54	0.4%	58	0.5%
Hot Water - OffPk1	114	1.1%	57	0.5%	44	0.4%	35	0.3%
TV	72	0.7%	109	0.9%	40	0.3%	27	0.2%
Space Heat	524	5.2%	495	4.1%	5	0.0%	8	0.1%
Dishwash	28	0.3%	43	0.4%	30	0.2%	28	0.2%
Dryer	64	0.6%	113	0.9%	18	0.2%	13	0.1%
Waterbed	49	0.5%	41	0.3%	7	0.1%	7	0.1%
WashMachn	45	0.4%	15	0.1%	22	0.2%	16	0.1%
Microwave	49	0.5%	74	0.6%	27	0.2%	18	0.1%
Miscell	80	0.8%	80	0.7%	83	0.7%	83	0.7%
Computers	23	0.2%	35	0.3%	13	0.1%	8	0.1%
Totals	***2,989***	***29.4%***	***3,689***	***30.3%***	***2,257***	***18.3%***	***2,502***	***20.1%***

4.2 Impact of Residential Sector EEI's on the Peak Electricity Demand Levels for Summer and Winter

As for the Commercial Sector analysis, electricity usage patterns derived for the NSW Residential Sector appliances and systems were used to derive a relationship between electricity consumption and demand for each of the Summer and Winter Demand peaks. The results of this analysis are shown in Table 4.2.

The Air Conditioning systems during the Summer peak were found to be the most sensitive to energy consumption savings due to their peaky consumption characteristics. Their demand factor was calculated as 297.5 MW per PJ per annum of electricity saved. Other applications of high sensitivity include Space Heating, Cooking and Dryers in Winter corresponding to reductions of 191.4MW/PJ (Air Conditioning and Space Heating Combined), 241.4 MW/PJ (Range and Microwave combined) and 137.3 MW/PJ respectively.

Figure 4.3 illustrates the difference in impact made by each major application of electricity on the Summer and Winter demand levels compared to the annual proportion of electricity consumption. For example, the intensity of the impact of air conditioners on the Summer peak (39%) is disproportionate to its proportion of annual electricity consumption (5%). In contrast, Hot Water services are responsible for 42% of total electricity consumption, however their Summer and Winter peak contributions are only 14% and 22% respectively.

Table 4.2: Residential Sector Electricity Demand/Consumption Factors

Application	Electricity Demand Factor MW/PJ	
	Winter	Summer
Refrigerators	29.9	46.2
Air Conditioners	80.0	297.5
Hot Water - On Demand	49.8	15.3
Hot Water – Off Peak 2	20.0	17.0
Freezer	30.1	45.6
Range	154.1	21.0
Pool pump	54.9	52.7
Lighting	95.4	10.7
Hot Water – Off Peak 1	5.2	3.2
TV	93.3	23.1
Space Heating	161.5	2.5
Dishwashers	40.6	26.5
Dryer	137.3	15.3
Waterbed	48.1	7.8
Washing Machine	24.2	25.5
Microwave	87.3	21.4
Miscellaneous	31.7	33.2
Computers	80.9	19.7

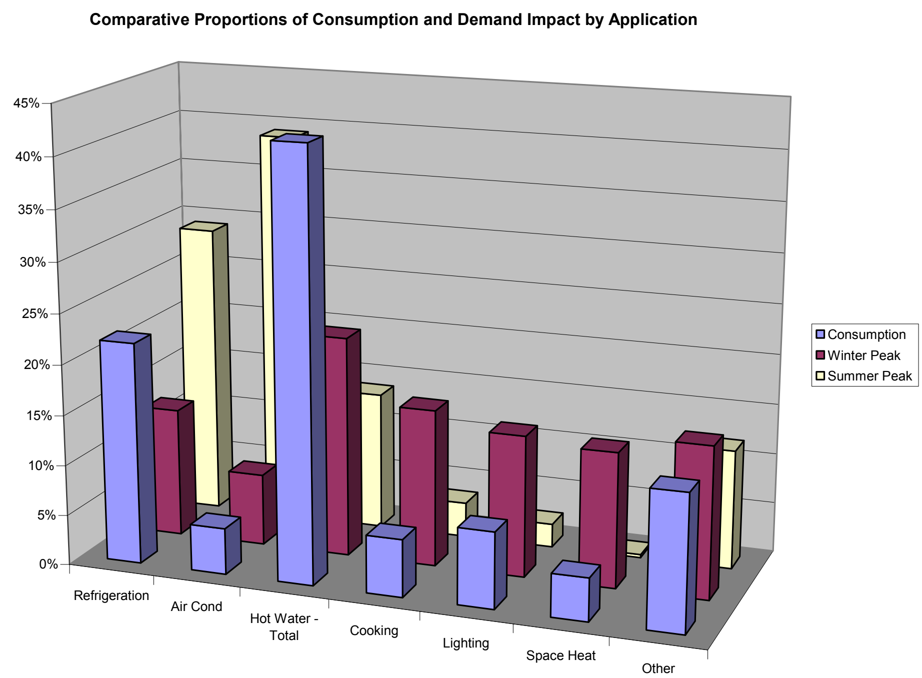

Figure 4.3 – Residential Sector – Comparative Proportions of Consumption and Demand Impact by Application

Each of the demand impact factors (refer to Table 4.2) was applied to the EEIs identified in the EMET/SEAV[3] and GWA/SEAV[4] studies for the residential sector and an estimate of the electricity demand reduction potential was made for each case. The results are shown in Table 4.3 (for the 4 year and 6.5 year payback ex. BAU cases). Also, Figure 4.4 compares the results for both the 4 year and 6.5 year payback cases (ex. BAU). Refer to Appendix 2 for a full tabulation of the results for the two payback cases.

The largest contributor to the Summer peak reduction for the 4 year payback case is Refrigeration at 91 MW. Cooking is the largest contributor to the Winter reduction at a level of 332 MW. The latter is followed closely by Refrigeration at 223 MW and On-demand Hot Water systems at 183 MW.

The total Summer and Winter impacts from the 4 year payback initiatives are 278 MW and 850 MW demand reductions respectively, beyond business as usual.

The 6.5 year payback case includes a major addition to the demand reduction potential from improvements in the Building Shell resulting in total Summer and Winter impacts of 951 MW and 359 MW demand reductions respectively, beyond business as usual.

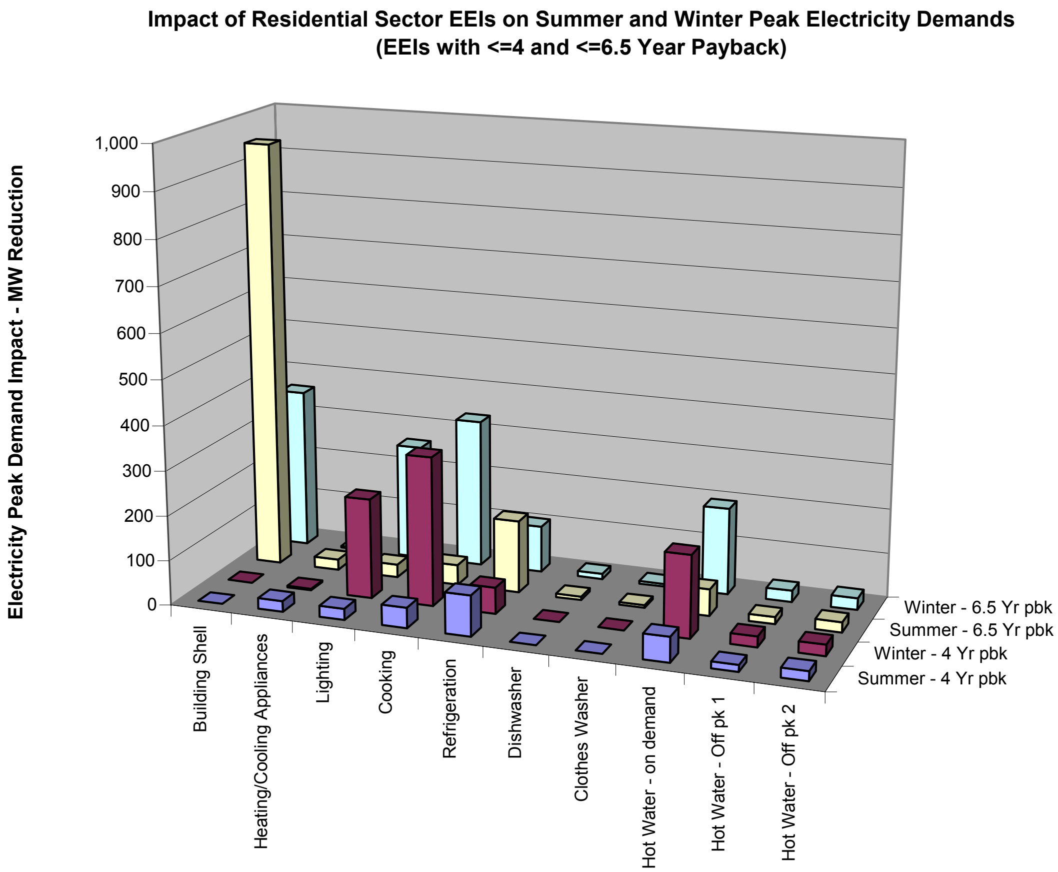

Figure 4.4 – Estimated Impact of Residential Sector EEIs on Peak Summer and Winter Electricity Demand Levels (4 year and 6.5 year payback periods ex. BAU)

Table 4.3 a & b: Residential Sector – Estimated Reduction in Peak Electricity Demand Levels by the Application of Cost-effective EEIs (4 and 6.5 year payback ex BAU)

a) 4 Year Payback Case

Sector Totals	Electricity Saving - PJ pa	Summer Peak Demand Reduction - MW	Winter Peak Demand Reduction - MW
Building Shell	0	0	0
Heating/Cooling Appliances	0.10	24	4
Lighting	2.34	25	223
Cooking	2.16	45	332
Refrigeration	1.96	91	59
Dishwasher	0.00	0	0
Clothes Washer	0.00	0	0
Hot Water - on demand	3.68	56	183
Hot Water - Off pk 1	4.68	15	24
Hot Water - Off pk 2	1.25	21	25
TOTALS	**16.16**	**278**	**850**

b) 6.5 Year Payback Case

Sector Totals	Electricity Saving - PJ pa	Summer Peak Demand Reduction - MW	Winter Peak Demand Reduction - MW
Building Shell	3.83	951	359
Heating/Cooling Appliances	0.10	24	4
Lighting	2.71	29	259
Cooking	2.16	45	332
Refrigeration	3.51	162	105
Dishwasher	0.29	8	12
Clothes Washer	0.24	6	6
Hot Water - on demand	3.91	60	195
Hot Water - Off pk 1	4.97	16	26
Hot Water - Off pk 2	1.33	23	26
TOTALS	**23.04**	**1,324**	**1,323**

5 References

1. EMET/MEU - *NSW Electricity Demand Study 2003* - EMET Consultants Pty Limited for the NSW Ministry of Utilities and Energy, October 2003

2. EMET/SEAV – *Energy Efficiency Improvement in the Commercial Sub-Sectors* – EMET Consultants Pty Limited for SEAV, February 2004

3. EMET/SEAV – *Energy Efficiency Improvement in the Residential Sector* - EMET Consultants Pty Limited for SEAV, March 2004

4. GWA/SEAV - *NFEE – Energy efficiency improvement potential case studies, residential water heating* -George Wilkenfeld and Associates for the SEAV, February 2004

5. Armstrong, G., SEAV, *Preliminary Assessment of Demand-Side Energy Efficiency Improvement Potential and Costs,* SEAV, November 2003.

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6 Appendixes

Appendix 1 – Electricity Demand Impact by individual Commercial Sector EEIs

Appendix 2 – Electricity Consumption and Demand Reduction Potential by Residential Sector EEIs

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Appendix 1 – Electricity Demand Impact by individual Commercial Sector EEIs

Table A1.1 lists the energy saving initiatives used in the analysis of EEIs in the Commercial Sector analysis (EMET[2]).

Table A1.2 lists the electricity demand impact factor applicable to each EEI as a proportion of electricity consumption (ie. the level of electricity demand applicable at the time of peak Summer and Winter system demand times, to the electricity consumption related to each initiative). This factor is shown in the units of MW/PJ and the initiatives are listed in a decreasing order of cost-effectiveness.

The codes used to identify each initiative relate to the list in Table A1.1. For example, the initiative code LGHTS-7.2c refers to the use of metal halide lamps in external areas of new[4] buildings, in place of the less efficient fluorescent and/or mercury vapour lamps.

Tables A1.3 lists the (raw) annual energy savings achieved in the various commercial sub-sectors, when implementing all EEI measures with paybacks up to and including 4-years. Tables A1.4 and A1.5 list the Summer and Winter potential electricity peak demand reduction by the application of each EEI across each of the sub-sectors analysed in the Commercial Sector Study[2].

4 The additional designator in the form of a letter is also used to determine the type of building to which the specific option refers. The letter "a" is used for existing buildings which have not undergone refurbishment by the year 2010 the letter "b" is used for existing buildings which will undergo refurbishment by the year 2010 and the letter "c" is used for new buildings.

Table A1.1: Categories of Greenhouse Gas Abatement Initiatives included in the Analysis Tool

System	Designator	Type of Initiative
Lighting	1	Lighting Control Systems for Internal Lighting
Lighting	1.1	Zone Control of Lighting
Lighting	1.2	Daylight Control
Lighting	1.3	Individual Lighting Controls for Offices, Stores etc.
Lighting	2	Conducting Lighting Surveys
Lighting		
Lighting	3	Lighting Control Systems for External and Common Area Lighting
Lighting		
Lighting	4	Regular Maintenance of Lighting Systems
Lighting		
Lighting	5	Replacement of Incandescents with Fluorescents
Lighting	5.1	Replacement of Incandescents with standard Fluorescent Fittings
Lighting	5.2	Replacement of Incandescents with Compact Fluorescent Lamps
Lighting	5.3	Replacement of Dimmed Incandescent Installations
Lighting		
Lighting	6	Replace Ballasts, and Luminaires for Fluorescent Lamps
Lighting	6.1	Installation of Super Low Loss Ballasts
Lighting	6.2	Installation of High Frequency Ballasts
Lighting	6.3	Installation of High Efficiency Luminaires.
Lighting		
Lighting	7	Replace Exterior MV and Fluor'nt Lamps with Metal Halide and High Press. Sodium
Lighting	7.1	High Pressure Sodium Installation
Lighting	7.2	Metal halide Lamp Installation
Lighting		
Lighting	8	Natural Efficiency Improvement in New Buildings
HVAC	1	Application of Outside Air Cycles
HVAC	1.1	Low Cost - Existing Buildings
HVAC	1.2	Medium Cost - Existing Buildings
HVAC	1.3	Difficult applications
HVAC	1.4	New Buildings
HVAC	2	Consolidation of Central Heating
HVAC	2.1	Institutional Buildings
HVAC	2.2	Commercial Buildings
HVAC	2.3	Elimination of Poor Efficiency in Design
HVAC	3	Calibration of Controls and their Regular Maintenance
HVAC	4	Improving Thermal Performance of Buildings
HVAC	4.1	Insulation in Community Services Buildings
HVAC	4.2	Major Improvements
HVAC	5	Efficient New Building Developments
HVAC	5.1	Basic Improvement in the Efficiency of New Buildings
HVAC	5.2	Optimising Designs for Maximum Efficiency
HVAC	5.3	Retrofit features applied to new buildings to recover opportunities not covered under the original design.
HVAC	6	Optimisation of Fans, Pumps, and Motors
HVAC	7	Optimisation of Equipment Stop/Start Control
Processes & Other	1	Alternative Means of Water Heating
Processes & Other	2	Hot Water System Management
Processes & Other	3	Cooking Equipment Management
Processes & Other	4	Refurbishment of Lift Controls
Processes & Other	5	Improved Control of Office Equipment

Table A1.2: Electricity Demand Impact Factors by EEI

FACTORS by EEI TYPE	Winter	Summer
	MW/PJ	MW/PJ
LGHTS-7.2c	51.8	64.5
LGHTS-7.2b	51.8	64.5
LGHTS-7.1c	51.8	64.5
LGHTS-7.1b	51.8	64.5
HVAC-Option 5.1	25.3	72.7
HVAC-Option 3.1	10.1	142.0
LGHTS-8	51.8	64.5
PROC-Option 3.3	48.9	26.4
PROC-Option 2.3	34.0	59.0
OTHR-Option 5.2	36.1	56.6
OTHR-Option 4.1	73.9	73.9
OTHR-Option 5.1	36.1	56.6
LGHTS-2a	51.8	64.5
LGHTS-2b	51.8	64.5
LGHTS-2c	51.8	64.5
HVAC-Option 1.4	25.3	72.7
HVAC-Option 1.1	10.1	142.0
LGHTS-4c	51.8	64.5
LGHTS-7.2a	51.8	64.5
LGHTS-7.1a	51.8	64.5
LGHTS-4b	51.8	64.5
LGHTS-4a	51.8	64.5
LGHTS-3c	51.8	64.5
HVAC-Option 1.2	10.1	142.0
LGHTS-3a	51.8	64.5
LGHTS-3b	51.8	64.5
PROC-Option 1.3	34.0	59.0
LGHTS-1.1c	51.8	64.5
HVAC-Option 5.3	25.3	72.7
PROC-Option 1.4	34.0	59.0
LGHTS-1.1a	51.8	64.5
LGHTS-1.1b	51.8	64.5
LGHTS-5.2a	51.8	64.5
LGHTS-5.2b	51.8	64.5
PROC-Option 1.2	34.0	59.0
PROC-Option 3.1	48.9	26.4
LGHTS-1.2b	51.8	64.5
LGHTS-1.2a	51.8	64.5
LGHTS-1.3c	51.8	64.5
HVAC-Option 7.1	25.3	72.7
LGHTS-6.1b	51.8	64.5
LGHTS-1.2c	51.8	64.5
LGHTS-6.1c	51.8	64.5
LGHTS-1.3b	51.8	64.5
LGHTS-1.3a	51.8	64.5
PROC-Option 2.2	34.0	59.0

HVAC-Option 6.1	34.3	61.9
LGHTS-6.2b	51.8	64.5
LGHTS-5.2c	51.8	64.5
PROC-Option 3.2	48.9	26.4
LGHTS-6.3b	51.8	64.5
LGHTS-6.2c	51.8	64.5
LGHTS-6.3c	51.8	64.5
HVAC-Option 1.3	10.1	142.0
HVAC-Option 5.2	25.3	72.7
LGHTS-6.2a	51.8	64.5
PROC-Option 1.1	34.0	59.0
HVAC-Option 4.2	73.9	73.9
LGHTS-5.1c	51.8	64.5
LGHTS-5.1b	51.8	64.5
LGHTS-5.3c	51.8	64.5
LGHTS-5.3a	51.8	64.5
LGHTS-5.3b	51.8	64.5
LGHTS-5.1a	51.8	64.5
LGHTS-6.1a	51.8	64.5
LGHTS-6.3a	51.8	64.5
HVAC-Option 2.3	22.9	33.1
HVAC-Option 2.1	22.9	33.1
HVAC-Option 2.2	22.9	33.1
HVAC-Option 4.1	25.3	72.7
PROC-Option 2.1	34.0	59.0

Table A1.3: Annual Electricity Savings in Commercial Sub-Sectors by EEI in 2010

SubSector	Wholesale/ Retail	Accomm & Rest'nts	Communic.	Financial Services	Govern't Services	Culture & Recreat'n	TOTAL Commercial Sector
EEI Type	***PJ pa***	***PJ pa***	***PJ pa***	***PJ pa***	***PJ pa***	***PJ pa***	***PJ pa***
LGHTS-7.2c	0.07	0	0	0.02	0.03	0.01	**0.13**
LGHTS-7.2b	0.09	0.01	0	0.02	0.03	0.01	**0.16**
LGHTS-7.1c	0.15	0.01	0	0.03	0.06	0.01	**0.26**
LGHTS-7.1b	0.19	0.01	0	0.04	0.07	0.01	**0.32**
HVAC-Option 5.1	0.2	0.04	0.03	0.24	0.27	0.06	**0.84**
HVAC-Option 2.3	0	0	0	0	0	0	**0**
HVAC-Option 3.1	0.27	0.05	0.04	0.35	0.51	0.11	**1.33**
LGHTS-8	1.03	0.06	0.03	0.24	0.4	0.08	**1.84**
PROC-Option 3.3	2.72	0.45	0.02	0.38	0.39	0.23	**4.19**
PROC-Option 2.3	0.99	0.2	0	0.44	0.89	0.23	**2.75**
OTHR-Option 5.2	0.66	0.12	0.1	0.56	0.86	0.09	**2.39**
OTHR-Option 4.1	0.01	0.14	0.01	0.06	0.19	0.05	**0.46**
OTHR-Option 5.1	0.5	0.09	0.08	0.42	0.86	0.07	**2.02**
LGHTS-2b	0.25	0.02	0.01	0.06	0.1	0.02	**0.46**
LGHTS-2a	0.37	0.02	0.01	0.08	0.11	0.03	**0.62**
LGHTS-2c	0.17	0.01	0	0.04	0.08	0.01	**0.31**
HVAC-Option 1.4	0.04	0.01	0.01	0.04	0.04	0.01	**0.15**
HVAC-Option 1.1	0.04	0.01	0.01	0.05	0.06	0.01	**0.18**
LGHTS-4c	1.13	0.07	0.03	0.26	0.58	0.09	**2.16**
LGHTS-7.2a	0.07	0.01	0	0.03	0.04	0.01	**0.16**
LGHTS-7.1a	0.15	0.02	0.01	0.06	0.11	0.02	**0.37**
LGHTS-4b	0.65	0.04	0.02	0.15	0.33	0.05	**1.24**
LGHTS-4a	0.97	0.06	0.03	0.22	0.37	0.08	**1.73**
LGHTS-3c	0.22	0.01	0.01	0.05	0.12	0.02	**0.43**
PROC-Option 1.3	0.2	0.04	0	0.09	0	0.05	**0.38**
HVAC-Option 1.2	0.09	0.02	0.01	0.1	0	0.03	**0.25**
LGHTS-3a	0.58	0.04	0.01	0.13	0.33	0.05	**1.14**
LGHTS-3b	0.38	0.02	0.01	0.09	0.22	0.03	**0.75**
PROC-Option 1.4	1.31	0.26	0	0.36	0	0.19	**2.12**
LGHTS-1.1c	0.87	0.05	0.02	0.2	0.52	0.07	**1.73**
HVAC-Option 5.3	0.76	0.21	0.13	0.42	0.78	0.17	**2.47**
PROC-Option 3.1	0	0.23	0	0.1	0	0	**0.33**
LGHTS-1.1b	1.17	0.07	0.03	0.27	0	0.09	**1.63**
LGHTS-1.1a	1.75	0.11	0.05	0.4	0.8	0.14	**3.25**
LGHTS-5.2b	1.12	0.07	0.03	0.26	0.54	0.09	**2.11**
LGHTS-5.2a	1.68	0.11	0.04	0.39	0.65	0.13	**3**
HVAC-Option 2.2	0	0	0	0.05	0	0	**0.05**
PROC-Option 1.2	0	0.56	0	0	0	0	**0.56**
TOTALS	**20.85**	**3.25**	**0.78**	**6.7**	**10.34**	**2.35**	**44.2**

Table A1.4: Summer Peak Electricity Demand Reduction Potential by EEI

SubSector	Wholesale / Retail	Accomm & Rest'nts	Communic.	Financial Services	Govern't Services	Culture & Recreat'n	TOTAL Commercial Sector
EEI Type	***MW***	***MW***	***MW***	***MW***	***MW***	***MW***	***MW***
LGHTS-7.2c	4.7	0.3	0.1	1.1	1.8	0.4	**8.3**
LGHTS-7.2b	5.7	0.4	0.1	1.3	2.2	0.4	**10.2**
LGHTS-7.1c	9.8	0.6	0.3	2.2	3.8	0.8	**17.4**
LGHTS-7.1b	12.0	0.7	0.3	2.8	4.6	0.9	**21.4**
HVAC-Option 5.1	14.4	3.1	2.3	17.7	19.6	4.2	**61.2**
HVAC-Option 2.3	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
HVAC-Option 3.1	38.9	6.6	5.4	49.7	72.4	15.1	**188.1**
LGHTS-8	66.4	4.1	1.7	15.2	25.5	5.2	**118.2**
PROC-Option 3.3	71.9	11.9	0.4	10.1	10.2	6.0	**110.5**
PROC-Option 2.3	58.5	11.7	0.3	25.9	52.2	13.6	**162.2**
OTHR-Option 5.2	37.5	6.7	5.8	31.5	48.9	5.2	**135.5**
OTHR-Option 4.1	0.2	10.6	0.5	4.7	13.8	3.6	**33.4**
OTHR-Option 5.1	28.1	5.1	4.3	23.6	48.9	3.9	**113.9**
LGHTS-2b	15.9	1.0	0.4	3.7	6.1	1.2	**28.4**
LGHTS-2a	23.9	1.5	0.6	5.5	6.9	1.9	**40.2**
LGHTS-2c	11.0	0.7	0.3	2.5	5.0	0.9	**20.2**
HVAC-Option 1.4	2.6	0.5	0.4	3.0	3.0	0.8	**10.3**
HVAC-Option 1.1	5.7	1.2	0.8	6.8	8.3	1.9	**24.6**
LGHTS-4c	72.9	4.6	1.9	16.7	37.4	5.7	**139.1**
LGHTS-7.2a	4.7	0.5	0.2	2.0	2.5	0.7	**10.6**
LGHTS-7.1a	9.7	1.1	0.5	4.1	6.9	1.4	**23.8**
LGHTS-4b	41.8	2.6	1.1	9.6	21.5	3.3	**79.8**
LGHTS-4a	62.7	3.9	1.6	14.4	24.2	4.9	**111.7**
LGHTS-3c	14.4	0.9	0.4	3.3	7.6	1.1	**27.7**
PROC-Option 1.3	11.7	2.3	0.1	5.2	0.0	2.7	**22.0**
HVAC-Option 1.2	12.4	2.6	1.8	14.6	0.0	4.0	**35.4**
LGHTS-3a	37.2	2.3	1.0	8.5	21.2	2.9	**73.2**
LGHTS-3b	24.8	1.5	0.6	5.7	14.2	1.9	**48.8**
PROC-Option 1.4	77.5	15.5	0.0	21.5	0.0	11.0	**125.6**
LGHTS-1.1c	56.2	3.5	1.4	12.9	33.6	4.4	**112.1**
HVAC-Option 5.3	55.4	15.0	9.6	30.5	57.0	12.2	**179.6**
PROC-Option 3.1	0.0	6.1	0.1	2.6	0.0	0.0	**8.7**
LGHTS-1.1b	75.2	4.7	1.9	17.3	0.0	5.9	**105.0**
LGHTS-1.1a	112.8	7.0	2.9	25.9	51.5	8.8	**209.1**
LGHTS-5.2b	72.4	4.5	1.9	16.6	35.2	5.7	**136.3**
LGHTS-5.2a	108.7	6.8	2.8	24.9	41.9	8.5	**193.6**
HVAC-Option 2.2	0.0	0.0	0.0	1.6	0.0	0.0	**1.6**
PROC-Option 1.2	0.0	33.2	0.0	0.0	0.0	0.0	**33.2**
TOTALS	**1257.5**	**185.5**	**53.8**	**445.2**	**687.8**	**151.0**	**2780.8**

Table A1.5: Winter Peak Electricity Demand Reduction Potential by EEI

SubSector	Wholesale / Retail	Accomm & Rest'nts	Communic.	Financial Services	Govern't Services	Culture & Recreat'n	TOTAL Commercial Sector
EEI Type	***MW***	***MW***	***MW***	***MW***	***MW***	***MW***	***MW***
LGHTS-7.2c	3.8	0.2	0.1	0.9	1.4	0.3	**6.7**
LGHTS-7.2b	4.6	0.3	0.1	1.1	1.8	0.4	**8.2**
LGHTS-7.1c	7.8	0.5	0.2	1.8	3.0	0.6	**14.0**
LGHTS-7.1b	9.6	0.6	0.2	2.2	3.7	0.8	**17.2**
HVAC-Option 5.1	5.0	1.1	0.8	6.1	6.8	1.5	**21.3**
HVAC-Option 2.3	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
HVAC-Option 3.1	2.8	0.5	0.4	3.5	5.1	1.1	**13.3**
LGHTS-8	53.3	3.3	1.4	12.2	20.5	4.2	**94.9**
PROC-Option 3.3	133.1	22.0	0.8	18.7	18.8	11.0	**204.5**
PROC-Option 2.3	33.7	6.8	0.2	14.9	30.1	7.8	**93.5**
OTHR-Option 5.2	23.9	4.3	3.7	20.1	31.2	3.3	**86.4**
OTHR-Option 4.1	0.2	10.6	0.5	4.7	13.8	3.6	**33.4**
OTHR-Option 5.1	17.9	3.2	2.8	15.0	31.2	2.5	**72.6**
LGHTS-2b	12.8	0.8	0.3	2.9	4.9	1.0	**22.8**
LGHTS-2a	19.2	1.2	0.5	4.4	5.5	1.5	**32.3**
LGHTS-2c	8.8	0.5	0.2	2.0	4.0	0.7	**16.3**
HVAC-Option 1.4	0.9	0.2	0.1	1.0	1.0	0.3	**3.6**
HVAC-Option 1.1	0.4	0.1	0.1	0.5	0.6	0.1	**1.7**
LGHTS-4c	58.6	3.7	1.5	13.4	30.0	4.6	**111.8**
LGHTS-7.2a	3.7	0.4	0.2	1.6	2.0	0.5	**8.5**
LGHTS-7.1a	7.8	0.9	0.4	3.3	5.6	1.1	**19.1**
LGHTS-4b	33.6	2.1	0.9	7.7	17.3	2.6	**64.1**
LGHTS-4a	50.4	3.1	1.3	11.6	19.4	3.9	**89.7**
LGHTS-3c	11.5	0.7	0.3	2.6	6.1	0.9	**22.3**
PROC-Option 1.3	6.7	1.4	0.0	3.0	0.0	1.6	**12.7**
HVAC-Option 1.2	0.9	0.2	0.1	1.0	0.0	0.3	**2.5**
LGHTS-3a	29.9	1.9	0.8	6.9	17.1	2.3	**58.8**
LGHTS-3b	19.9	1.2	0.5	4.6	11.4	1.6	**39.2**
PROC-Option 1.4	44.7	9.0	0.0	12.4	0.0	6.3	**72.4**
LGHTS-1.1c	45.1	2.8	1.2	10.4	27.0	3.5	**90.0**
HVAC-Option 5.3	19.3	5.2	3.3	10.6	19.8	4.2	**62.5**
PROC-Option 3.1	0.0	11.2	0.2	4.8	0.0	0.0	**16.2**
LGHTS-1.1b	60.4	3.8	1.6	13.9	0.0	4.7	**84.4**
LGHTS-1.1a	90.7	5.7	2.3	20.8	41.4	7.1	**168.0**
LGHTS-5.2b	58.2	3.6	1.5	13.4	28.2	4.6	**109.5**
LGHTS-5.2a	87.3	5.5	2.3	20.0	33.6	6.8	**155.5**
HVAC-Option 2.2	0.0	0.0	0.0	1.1	0.0	0.0	**1.1**
PROC-Option 1.2	0.0	19.1	0.0	0.0	0.0	0.0	**19.1**
TOTALS	**966.6**	**137.6**	**30.7**	**275.3**	**442.5**	**97.3**	**1950.0**

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Appendix 2 – Electricity Consumption and Demand Reduction Potential by Residential Sector EEIs

Tables A2.1 and A2.2 list the energy saving and electricity demand reduction potential available in the Residential Sector through the application of energy management initiatives within each area of energy application. Table A2.1 shows the summated results of all initiatives with up to and including a 4 year payback period and Table A2.2 includes initiatives to 6.5 year payback. Both tables exclude expected Business as Usual improvements in the sector.

Refer to the relevant EMET[3] and GWA[4] studies for a more detailed discussion of each initiative and methodologies adopted in the calculation of energy saving potential.

Table A2.1 - Energy Consumption and Peak Seasonal Electricity Demand Reduction Potential for the Residential Sector – 4 Year payback

Application	Total Estimated Energy Saving PJ pa	Estimated Electricity Saving PJ pa	Summer Demand Reduction MW	Winter Demand Reduction MW
Building Shell	0.00	0	0	0
Heating/Cooling Appliances	16.89	0.10	24	4
Lighting	2.34	2.34	25	223
Cooking	3.90	2.16	45	332
Refrigeration	1.96	1.96	91	59
Dishwasher	0.00	0.00	0	0
Clothes Washer	0.00	0.00	0	0
Hot Water - on demand*	8.08	3.68	56	183
Hot Water - Off pk 1*	10.28	4.68	15	24
Hot Water - Off pk 2*	2.74	1.25	21	25
TOTALS	**46.19**	**16.16**	**278**	**850**

Notes: * Estimates of total energy and electricity for the "Hot Water" items were derived from the GWA/SEAV[4] study. Estimates for all other applications were sourced from the EMET/SEAV[3] study.

Table A2.2 - Energy Consumption and Peak Seasonal Electricity Demand Reduction Potential for the Residential Sector – 6.5 Year payback

Application	Total Estimated Energy Saving PJ pa	Estimated Electricity Saving PJ pa	Summer Demand Reduction MW	Winter Demand Reduction MW
Building Shell	16.18	3.83	951	359
Heating/Cooling Appliances	23.73	0.10	24	4
Lighting	2.71	2.71	29	259
Cooking	3.90	2.16	45	332
Refrigeration	3.51	3.51	162	105
Dishwasher	0.29	0.29	8	12
Clothes Washer	0.24	0.24	6	6
Hot Water - on demand*	8.39	3.91	60	195
Hot Water - Off pk 1*	10.67	4.97	16	26
Hot Water - Off pk 2*	2.85	1.33	23	26
TOTALS	**72.46**	**23.04**	**1,324**	**1,323**

Notes: * Estimates of total energy and electricity for the "Hot Water" items were derived from the GWA/SEAV[4] study. Estimates for all other applications were sourced from the EMET/SEAV[3] study.

7 Attachments

Attachment 1 – MMA Modelling of Energy System Impacts

The following is a description of the modelling process and options used by McLennan Magasanik Associates (MMA) who are undertaking some work to estimate the energy system impacts - avoided investment in electricity generation plants, network upgrades, etc - for implementing the identified EEI potentials over a certain time period.

The modelling by MMA used this process and made some assumptions about the relationship between the energy efficiency measures and their likely impact on electricity peak demand in the residential, commercial and industrial sectors.

Attachment #1 – MMA modelling of energy system impacts

MMA Modelling of Energy Sector Impacts

The purpose of this modelling is to determine any benefits that might flow from avoided investment in electricity generation plants, network upgrades for both gas and electricity, and any benefits from reduced peak electricity prices, that might arise from introducing the identified energy efficiency potential in the commercial, residential and industrial sectors at a certain rate. This work compliments the economic modelling being undertaken by CoPS Monash, to determine the economy wide impacts.

The MMA modelling uses the Strategist model. This contains a number of generic marketing program options – Load Forecast Adjustment Modules (see below) - that simulate the impact of demand management programs. The peak shave, percent shave and unscheduled shave were selected to most accurately represent how the energy reduction would be distributed across the residential, commercial and industrial sectors, respectively, in the initial modelling.

Load Forecast Adjustment Module

The (LFA) Module is a multi-purpose tool for creating and modifying load forecasts and evaluating marketing and conservation programs. Using the LFA, a strategic planner may address key issues related to future electricity or gas demand and impacts attributed to each customer group.

Because availability of load data is often limited, the LFA is designed to process data at the level of detail readily available. Load data is processed in the LFA by user-defined load groups. It is possible to define these load groups as very detailed or very summary in scope. The LFA categorizes group data based on availability of hourly load shapes. Customer groups for which shapes are not available are processed differently than those with shapes.

The analysis of programs which lack historic data, such as new demand-side technologies, will also benefit from the LFA's unique features. For example, a relamping program may be quickly modelled with estimates of energy savings per customer and reductions in peak demand. The model then schedules the hourly impact of these programs based upon optional rules specified by the user.

Load impacts may be input chronologically for each program, or may be determined by the module based on inputs for peak, energy, and program type. MWh data may be input seasonally or annually. If the user desires, the MWh for each season may be specified as a percent of the annual value. Peak load in MW or as a load factor may be input. If peak loads are not input for a group, peak is determined from input load profiles.

Company peak, energy, and load shape are developed for each season defined in the Strategist database. Seasons are identified by the number of days in each season. A user-defined number of seasons may be modelled. Each season's load shape is represented by a chronological 168-hour load profile called a typical weekly profile.

Data is entered at the group level and consists of a seasonal forecast of non-coincident peak, sales, and a typical weekly shape. This shape may be input as a typical week or the profile can be built from a library of typical daily load shapes; or the profile can be built from a library of typical weekdays, weekend days, and peak days;

The LFA Module first develops energy sales and peak demand for each load group by multiplying the inputs by a user-defined penetration factor (less persistence) and by adjusting for price elasticity impacts. For groups which have shape data input, the LFA compares the load factor of the group shape to the implied load factor in the group peak and sales forecast. Any discrepancy is eliminated by modifying the load profile. Finally, the module develops the group requirements shape by scaling the sales shape by the user input group loss factor for the season.

Once each group has been processed, the hourly profiles are summed to create class load profiles and the class profiles are in turn summed to produce total company loads.

In many instances, peak, energy, and profile data requirements cannot be obtained for every load group represented in the database. In such cases the module will allow the following combinations of minimum data inputs:

1. Load shape and sales forecast. Non-coincident peak will be calculated by fitting the given energy under the given shape.

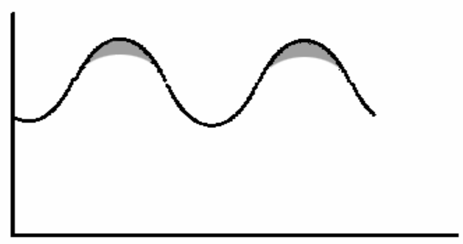
2. Load shape and non-coincident peak. Sales will be developed for each hour by multiplying the normalized shape against the input peak.

Often only the general characteristics of a marketing program are known. For this situation the LFA provides eight generic programs to choose from:

1. Peak Shave	5. Percent Shave
2. Peak Build	6. Percent Build
3. Valley Shave	7. Unscheduled Shave
4. Valley Build	8. Unscheduled Build

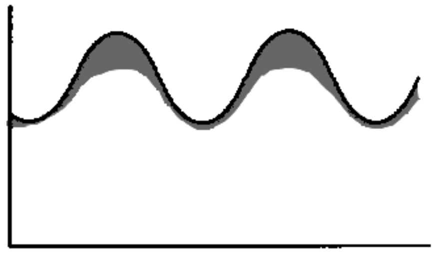
Programs selected for initial modelling
Of these generic marketing programs, peak shave, percent shave and unscheduled shave were selected, for the initial modelling, to most accurately represent how the energy reduction would be distributed across the residential, commercial and industrial sectors, figures showing how these programs are applied are contained at the end of this document.

The residential sector is assumed to have energy savings predominantly occurring during peak periods, the peak shave program assumes savings based on reductions in peak maximum demand and energy consumed during peak periods only.



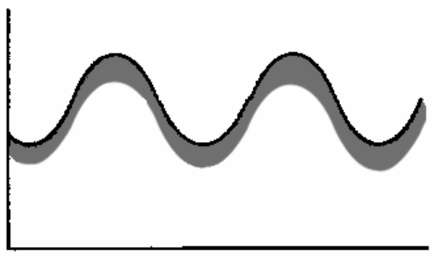
Peak Shave

The commercial sector is assumed to have energy savings occurring during all periods but the majority would be during peak periods. The percent shave program assumes savings based on percentage reductions in maximum demand over all periods ensuring energy savings are met. The load is modified by a certain fraction of base load over all hours; this implies savings predominately occur during peak periods. Note that the reduction is not a percent of the base load but rather the actual peak. For instance, if the base load is 150MW, a peak input of 30MW would correspond to a 20% shave.



Percent Shave

The industrial sector is assumed to have continuous energy savings across all periods. The unscheduled shave program assumes a constant decrease is applied to the base load, best described as flat.



Unscheduled Shave

Marketing programs - general

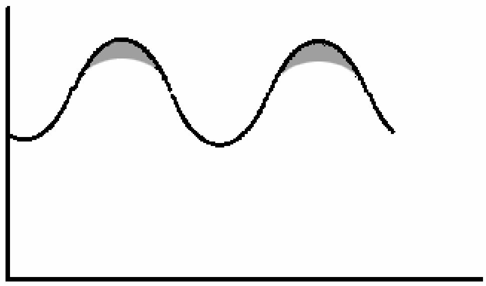
These programs are applied to either class load or company load. The first four (of the 8) programs require peak and energy, and calculate the load shape from the load duration curve so that peak and energy requirements are met.

The remaining four programs require only one input - peak or energy. If both are input, the shape will be modified so that peak and energy are consistent. For example, a program that shifts load from peak hours to non-peak hours can be modelled as a peak shave and a valley build. The peak and valley modifiers are useful when marketing is schedulable.

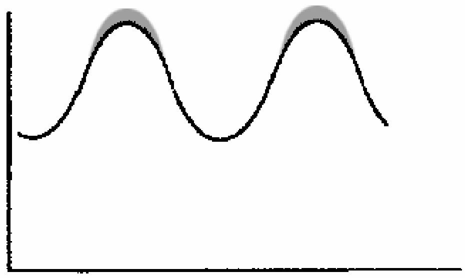
An efficiency program, on the other hand, typically modifies load by a certain fraction of base load over all hours. This is best represented by a percent shave. The user should notice that the input is not percent of the base load but rather the actual peak or energy of this load group. For example, if the base load peak is 150 MW, the load group peak input 30 MW would correspond to a 20% shave/build. Unscheduled builds and shaves, finally, represent marketing programs that are flat, i.e. a constant increase/decrease is applied to the base load.

Marketing programs can be modelled in two ways, depending on whether the load shape is known or not.

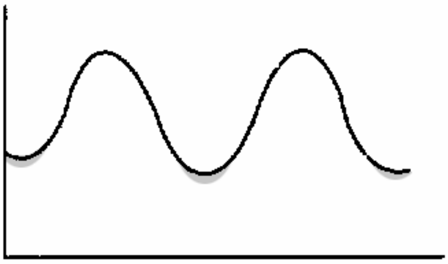
A Load Group representing marketing programs for which load shape data does not exist requires peak and energy forecasts and one of eight standard program types. The model applies these programs directly to either class or company load shapes. Strategist calculates capacity credits for these load groups.



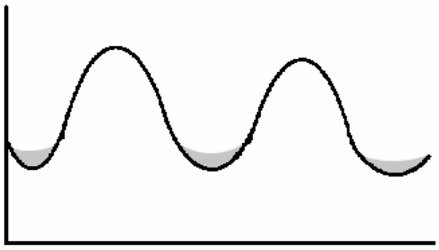
Peak Shave



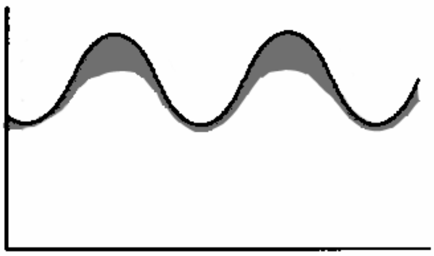
Peak Build



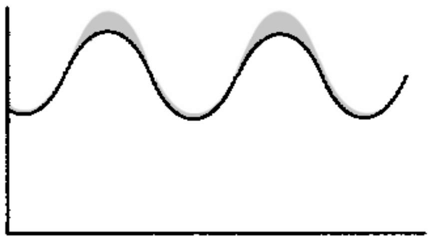
Valley Shave



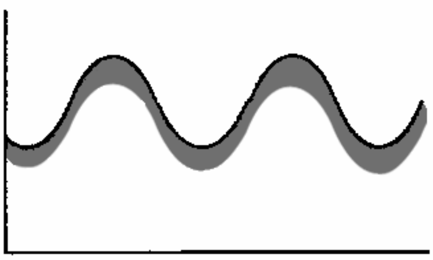
Valley Build



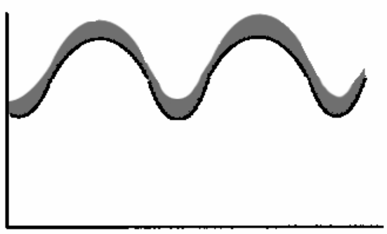
Percent Shave



Percent Build



Unscheduled Shave



Unscheduled Build