NATHERS – Peak Load Performance Module Research

FINAL REPORT

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EXECUTIVE SUMMARY

A methodology for rating residential buildings in both Australia and New Zealand according to their contribution to seasonal peak power demand has been developed. Based on a number of previous investigations it is proposed that heating and cooling appliances be selected as the 'peak' appliances which directly contribute to the household winter or summer peak power demand for each season. Other appliances are treated as the 'base' appliances which contribute to average power demand. The main parameter proposed for rating the peakiness of the household electrical power demand for a dwelling is the peak demand ratio which is defined as the sum of average and the peak heating/cooling power demands divided by the average power demand.

For a dwelling where properly sized conditioning appliances are specified, the 'peak' demand is evaluated as the rated electrical power input of the heating and cooling appliances which can be obtained from the energy rating website (www.energyrating.gov.au). If the appliance information is unavailable or inadequate, the averaged ten highest winter/summer conditioning contribution to peak power at the time period of the local utility peak is used. This information can be deduced from the heating/cooling AccuRate modules. It is proposed that the utility peak demand periods are determined on the basis of local distributors' historical data.

The average power demand is determined using the greenhouse gas emission data / formula developed by the AccuRate GHG module. In evaluating the average power demand using the GHG module formula, the greenhouse gas emission contribution from space conditioning is excluded and local renewable energy generation is included.

It is proposed that a summer or a winter peak demand parameter or both parameters should be considered depending on location.

It is proposed that the next steps are to trial the use of the methodology on a range of house designs subjected to different climatic conditions and to organise a workshop involving various stakeholders to discuss the methodology developed in this module and the implication of its adoption.

1. INTRODUCTION AND AIMS

Increased peak electricity demand has become one of the most serious problems faced by many countries. Power blackouts in developing countries are a daily reality due to increased economic activities. In developed countries including Australia, increased peak demand has resulted in increased electricity cost due to the need for the installation of peaking power plants which serve for very short periods annually, normally during the peak summer days, and the cost of transmission infrastructure necessary to cope with the peak demand. In fact Australia and South Australia in particular is one of the peakiest regions in the world (Origin Energy website, 2008).

Households are one of the main energy consuming sectors; however, their contribution to increasing peak demand has not yet been given sufficient attention. A need for research on the contributions of residential energy (especially energy for air conditioning) to electricity peak demand is considered very important (DEWHA, 2008). However, local household monitoring suggests that households' space conditioning is primerily responsible for the peak demand.

The peak summer demand impacts are expected to increase due to climate change. Depending on the prevailing increase in average air temperature at the Earth's surface (called the global mean temperature change), the frequency of days where temperatures are above 35°C and associated hot spells are expected to increase in a number of sites in Australia (CSIRO, 2007), including major cities of Adelaide, Brisbane, Canberra, Darwin, Hobart, Melbourne and Sydney, all being the sites of the population concentration and industrial activities. This will lead to more locations needing to face up to summer peak demand issues in the future.

According to a report released by Energy Efficient Strategy (EES, 2004), peak electricity demand in Victoria has shifted from winter to summer since the mid 1990s that saw rapid penetration of air conditioners in that State. This is in line with South Australia which also experiences peak demand in summer (Saman, 2003). The general move towards more energy efficient housing while reducing the overall energy use has often increased the gap between average and peak demands.

While *peak demand* is a very well known term, the peak demand issue has not been clearly defined reflecting the complex nature of the issue. The straightforward and easily recognised problem associated with the peak demand is the surge of demand at a relatively short period of time and associated astronomical electricity costs at peak events on the one hand and often constrained capacity to satisfy that demand by the utilities on the other. The less clear issues associated with peak demand include among others the main factors contributing to it and strategies to minimise these causes.

The residential sector is one of the major contributors to greenhouse gas emission with its share of about 20%. Various reports have shown that the residential sector contributes significantly to increasing peak electrical demand (see e.g. Koomey & Brown, 2002; TEPCO, 2004; EES, 2004). On the other hand, the residential sector is among the regular victims of the problems associated with peak demand which it partly creates (ETSA Utilities, 2009). It is therefore important to develop a methodology to assess the household contribution to peak demand which will assist decision makers and relevant parties to take appropriate actions to address related issues.

The objective of the research is to develop a methodology for the ranking of residential buildings in both Australia and New Zealand according to their contribution to seasonal peak power demand.

The proposed peak demand methodology will be incorporated into NatHERS to allow assessment of the contribution of individual residential buildings to seasonal peak power demand and their associated impacts on local energy generation/transmission network.

2. PEAK LOAD: DEFINITIONS AND TIME OF OCCURRENCE

2.1 Definitions

For the purpose of this current module a number definitions of peak load and other related terms have been compiled from various sources and presented here.

The Energy Vortex website (EV, 2008) defines the peak load and other related terms as follows:

Peak load or peak demand
These two terms (i.e. peak load and peak demand) are used interchangeably to denote the maximum power requirement of a system at a given time, or the amount of power required to supply customers at times when need is greatest. They can refer either to the load at a given moment (e.g. a specific time of day) or to averaged load over a given period of time (e.g. a specific day or hour of the day).

Peak supply
This term does not refer to the amount of energy available when supply is at peak. Instead it refers to the party who supplies energy used to meet peak demand requirements. In other words, a peak supply is a supply of energy which will be used to augment existing energy sources during periods of peak demand. As examples, the noontime output of a hydroelectric generator is not considered to be a peak supply. The peak supply is instead the generating unit which produces output for noontime use.

Peaking capacity
Any generating capacity intended to meet peak demand; generating capacity assigned for use as a peak supply.

Baseload supply
This is the actual available power used to meet minimum expected customer requirements at a given time (baseload demand). Baseload supply is not the opposite of baseload demand. It's actually the opposite of peak supply. Price structures for baseload supply tend to run in the opposite direction of prices for peak supply. Baseload supply tend to be steady and relatively cheap, although the fixed costs are normally much higher than peak supply prices. Peak supplies tend to be costly, but fixed costs are

relatively low since the facilities used to generate peak supplies don't have to be in steady operation.

baseload, base load, baseload demand
Most commonly referred to as baseload demand, this is the minimum amount of power that a utility or distribution company must make available to its customers, or the amount of power required to meet minimum demands based on reasonable expectations of customer requirements. Baseload values typically vary from hour to hour in most commercial and industrial areas.

Windows on Washington website (WW, 2008) defines peak heating or cooling load as:

The maximum thermal load to be provided by a heating or cooling system in a house.

Stream Net website:
The maximum electrical demand in a stated period of time.

Low-Income Home Energy Assistance Program Clearinghouse Web site (LIHEAP, 2008) defines peak load as:

The maximum load experienced (e.g., by a customer of a utility system) over a given period of time.

The Canadian Renewable Energy Network website (CERN, 2008):
The electric load at the time of maximum demand.

Alameda Power & Telecom website (APT, 2008):
The maximum demand for electric energy from all of the customers of a utility or over a geographic area. It usually refers to the largest demand experienced during a calendar year, though it can be the largest demand for a month, or other specified period.

PPL Website (PPL, 2008):
The greatest demand that occurred during a specific period of time. Also known as peak demand.

Various definitions of peak load cited above contains two important keywords: *maximum* or *greatest* demand and *specific period of time*. In other words, the peak demand is the maximum or greatest demand at a given period of time.

Koomey and Brown (2002) define various types of peak load as follows:

Peak Load
The maximum simultaneous demand for some portion of the electrical system, typically averaged over an hour. It is typically characterized as annual, daily or seasonal.

System Peak Load
System peak load is measured at the power plant busbar, representing the load served by generating plants.

Coincident Peak Load
The simultaneous peak load for end users (e.g. for an entire utility service territory).
In the current module this term is called the utility peak demand.

Non-coincident Peak Load
The simultaneous peak load for subgroups of end-users (e.g. all industrial customers).

In the current module this term is called the residential peak demand.

Photius website (Photius, 2009) defines two other related terms, the load factor and the average load as follows:

Load factor
The ratio of the average load to peak load during a specified time interval.

Average Load
Energy demand divided by number of operating hours.

2.2 Times of Peak Demand

Times of peak demand relevant to the current module relate to (a) the utility peak demand and (b) the individual household peak demand.

The establishment of the household contribution to utility peak load will be based on the time of occurrence of the utility peak demand.

3. MAJOR FACTORS THAT WILL IMPACT RESIDENTIAL BUILDING CONTRIBUTION TO PEAK DEMAND

3.1 Cooling and heating requirements

Koomey & Brown (2002) revealed that US peak demand in warmer regions "is driven mainly by air conditioning loads on the hottest summer afternoon. For colder regions, peak demand is in the winter, and is driven by the demand for electric heating on the coldest mornings of the year." In Japan, the peak demand occurs in summer due to demand for air conditioning for this period (TEPCO, 2004).

This situation is true in Australia and Zealand. The impact of weather on peak demand is associated with high temperature summer requiring residential houses to switch on air conditioners and low temperatures in winter which prompt some households to use electric heaters. A report prepared by Energy Efficient Strategies for VENCORP (EES, 2004) pointed out that the peak demand always coincides with days of high outdoor temperatures and that this is due mainly to the use of refrigerative air conditioners coinciding with rapid increases in the penetration of air conditioners. The report also noted how the penetration of air conditioning in Victoria has shifted Victorian peak electricity demands period from winter to summer since mid 1990's.

The penetration of air conditioners (including evaporative coolers) in Australia has seen a rapid growth from 1999 onwards, as shown in Figure 1.

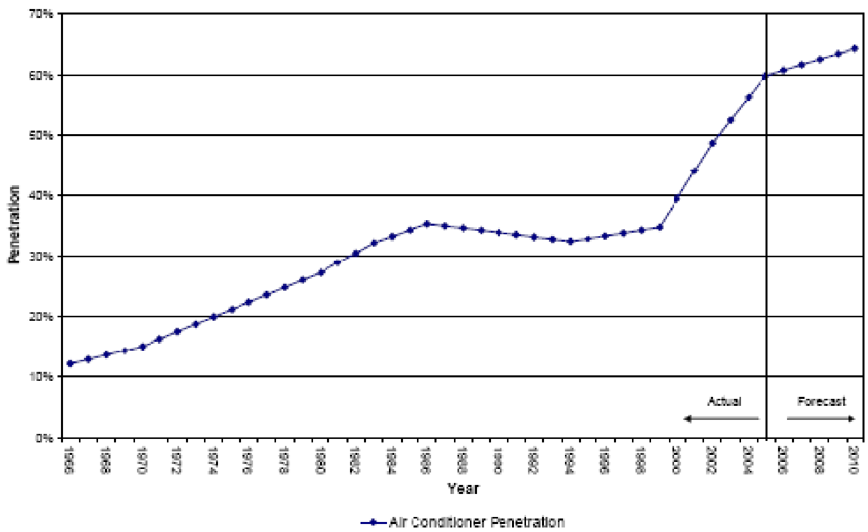

Figure 1 – National Penetration of Air Conditioners 1966 – 2010 (EES, 2006)

Fig. 2, taken from a detailed housing monitoring program carried out by UniSA (Saman, 2003), demonstrates the influence of air conditioning systems on the peak electrical demand of a typical house on a hot Adelaide summer day. The figure demonstrates that cooling energy use is by far the most dominant element of household peak demand. This and other extensive 2 year monitoring data, show that on such days, air conditioners are switched on and operate at full capacity for extended periods of the day. Their electrical input completely dominates the total household electrical power consumption.

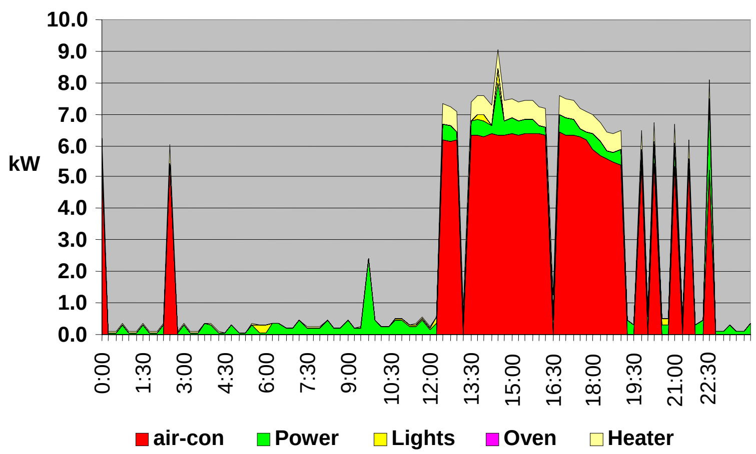

Figure 2 - Electricity Peak Summer Day (Saman et al, 2003)

Fig. 3 shows the peak day load profile for the ETSA utilities system on 8 February 2001 (ESCOSA, 2007). As shown, the utility peak demand occurred at about 16.00 while the residential peak demand occurred two hours later, at about 18.20. This may be due to the fact that during the time of utility peak demand, people are still at work. As the evening approaches, more and more people are getting home and switch their air conditioners and other appliances on. This time offset is important in establishing the appropriate contribution of households to the utility peak demand.

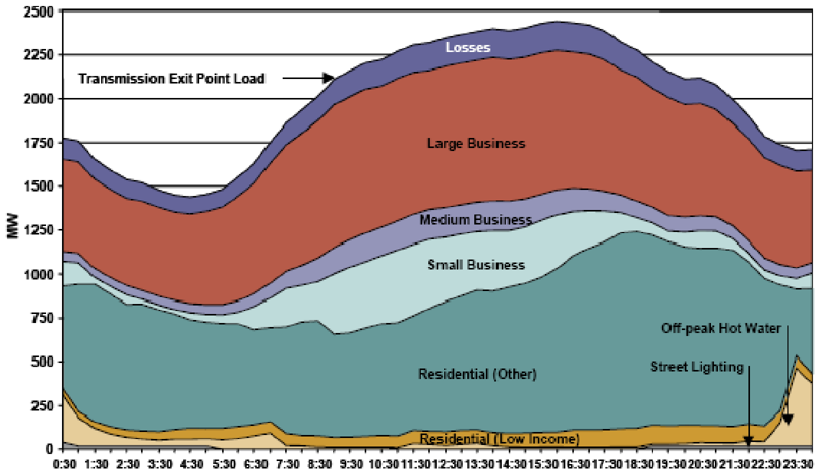

Figure 3 - Peak day load profile for the ETSA utilities system on 8 February 2001 (ESCOSA, 2007)

On a hot day (17 March 2008), the electricity demand peaked at 3172 MW in South Australia, an increase of 218 MW from the previous peak of 2953 MW which occurred on 20 January 2006 (ESCOSA, 2008) as shown in Fig. 4. This figure again shows that the utility peak demand occurred in late afternoon at about 16.30, close to the period of utility peak demand occurrence in 2001 (Fig. 3).

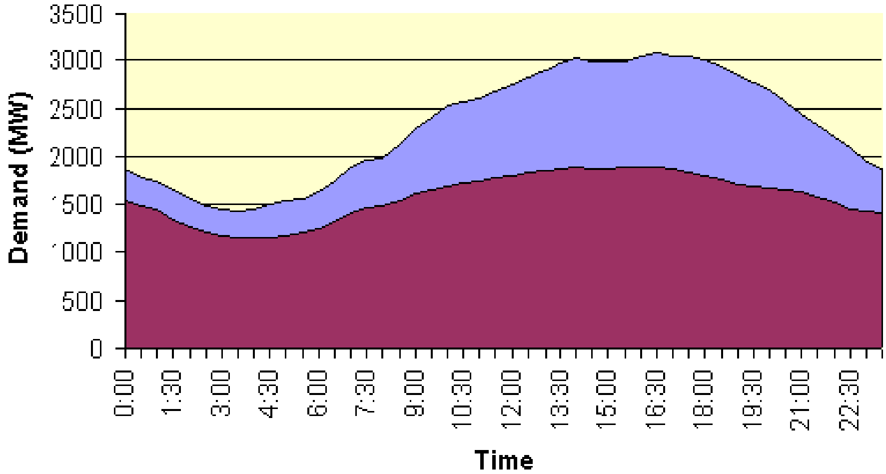

Figure 4 – South Australia's Total System Peak Demand and averaged (dark shaded) across the period 1 December 2007 – 31 March 2008 (ESCOSA, 2008)

Fig. 5 shows the load duration curve for a new residential development and a single air conditioner in South Australia (Oliphant, 2008). These curves show how the peak load takes place during a very short duration in a year which is why it becomes a very serious issue in terms of electricity supply. Similarly, the offset graph indicates that air conditioners are only in service in a very narrow period of the summer and in even narrower period to deal with the very hot days when the peak demand occurs.

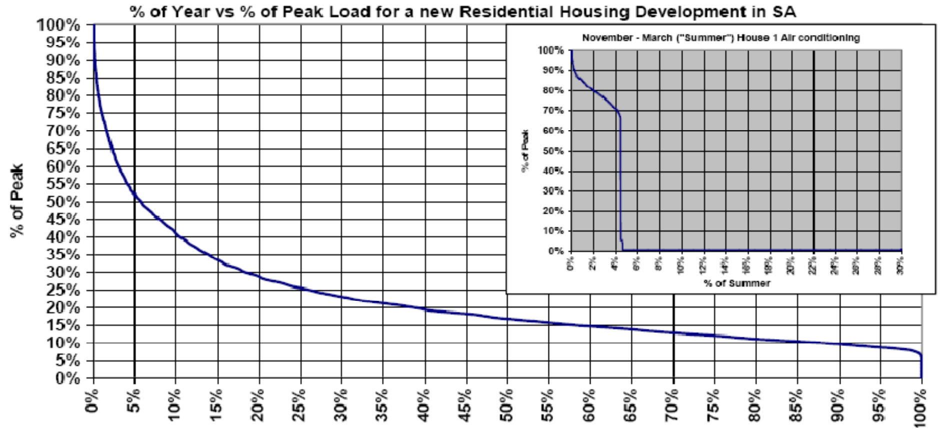

Figure 5 - Load Duration curve for new residential development and a single air Conditioner (Oliphant, 2008)

On the other hand, while generally less significant, the winter peak demand is important in colder climates where electrical heating is widely used. As heating energy sources are more diversified with considerable use of natural gas, liquid fuels and wood, the only relevant component of the peak winter demand is the electrical power used for electrical resistance heaters and reverse cycle air conditioners.

Figs. 6 and 7 show the 10 year data for South Australian peak winter demand during the 1998-2007 period (ESIPC, 2008). The profile shows a very gradual and nearly linear increase of peak demand during this period. Compared to summer peak demand, the magnitude is below (around 500 MW lower than) the summer peak demand magnitude. However, the embracement of refrigerative heat pumps by more residential houses in preference to gas heating can be expected to further accelerate the winter peak demand increase.

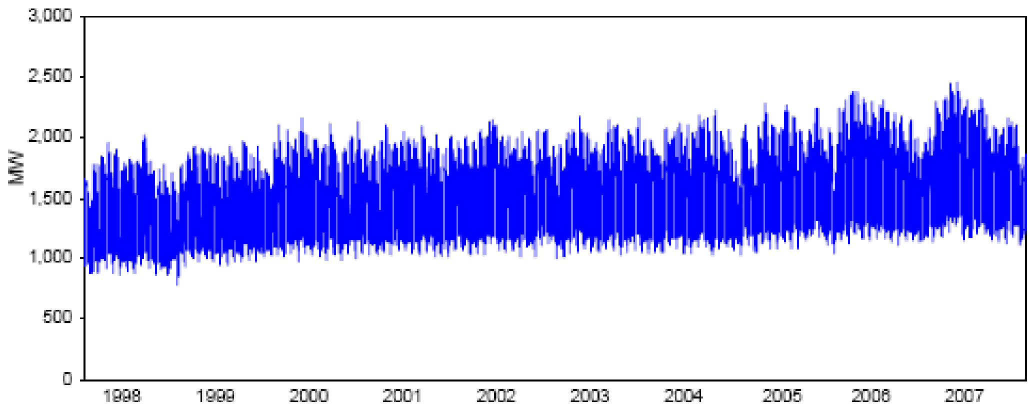

Figure 6 - Half hourly winter demand, 1998 to 2007(ESIPC, 2008)

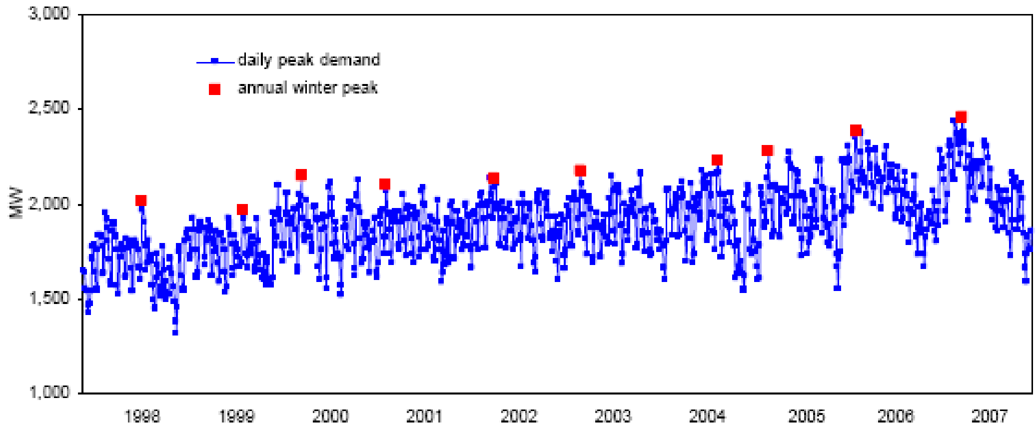

Figure 7 - Daily and annual winter peaks, 1998 to 2007 (ESIPC, 2008)

The time of utility winter peak demand for South Australia in 2007 is shown in Fig. 8 where the peak occurs within the half hour ending at 6.30 pm. This is about 2 – 2.5 hours later than typical summer peak time shown in Figs. 3 and 4.

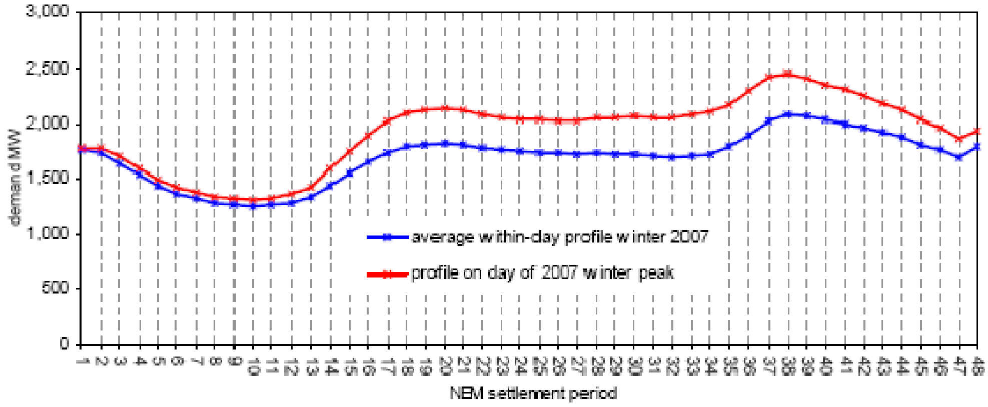

Figure 8 - Winter peak demand on a day in 2007 (each period is of half hour duration) (ESIPC, 2008)

Figs. 9 and 10 present a slightly different situation for New Zealand – a colder country – where winter peak demands are higher than summer peak demands (EC, 2007). However, the main causes of both summer and winter peak demands are the same as those for Australia (Sohel et al., 2009).

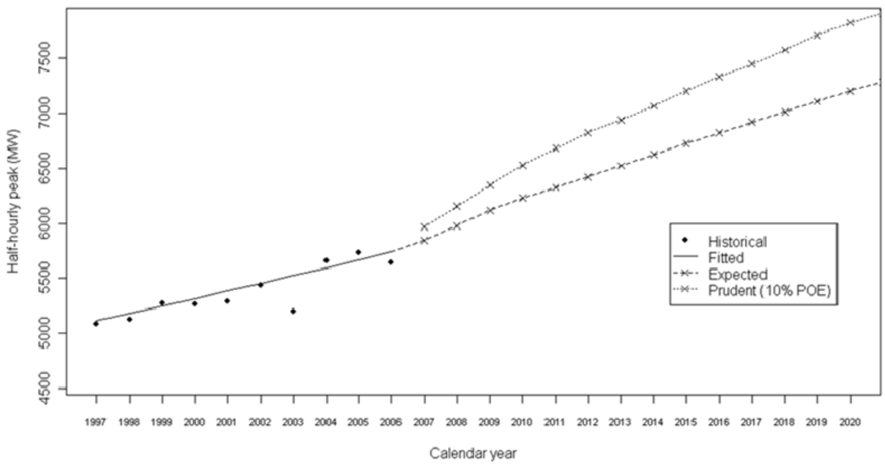

Figure 9 - New Zealand total (historical and predicted) summer peak demands

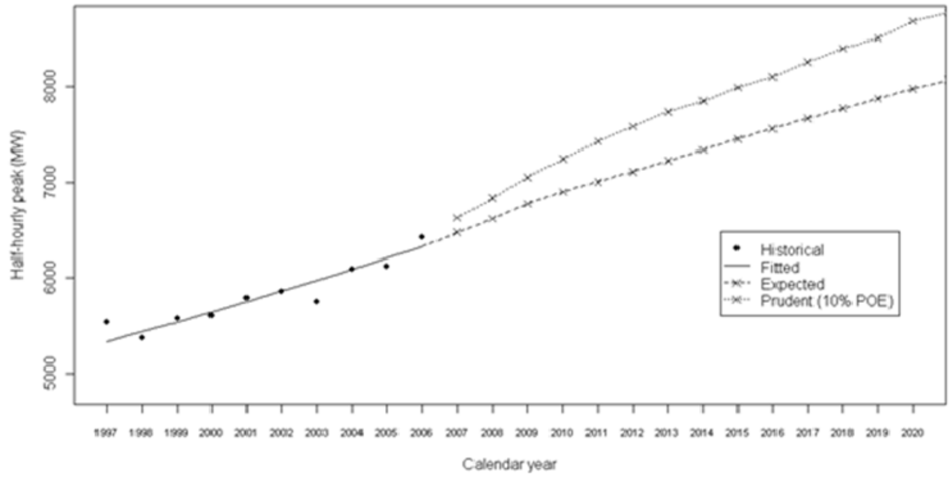

Figure 10 - New Zealand total (historical and predicted) winter peak demands

3.2 Building Shell Performance

For an individual dwelling, the building shell performance is expected to affect peak load due to its direct impact on cooling/heating requirements. The study carried out by EES (2004) on Victoria's state electricity peak load shows that an increase in star rating of the Victorian housing stock from 3.5 to current 5 star rating reduced the peak demand by 533 MW.

However, the rating of the building shell thermal performance, obtained by rating tools such as AccuRate, cannot be linked directly to peak demand. Increased house energy rating may decrease the peak demand but increase the difference between the average demand and peak demand. The exact impact depends on thermal mass and timing of major load components. A study by House Energy Rating (HER, 2007) shows plots of maximum load vs. AccuRate star rating (Fig. 11). The data scatter in the plot confirms that the energy star rating of the building shell cannot be relied upon to give a direct indication of the peak demand.

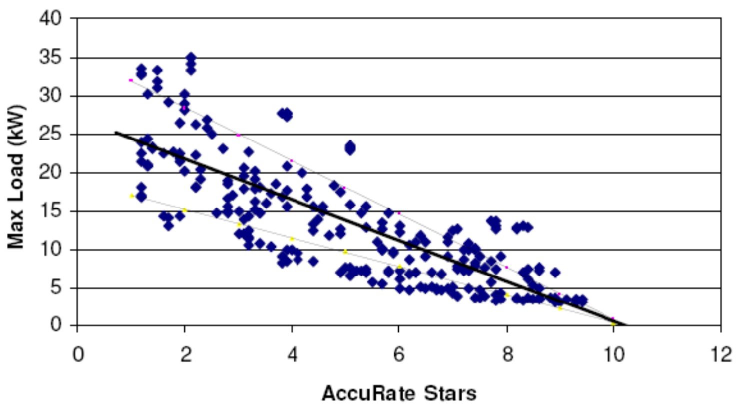

Figure 11 – Peak Load vs. AccuRate Stars (HER, 2007)

3.3 Electrical load of appliances

The rated load of an appliance such as an iron or a fridge may not contribute to the peak load directly, depending on whether it is in operation or not during the peak demand period. However, it may affect the level of base and the peak demands. A smaller size will draw less power irrespective of whether it operates during peak or off peak period. It is the total load from all electrical usage during the period of utility peak demand that decides the contribution to peak demand.

The information on the electrical load of many appliances is available on the energy rating website (www.energyrating.gov.au) and can be used to give an indication of the household average power demand (see Section 4.2 below). Alternatively, the base power demand can be determined from the average power use. This can be determined from household greenhouse gas (GHG) emission calculated using the method developed by the GHG research module after excluding the contribution of heating/cooling appliances. The latter is preferred for use in the proposed methodology as the rating tool needs to be generic and independent of the specific household, the specific appliances, types and patterns of use.

4. PROPOSED METRIC FOR RANKING BUILDINGS ACCORDING TO THE IMPACT ON LOCAL ENERGY NETWORKS OF HOUSEHOLD PEAK LOAD ENERGY DEMAND

4.1 The Peak Demand Ratio

The main parameter proposed for determining the *peakiness* of power demand for a dwelling is the *peak demand ratio* which can be defined as the ratio between the peak power demand to the average power demand (excluding space conditioning) during a specific period. Mathematically, the peak demand ratio (PDR) can be defined as:

$$PDR = \frac{PPD}{APD} \qquad (1)$$

where:
PPD = peak power demand, kW
APD = average power demand excluding space conditioning, kW

The higher this ratio, the longer the energy infrastructure will remain underutilised. Many technical innovations and pricing mechanisms are being introduced in order to shave the peak and reduce this ratio. Accordingly this is the metric being proposed as appropriate for ranking residential buildings to determine their impact on their local energy networks.

The Peak Demand Ratio is the reciprocal of the *load factor* defined in Section 2.1. In view of some uncertainty in the load factor definition, the peak demand ratio is proposed.

4.2 Relation between Peak and Average Power Demands

The peak power demand will incorporate an average power demand component to allow for other energy uses during peak heating/cooling demand periods.

$$PPD = APD + PPL \qquad (2)$$

where:
APD = average power demand excluding space conditioning, kW
PPL = peak portion of the load due to space conditioning (heating or cooling), kW

Table 1 lists representative major appliances contributing to based and peak demands.

Table 1 - Typical 'Base' and 'Peak' Appliances

A	Base load appliances
1	Television/Other entertainment units
2	Fridge
3	Dishwasher
4	Cloth washer
5	Cloth dryer
6	Computer, printer and other home office equipment
7	Lighting, internal and external
8	Electric water heater
9	Electric cooker
10	Microwave oven and other kitchen appliances
B	Peak load appliances
1	Air conditioner (cooling/heating)
2	Electrical resistance heater (various types)

4.3 Determining the household peak demand

For the purpose of rating, two approaches are offered for discussion among stakeholders. The first approach is based on the estimated magnitude of the household power demand for heating/cooling that coincides with the time of utility peak demand. The peak demand based on this definition is evaluated using the cooling module of AccuRate energy rating software. The second focuses on the rated electrical power inputs of all cooling or heating appliances. The peak demand based on this approach can be estimated from the information on the electrical input power of appliances available at the energy rating website (www.energyrating.gov.au).

4.3.1 Household peak demand evaluation using AccuRate and appliance rated power inputs

As shown in Fig. 3, the times of utility and residential peak cooling demands for Adelaide are about 2 hours apart. The utility demand peaks earlier at about 16.00 whilst the household peaks at about 18.00. The main interest for this rating is the portion of household load which coincides with the utility peak demand period. This portion, as explained, may not necessarily represent the household real peak demand. It is therefore reasonable to assume that the individual household contribution to the grid peak demand is somewhat lower than its actual peak demand due to this time offset.

The methodology for evaluation of the household contribution to utility peak demand according to the proposed first approach involves establishing (1) the period of utility peak demand, (2) the pattern of household demand using AccuRate, and (3) the power demand at the time period of the utility peak.

The establishment of the period and magnitude of utility peak demand is discussed in Section 4.4 below.

Referring to Fig. 12, determining the period of household contribution to peak demand using AccuRate involves identification of 10 days with greatest seasonal peak demands from AccuRate's energy.txt file. These values are then converted into electricity demand using relevant EER or COP whose values for most appliances are available from the energy rating website.[1] The profiles of these 10 days of maximum demand are drawn on a Demand vs. Time diagram (M1 – M10). The profile of an averaged values of these demands is also constructed on the same diagram ('AVE'), which peaks at point A. This average profile is used to avoid the extreme value assigned for the peak demand.

As shown, the majority of the profiles peak at 5.00 pm whilst 2 profiles (M-6 and M-7) peak at 7.00 pm. The average profile therefore peaks at 5.00 pm (line (a)).

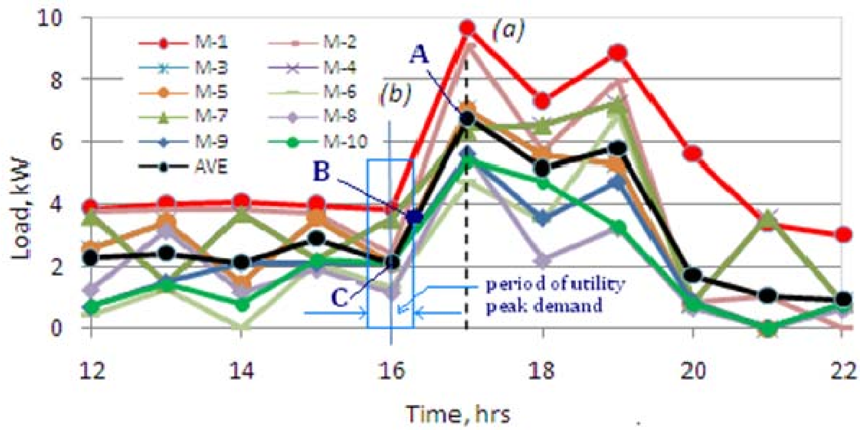

Figure 12 – Demand vs Time showing the Step 3 -5 of the rating methodology

In a practical situation, the profiles shown in Fig. 12 should be smoother were the AccuRate capable of running with time steps less than one hour. This should be taken into account when estimating the real contribution of the residential peak demand to utility peak demand.

Once the period of household peak demand has been established, the actual household contribution to the utility peak demand is represented by point B, the intersection between vertical line (b) and line A-C, the line connecting the point of household peak demand **A** and the household demand at the time of utility peak demand **C**. This value is often lower that the absolute household peak represented by point A.

4.3.2 Household Peak Demand Direct Evaluation

[1] It is assumed that every home to be rated has its heating and cooling appliances specified, otherwise the peak load rating is dependent on the MEPS' lowest energy efficiency ratio which is currently 2.5. For details refer to Appendix 3 of the Cooling Module report (Saman et al., 2009a).

On peak hot/cold days the cooling/heating appliances are expected to operate at full capacity for extended hours of the day including the utility peak (see Fig. 2).

If the above observation is true, then a more simple approach for estimating the household contribution to peak demand can be adopted. That is, simply to assign the household rated electrical power demand of the cooling/heating appliances as the household contribution due to cooling/heating to utility peak demand.

4.4 Determining the period of utility peak demand

For the purpose of this rating, it is proposed that the period of utility peak demand be the period when peak demands averaged over the past 5 consecutive years occurs. Historical data for this should be available for utilities in each jurisdiction. This period should be updated periodically. The duration of the period when the utility peak demand is likely to occur may be half an hour to 2 hours. The duration of the peak demand event should be fixed in various locations after consultation with local electrical utilities.

4.5 Determining the Average Power Demand (APD)

A simple, yet realistic approach to determine the average power demand would be to establish the APD using the greenhouse gas emission data / formula developed by the GHG module after subtracting the components relating to space conditioning (heating/cooling). This is the approach proposed for this rating purpose. As the results of the GHG module are yet to be released, the relevant information required for this purpose will be provided at a later date.

In determining the average electrical power demand, consideration must be given to available local generation capacity from a distributed generation system, including a renewable energy system. The locally generated electrical power coinciding with the peak demand period will be subtracted from the peak power demand in determining the net value for the dwelling. Thus,

$$NPD = PPD - LGP \qquad (4)$$

where:
NPD = net peak electrical power demand, kW
LGP = locally generated electrical power, kW

4.6 Unserviced Zones/Undersized Heating/Cooling Systems

As described in the cooling module report (Saman et al 2009) an unserviced zone is a zone not serviced by any heating or cooling appliance but needs heating / cooling based on AccuRate evaluation. Unserviced zones need to be penalised to anticipate the installation of the cooling / heating system in those zones in a later date. The amount of penalty equal the peak demand predicted by AccuRate subject to appropriate EER or COP. Rating of dwellings including unserviced zones/undersized space conditioning systems can only be carried out using the methodology detailed in section 4.3.1.

5. PEAK DEMAND STAR RATING ASSIGMENT

Once the Peak Demand Ratio of a house has been established, the next step is to translate this value into the number of stars. In Table 2, the same description of star values has been presented. The first line includes the PDR value for the star rating of 10. Since PDR values can range from 1 to infinity, the methodology must set the upper limit (UL) which corresponds to the lowest rating (1 star). The star rating bands can be determined for various climatic zones after analysing the PDR value for representative dwellings around Australia.

As an initial approximation, the relationship between the PDR and the number of stars (STARS) can be assumed to be linear, as shown in Fig. 13.

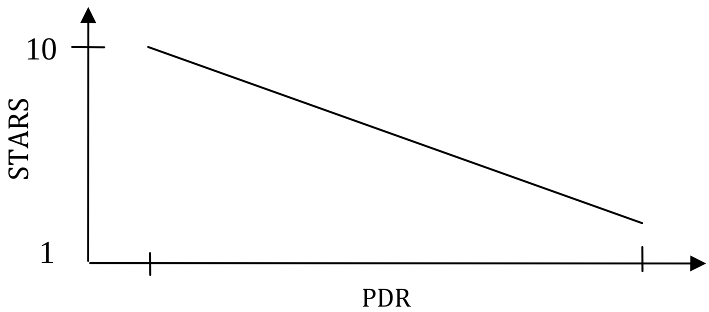

Figure 13 – Assumed linear relationship between PDR and STARS

6. THE DISTRIBUTION CHART OF PEAK LOAD ENERGY DEMAND COMMONLY FOUND IN RESIDENTIAL BUILDINGS IN AUSTRALIA AND NEW ZEALAND

The use of the methodology and the metric described in Section 4 above can be used to evaluate the range of peak demand ratios for the houses in every climate zone. This will enable the establishment of a relationship for calculating the peak load star rating for a house or a unit in multi unit dwellings from the peak demand ratio as shown in Table 2.

Table 2 - Relation between Star Rating and Peak Demand Ratio

Star	Peak Demand Ratio	Description
10	~ 1	Excellent performance, low power demand for heating/cooling and / or compensation by grid connected renewable energy or storage system
4 – 6		Describes a moderately *peaky* home
1		Signifies a dwelling of very high heating/cooling demand, poor thermal house design and low performance heating/cooling system.

It is anticipated that the star band allocation will be determined by Government after consultation with relevant stakeholders. It is anticipated that for most climatic zones, the dominant peak demand will be either during the heating or cooling season. For those cases, the peak season will also be included in the rating (e.g. 5 Star Summer Peak Rating). For dwellings in climatic zones having prominent summer and winter peaks, both ratings will be disclosed (e.g. 7 Star Winter, 4 Star Summer peak demand). The range of peak demand ratios when one or both ratings need to be reported will be fixed in light of the work described in Section 5.

7. THE SET OF DATA TO BE COLLECTED TO PERFORM THE ASSESSMENT

The methodology described above for rating the peak demand of residential building will utilise the dwelling and appliance data required in determining the other rating modules. The only additional data entry required is the time period of the locally generated electrical power during the peak demand event. An addition to the AccuRate engine, an algorithm is required for performing the calculation as shown in Section 8.

8. STEPS FOR RANKING/RATING HOUSEHOLDS BASED ON THEIR CONTRIBUTION TO ELECTRICITY PEAK LOAD

The following is the proposed procedure for rating the household based on its contribution to utility electrical peak load.

1. Establish the utility peak load period from historical data of electrical power demand. Utility peak load data of the last 5 years for various jurisdictions around Australia and New Zealand will be averaged and the time interval where the averaged peak load occur is set as the utility peak load period.
2. Determine the peak demand using the procedure described in Section 4.3.1 or Section 4.3.2, keeping in mind the existence of unserviced/undersized zones.
3. Determine the average peak demand – APD - (weather insensitive component) of the house using the household greenhouse gas emission formula developed by the GHG module with appropriate emission factor.
4. Peak Power Demand (PPD) is the sum of the Average Power Demand (APD) calculated in step 4 and the PPL calculated in step 2.
5. Evaluate the ratio, $PDR = PPD/APD$
6. Rank the house according to the classification discussed in Section 5.

9. CONCLUSIONS AND RECOMMENDATIONS

A methodology for ranking residential buildings in both Australia and New Zealand in terms of their contributions to the utility peak electricity demand has been established. In this methodology, the ranking is based on the *peak demand ratio* defined as the ratio between the peak power demand and the average power demand during a specific period. Residential peak power demand is defined as the power demand as a result of operating 'peak' appliances during the utility peak power period of the relevant season.

The methodology offers two definitions of the household peak demand used for rating, namely: (1) the value of demand calculated at the time of utility peak demand, and (2) the rated input electrical power of the heating/cooling appliances.

Both summer and winter peak demand ratings may be necessary for some Australian/New Zealand locations. When either cooling or heating is the main space conditioning requirement, a single summer or winter rating is sufficient.
For the purpose of rating, it is proposed that the rated electrical input of all electrical heating and cooling appliances be listed in the energy rating website.

It is proposed that the next steps are to trial the use of the methodology to rate a range of dwelling designs subjected to different climatic conditions. It is also recommended that a workshop involving all stakeholders be organised to further discuss the methodology and the implications of its adoption.

10. REFERENCES

APT, 2008: Alameda Power & Telecom website:

www.alamedapt.com/electricity/glossary.html

CERN, 2008: The Canadian Renewable Energy Network website:

www.canren.gc.ca/prod_serv/index.asp

CSIRO, 2007: Climate change in Australia – Technical Report 2007.

Department of the Environment, Water, Heritage and Arts (DEWHA), 2008: *Energy Use in the Australian Residential Sector*, 1986 – 2020.

EC, 2007: LPC and peak demand forecast plots nip N.Z.G. Electricity Commission. http://www.electricitycommission.govt.nz/opdev/modelling/gpas/May2007/Demand/index.html>

EES, 2004: *Electrical Peak Load Analysis – Victoria 1999* – 2003, Energy Efficient Strategies, prepared for VENCORP.

EES, 2006: *Status of Air Conditioners in Australia*, Energy Efficient Strategies - Report to NAEEEC 2005/09 (Updated).

Energy rating website: www.energyrating.gov.au

Origin Energy Website: www.originenergy.com.au/2074/Quarantine-Power-Station-expansion, accessed 7 December 2008.

ESCOSA, 2007: ETSA Utilities Demand Management Program – Progress Report, June. The Essential Services Commission of South Australia

ESCOSA, 2008: ETSA Utilities Demand Management Program – Progress Report, October. The Essential Services Commission of South Australia

ETSA Utilities, 2009: Load Shedding Hits 83 Suburbs, ETSA Utilities Media Release, 30 January 2009.

http://www.etsautilities.com.au/centric/news_information/media_releases/load_shedding_hits_83_suburbs.jsp

ETSA Utilities, 2008: Air conditioners "Beat the Peak" trial to expand following solid results over two summers – Media Release, 8 October 2008.

EV, 2008: Energy Vortex website –

www.energyvortex.com/energydictionary/peak_load__peak_demand.html - accessed 15 November 2008.

www.energyvortex.com/energydictionary/baseload__base_load__baseload_demand.html - accessed 15 November 2008.

HER, 2007: Report into a peak demand performance rating methodology for residential buildings – A report for the Department of Transport, Energy and Infrastructure – SA Government.

Koomey, J. & Brown, R.E., 2002: *The role of building technologies in reducing and controlling peak electricity demand*, Energy Analysis Dept. – Environmental Energy. Technologies Division – Ernest Orlando Lawrence Berkeley National Laboratory – University of California – Berkeley, CA 94720, September – http://enduse.lbl.gov/Info/LBNL-49947.pdf.

LIHEAP, 2008: Low-Income Home Energy Assistance Program Clearinghouse Web site: www.liheap.ncat.org/iutil2.htm

NEMMCO, 2009a: NEMMCO Media Release, Friday 30 January 2009.

NEMMCO, 2009b: *Pricing Event Reports - January 2009*, www.nemmco.com.au/opreports/pricing_jan.html

Oliphant, M. 2003, *South Australian Residential Sector Baseline Study Of Energy Consumption: Final Report*, Sustainable Energy Centre, University of South Australia, Mawson Lakes, Adelaide.

Oliphant, M., 2008: *Household monitoring and intelligent grid*, presented at the Intelligent Grid Cluster Adelaide Industry Forum, Adelaide, 5 December 2008.

Pothius, 2009: www.photius.com/energy/glossaryl.html - accessed March 2009.

PPL, 2008: PPL Website: - www.pplweb.com/glossary.htm - accessed 15 November 2008.

Saman, W. & Bruno, F. 2008, *Developing a methodology for rating evaporative air conditioners*, A report submitted to the Australian Evaporative Air Conditioners Manufacturers.

Saman, W.Y. & Mudge, L.T. 2003, *Development, Implementation and Promotion of a Scoresheet for Household Greenhouse Gas Reduction in South Australia: Final Report*, Sustainable Energy Centre, University of South Australia, Mawson Lakes, Adelaide.

Saman, W., Mudge, L., Halawa, E., Teng, C.Y., Bruno, F., 2009: *ANZHERS – Space Cooling Rating Tool* – Final Report, submitted to Residential Building Efficiency Team – DEWHA, November.

Saman, W., Oliphant, M., Mudge, L. & Halawa, E., 2008: *Study of the Effect of Temperature Settings on AccuRate Cooling Energy Requirements and Comparison with Monitored Data* - Final Report, submitted to Residential Building Efficiency Team – DEWHA, June.

Sernhed, K., 2006: *What's on the top? Household load patterns and peak load problems*, International Energy Efficiency in Domestic Appliances & Lighting Conference - EEDAL'06, 21 – 23 June, UK.

Sohel, M.I., Sellier, M., Brackney, L.J. and Krumdieck, S., Efficiency improvement for geothermal power generation to meet summer peak – Energy Policy (2009), doi:10.1016/j.enpol.2008.12.036.

SN, 2008: Stream Net website:

www.streamnet.org/pub-ed/ff/Glossary/glossarydam.html - accessed 15 November 2008.

TEPCO, 2004: Electricity Market in Japan – Tokyo Electric Power Company website:

http://www.tepco.co.jp/en/news/presen/pdf-1/0406-e.pdf - accessed 27 March 2009 -

WW, 2008: Windows on Washington website –

www.windowsonwashington.net/Pages/Service_/Glossary/GlossaryN-P.aspx - accessed 15 November 2008.