Demand Management & Planning Project

Big Demand, Big Opportunity

A report on the investigations at sites with demand greater than 5 MVA

Public Report
April 2008

NSW Government
Department of Planning

Demand Management and Planning Project

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This public report is an amended version of a confidential report prepared for EnergyAustralia, TransGrid and the NSW Government. Specific references to participating entities have been removed.

Contents

Executive Summary

The 5MVA Investigation (investigations at sites with demand greater than 5 MVA) sought to identify and cost the demand reduction opportunities available at the sites of the largest electricity consumers in inner metropolitan Sydney — those with summer peak demand of at least 5,000 kVA (5 MVA). Large power users matter. Many are included in the NSW Government's Energy Savings Action Plans, administered by the Department of Environment and Climate Change, and the Australian Government's Energy Efficiency Opportunities scheme. Further, an emissions trading scheme is likely to be implemented in the next few years, and it will be the 'big' power consumers that will be most affected — and will need to be affected if the scheme is to be effective.

The 5MVA Investigation identified almost 330 opportunities to reduce peak electrical demand, of which less than one-third were assessed commercially viable. The investigation revealed that identifying (never mind implementing) realistic opportunities to reduce peak electrical demand was much more complex and challenging than expected. The DMPP met the challenge by operating beyond the current market paradigm. For the 5MVA Investigation, the DMPP team developed an 'active facilitative' as opposed to a traditional 'project management' approach.

Active facilitation involved the DMPP team visiting each site and working with management to understand the business and its future plans with a view to identifying demand reduction opportunities that supported the business and its strategy. Project management would have delivered the minimum to meet a scope of work rather than an effective client solution. Active facilitation was necessary because demand management is not well understood by many businesses, and even by some energy sector consultants. At each site, management, the DMPP and a consultant with the specific industry expertise formed a partnership with a common set of objectives. The investigations were tailored to the unique characteristics of each site and the level of expertise of each consultant. The large number of opportunities identified is a direct result of the high level of effort on the part of the DMPP and the extent of its participation and facilitation in the process.

It is clear from the 5MVA Investigation that the actual implementation of significant peak demand reduction will not happen without considerable financial, technical and moral support. The 25 MVA of opportunities assessed as commercially viable, but are not being implemented, raised the question, What matters? It seems money matters — but not as expected — and so does timing. Some pieces of equipment have very long lives so even if an opportunity is identified, the equipment is unlikely to be changed until the end of its useful life. Projects thus need to be timed to fit with the site's capital expenditure schedule.

When consideration is given to the lower than expected take up of the DMPP's offer of funds for feasibility studies and support through measurement and verification, it appears that the most important factor is the extent to which there is in-house technical expertise and resources in energy management. Those organisations with a dedicated and qualified energy manager needed little by way of facilitation to undertake demand management projects. The DMPP concluded that there needs to be at least one dedicated person, either from within the organisation or brought in as a consultant, whose sole task is to manage energy in all its aspects. Otherwise there is no-one in place to sustain any momentum in demand management and, by implication, energy efficiency and greenhouse gas emission reduction.

This begs some big questions:

At what point will carbon trading change the cultural outlook of an organisation?

Will the organisation change, or will the business decide to relocate or even shut down?

The key recommendation from the 5MVA Investigation is for the NSW Government to provide facilitation by establishing a dedicated, full-time, technically-skilled and business-savvy 'Demand and Energy Management Team,' with a mandate and funding access to continue exploring and initiating large-scale and/or widespread opportunities for viable demand reductions and energy efficiencies across the entire state.

Finally, the greatest opportunity to reduce demand and energy may exist when major works are being developed by organisations. This provides an opportunity for regulatory authorities and the proponents to work together to identify an effective solution that minimises demand and energy use for many years to come.

5MVA Investigation in Context

The 5MVA Investigation (investigations at sites with demand greater than 5 MVA) is a key part of the Investigative Works Program of the DMPP. The DMPP was established to meet the conditions of consent for the MetroGrid project — an augmentation of the electricity distribution network by TransGrid (TG) and EnergyAustralia (EA) in the inner metropolitan region of Sydney. It was required to assess, quantify and cost the available demand management resources. This means delivering the following outcomes:

1. A framework for other organisations wishing to reduce consumers' demand for electricity.
2. Identification of the amount and cost of demand reduction opportunities in the inner Sydney region through investigation of power factor correction, load shifting/interruptibility, energy efficiency, fuel switching, cogeneration and energy management in specific areas.
3. Confirmation of actual costs and performance of demand reduction projects.
4. An inventory of emergency standby generators and options for their use for demand management.
5. The aggregation, analysis and extrapolation of findings to provide a consolidated view of the demand management resources in the inner Sydney region.
6. Reports detailing the methodology and summarising the results of the project for use in Sydney and other areas of NSW and for dissemination to the community.

The DMPP's activities are split into three main components:

- Project management and administration
- Investigative works
- Demonstration works.

Investigative works entailed demand studies at major facilities – the approximately 1,000 sites with demand greater than 500 kVA (see Box 1 for an explanation of kVA, MVA and related concepts). The sites cover all classes of consumers, including hospitals and other health facilities; hotels, cinemas, clubs and other hospitality venues; factories; government agencies; multi-dwelling residences; educational facilities; and commercial and retail premises.

The investigations were undertaken over the period 2005 to 2007. The sites were split into two groups: those with summer peak demand in excess of 5,000 kVA (the 5MVA Investigation sites) and the rest. Together, the 5MVA Investigation sites account for more than 10% of peak summer electrical demand in the study area. The study area extends from Hornsby in the north to Sutherland in the south. At its widest point it extends to Ryde in the west. These are the boundaries of EA's 'default' network. This area accounts for 1.1 million EA customers and 4,000 MW of electrical demand (80% of EA's total capacity).

Considering the 5MVA Investigation in a broader context, 'big' electricity users matter. Many are included in the NSW Government's Energy Savings Action Plans (ESAPs), now administered by the Department of Environment and Climate Change (DECC), and the Australian Government's Energy Efficiency Opportunities (EEO) scheme. In 2005 the NSW Government introduced legislation that requires high energy users (businesses in NSW using more than 10 GWh (gigawatt hours) per year at a site; all local councils in NSW with populations of more than 50,000 people; and NSW Government agencies which use more than 10 GWh per year at a site) to prepare and implement ESAPs. The plans should quantify current (2006) energy use and identify opportunities to reduce energy consumption over the four years to 2010. The plan of action with a prioritised list of projects is to be submitted to the government for approval. Implementation is to be monitored through annual reports, and ESAPs are to be reviewed every four years.

BOX 1

Electric Power, Power Factor (PF) and Power Factor Correction (PFC)

Electric power is measured in watts (W), and is a combination of electric current, measured in amperes (A), and force, measured in volts (V).

W = V x A

The higher the current, the more energy; the higher the voltage, the more force and the further the electric current can travel. Power stations generate gigawatts (GW) of power; consumers tend to use kilowatts (kW), but it is all watts.

1 GW = 1,000 MW = 1,000,000 kW = 1,000,000,000 W

Electrical equipment is denominated in kW and the use of power is measured in kW. However, because the power used can be less than the power delivered due to inefficiencies in some equipment, 'real' power is measured in kVA and MVA. This is an important distinction for the DMPP. An electricity customer in Sydney could take action to reduce the measured load of its equipment in kW, but if the customer's equipment has PFs less than one, the impact on the distribution system will be lower when measured in kVA. It is kVA that matters. This is reflected in the electricity accounts of large commercial and industrial customers whose network charges (the cost of using the distribution network) usually include a demand charge based on maximum demand measured in kVA. The difference is called the 'power factor', a number less than or equal to one such that:

kW = kVA x PF

The NSW Service and Installation Rules requires PFs of 0.9 or better. While this requirement is often not enforced by distributors, they have the right to insist that PFC equipment be installed if a lower PF is likely to lead to inefficient use of the network. Where sites have a poor PF, PFC equipment can be installed as an alternative to investing in additional network capacity.

The EEO scheme encourages large energy-using businesses to improve their energy efficiency by requiring them to identify, evaluate and report publicly on cost-effective energy saving opportunities. Participation is mandatory for the estimated 250 corporations that use more than 0.5 petajoules (PJ) of energy (equivalent to 139 GWh of electricity consumption) per year. This is equivalent to the electricity used by 20,000 households each year. The scheme applies to corporations in all sectors of the economy. Corporations that use more than 0.5 PJ of energy per year are together responsible for more than 60% of the total amount of energy used by businesses, and around 40% of all energy used in Australia.

Further, an emissions trading scheme is likely to be implemented in the next few years, and it will be the 'big' power consumers that will be most affected — and will need to be affected if the scheme is to be effective.

A 2007 study by Proudfoot Consulting, reported in "Meeting the Corporate Energy Challenge: Are Companies Walking the Talk on Energy Efficiency?", assessed the role of energy efficiency in business by surveying 102 companies in Australia and New Zealand. The participating companies were from 11 industry sectors including construction, financial services, government, hospitality and leisure, manufacturing, mining, professional services, retail, transport and logistics, utilities and wholesale. Half of the participating companies in the survey have sales revenue of more than $500 million and 13 are ASX100 listed companies with a combined market capitalisation of $268.5 billion.

Of the surveyed companies,

- 53.9% have no formal energy efficiency policy
- 35.2% have not set an energy efficiency improvement target for 2007–08
- 65.7% have no published energy improvement goals
- 41.1% don't have a designated person or function responsible for energy
- Only 19.6% have a designated energy team that meet regularly with specific goals
- 43% said that there is no information on energy efficiency targets, programs and initiatives communicated within their organisation
- Only 12% said that there is senior executive communication on energy efficiency
- 51.9% do not define, measure or monitor energy KPIs (key performance indicators).

These survey results demonstrate the challenge ahead for governments in meeting energy and environment policy objectives. The experience of the 5MVA Investigation has given the DMPP some important insights into why some businesses have been slow to respond, and why they may not respond to market signals alone in the future.

5MVA Participants

The 5MVA Investigation assessed and reported on 24 entities which included 33 sites across five industry sectors, including both private companies and government bodies (see Box 2).

Four sites — the Caltex petroleum refinery, Macquarie University, Sydney Airport and Sydney University — were unable to participate for various reasons.

BOX 2

5MVA Investigation Participants

Infrastructure

RailCorp

- The Rail Network
- Flemington Maintenance Centre
- Central, Bondi Junction, St Leonards, Strathfield and Wynyard Railway Stations

Sydney Water

- Bondi Sewage Treatment Plant (STP)
- Malabar STP
- North Head STP
- West Ryde Water Pumping Station (WPS)

Health

- Concord Hospital
- Prince of Wales Hospital
- Royal North Shore Hospital
- Royal Prince Alfred Hospital
- St Vincents Hospital

Manufacturing and Services

- ADI Garden Island Docks
- Air Liquide Port Botany Gas Production Facility
- Amcor Botany Paper Mill
- ANSTO Lucas Heights Nuclear Facility
- BATA Eastgardens Tobacco Manufacturing Plant
- Boeing Bankstown Aerospace Plant
- Fairfax Chullora Printing Facility
- Food Manufacturer's Main Factory
- Lion Nathan Lidcombe Brewery
- Star City Darling Harbour Entertainment Precinct
- Sydney Markets Flemington
- Weir-Warman Artarmon Foundry

Botany Industrial Park

- Huntsman Surfactants Plant
- Orica Chlor-Alkali Plant
- Qenos Olefins Plant

Education

- University of New South Wales (UNSW)
- University of Technology Sydney (UTS)

Methodology

The DMPP team developed its own methodology for the 5MVA Investigation. Even though Australian Standard *AS3598:2000 Energy Audits* sets out minimum requirements for commissioning and conducting energy audits which identify opportunities for cost-effective investments to improve efficiency and effectiveness in the use of energy, the standard's procedures are not suited to this investigation. Audits under the standard would not uncover the full range of available electrical demand reduction opportunities because the focus of the standard is energy consumption, not demand. Although the standard includes fuel switching and embedded generation, it does not capture opportunities associated with PFC, load shifting, and standby generation. Therefore, significant opportunities would have been missed if a unique methodology had not been developed.

Large sites warranted an in-depth process to capture the information needed to identify and quantify the significant demand reduction opportunities that were expected at these sites. The DMPP team adopted a personalised approach that took into account the unique characteristics of each site. The process started with a site visit to explain the 5MVA Investigation and to ascertain the level of interest in participating in the program. Each site visit was an opportunity to get a better understanding of the business, to discuss future plans, and to discover if there were any issues related to implementing demand management projects. During the site visits, the DMPP team observed, at some sites, a lack of in-house engineering staff with respect to energy usage. At these sites, the DMPP undertook active facilitation to identify peak demand reduction opportunities.

This included:

- ❖ A walk-through site inspection to gain a better understanding of business activities.
- ❖ A detailed follow-up discussion with management to find the links between the production processes and the demand reduction goals of the network provider, with a view to finding opportunities beneficial to both parties.

Discussions included future expansion and refurbishment plans so that possible load shifting opportunities could be aligned with improving processes to achieve optimum operation going forward. During these discussions, the DMPP team's articulate probing questions earned the respect of site managers who were confident that the DMPP would understand the technical aspects of their industrial process and would seek opportunities that would support the organisation's business strategy. The DMPP team, in consultation with the site management, selected the most appropriate consultant to undertake each investigation. Despite this selection process, in a few situations, the DMPP had to actively lead the consultant as well.

Each consultant undertook a desktop review of the site's overall electricity consumption and electrical demand patterns as well as the potential for PFC. This review used billing data and half-hourly load profile data provided by EA. Armed with this information, the consultant undertook a detailed site inspection, including interviews with management and technical staff, inspection of major equipment, and a walk-through of all relevant areas of the site. Items assessed and identified included:

- Site demand and energy consumption characteristics and end-use breakdown.
- Opportunities to reduce peak demand from six 'action' categories: PFC, standby generation, energy efficiency, load shifting/interruptibility, fuel switching and embedded generation.
- Details of all installed standby generators.
- Site payback criteria for energy-related investments.

Consultants then prepared a demand management site report for each site in a consistent format that included details of the site's performance and the demand reduction opportunities in each of the action categories; estimates of the demand and energy consumption impacts, implementation costs, and ongoing costs and savings for each opportunity identified; indicative financial viability (in terms of simple payback); and recommendations for the implementation of the identified opportunities.

This higher level of involvement by the DMPP team ensured a greater quantity of demand reduction opportunities than would otherwise have been identified had the DMPP only 'project-managed' the consultants. Further, the opportunities identified were more likely to be ones that would generate positive returns for the site's business.

The consultants' reports were reviewed by the DMPP team and site management, and final reports were completed in 2006 and 2007. With a couple of exceptions, there is a report for each site. These individual site reports are confidential, however the conclusions presented in this public report are drawn from the information in the individual site reports as well as interviews with the DMPP team and 5MVA site managers.

Results Summary

The 5MVA Investigation identified almost 330 opportunities to reduce peak electrical demand. However, most of these opportunities (as shown in Table 1) require some level of financial subsidy (expressed in $/kVA) for the opportunity to be considered commercially viable.

TABLE 1: 5MVA DEMAND REDUCTION OPPORTUNITIES

	MVA	FS	EG	EE	LS	PFC*	Cum. MVA
Commercially viable projects	25	neg.	2	21	2	-	25
Projects requiring up to $100/kVA	27	-	-	1	17	9	52
Projects requiring b/w $100 to $200/kVA	20	neg.	-	2	-	18	72
Projects requiring b/w $200 to $1,000/kVA	26	1	11	4	-	10	98
Projects requiring over $1,000/kVA	44	1	23	18	2	-	142
MVA by type of opportunity		2	36	45	22	37	
Standby generation capacity on site (MVA)							49

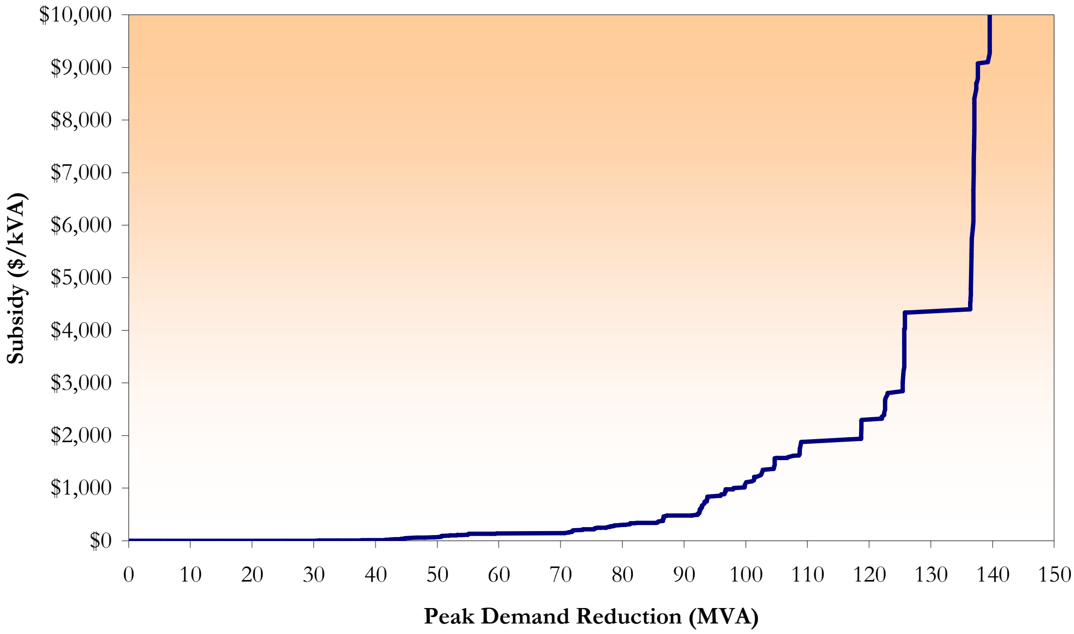
** SKM's 2004 desk-top assessment*

FS= fuel switching; EG = embedded generation; EE = energy efficiency; LS = load shifting/interruptibility

Projects requiring an incentive up to $200/kVA provide demand reduction of approximately 47 MVA. These opportunities are mostly PFC projects (55%) and load shifting (40%). Projects requiring an incentive greater than $200/kVA are in embedded generation, energy efficiency and PFC. More than 30% of the demand reduction opportunities require a subsidy in excess of $1,000/kVA.

The sum of the total technical demand reduction opportunities available and the standby generation rated capacity at 5MVA Investigation sites exceeds 190 MVA, which is equivalent to about 5% of entire network demand in the study area. However, achieving even a fraction of this level of demand reduction will require considerable technical and financial support; but most of all cultural change is needed for the implementation of opportunities.

FIGURE 1: 5MVA TOTAL OPPORTUNITIES BY SUBSIDY REQUIRED TO BE COMMERCIALLY VIABLE*



** Includes opportunities requiring financial subsidy <$10,000/kVA, and excludes standby generation capacity*

The 5MVA Investigation sites account for just under 30% of the total demand reduction potential in the study area, as identified in all the DMPP investigations. The 5MVA sites are particularly important to embedded generation, energy efficiency (mostly process-related) and load shifting opportunities. The 5MVA sites account for more than 60% of compressed air opportunities, more than 90% of process-related opportunities; and nearly all of cogeneration opportunities. In fact, process accounts for the majority of opportunities at many 5MVA sites. Therefore, demand management programs for large energy users need to be individually tailored to the specific needs and characteristics of each site and their implementation needs to be closely facilitated by expert consultants.

There are over 100 commercially viable opportunities and most of these opportunities are energy efficiency measures. This raises the question, 'Why are they not being implemented?' It could be argued that the fact that they are not being implemented means they are not commercially viable. The DMPP found that, although energy efficiency is reasonably understood by most clients, in the majority of cases the focus of the business was maximisation of growth and product diversity not cost minimisation. In addition, energy costs are usually small compared to other costs within the business and are often treated as fixed costs, even though demand and energy charges are mostly variable. Other barriers to implementation include:

- Lack of organisational commitment.
- Lack of awareness of the opportunities.
- Insufficient internal resources to identify opportunities, let alone implement these opportunities.
- No interest in the philosophy of Energy Performance Contracts (EPCs), except in the public sector where there is little alternative.
- Little trust in energy service providers and energy consultants based upon previous experience.
- Projects competing for limited funds with projects that generate income instead of reducing costs.
- Timing — organisations set capital works budgets at least 12 months ahead but the planning of these works can be scheduled up to five years in advance. Capital budgeting is a complex and competitive process in which projects are assessed and either accepted or rejected. If an opportunity is missed, it may not be assessed again for the entire life of the investment which can be up to 20 years or more.

The 5MVA Investigation found that demand management and the impact that it has upon the distribution network are not well understood. During the investigation, businesses did not see the need to identify opportunities that were not commercially viable. It was perceived as wasting everybody's time because the projects would never be implemented. When the DMPP informed businesses and consultants about the possibility of funding from the utilities and other government sources, their attitude changed and numerous additional opportunities were identified.

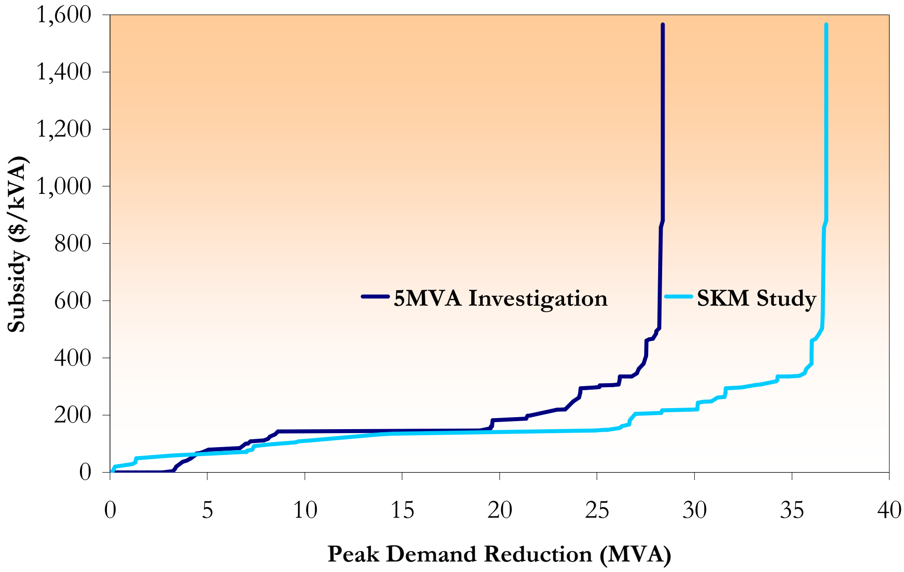
Results by Action Category

POWER FACTOR CORRECTION

In 2003, the DMPP commissioned Sinclair Knight Merz (SKM) to undertake a desktop study of the opportunities for reducing peak demand through the installation of PFC equipment. For the 5MVA Investigation, the DMPP provided consultants with a PFC calculation tool and asked them to assess the SKM results and to identify any technical or economic constraints to the implementation of PFC.

Although the 5MVA Investigation process implies a lower technical potential (28 MVA, compared with 37 MVA in the SKM study), the relationship between demand reduction and subsidy required is much the same. Half of the total demand reduction opportunity requires less than $150/kVA.

FIGURE 2: 5MVA PFC OPPORTUNITIES BY SUBSIDY REQUIRED TO BE COMMERCIALLY VIABLE



Some large energy users either did not realise the financial implications of poor PF or did not consider the gains available by improving their PF to be significant, relative to gains from other projects such as process improvements. PFC is often relatively cheap to implement and, in many cases, requires no (or minimal) subsidy to be financially viable. Only sites whose electricity bills include a demand tariff benefit financially from the installation of PF equipment. Most 5MVA sites pay a network charge, but this charge is often less than 20% of the total bill. Further, in recent years, increases in network charges have fallen behind increases in energy charges. Sites that do not pay a demand charge tend to be very large electricity consumers. Large energy users tend to implement PFC improvements as part of major capital projects. The most common technical obstacle to implementing PFC is simply a lack of available space.

STANDBY GENERATION

5MVA Investigation consultants were asked to include an inventory of standby generation units in the demand management site reports. Specifically, they were asked to provide a brief overview of all generators with capacity in excess of 300 kW in public and private sector premises in the CBD and inner Sydney region that may be suitable for supplementing the supply of electricity in the network. For smaller generators, consultants were asked to list capacity and operational status.

The 5MVA Investigation consultants identified 60 large standby generators with a total rated capacity of 49 MVA. About 55% of the generators are 'typical' standby generators (see Box 3); just under 25% have SCTT; and just over 20% have full parallel capability. For the investigations, the DMPP conservatively assumed 50% of rated capacity to be available from generators without full parallel capability. Assuming that all typical standby generators are upgraded to SCTT, and these generators operate at 50% of their rated capacity, the expected coincident peak demand reduction available would be in the order of nearly 30 MVA. Management at some of the 5MVA sites were keen to make their generators available in a demand reduction demonstration, and three sites participated in the DMPP Load Shifting Trial.

BOX 3

Standby Generators and Demand Management

In a 'typical' standby generation situation, one or more diesel-powered generators are connected to an automatic transfer switch (ATS). If there is a loss of mains power from the network, the voltage drops to a level that triggers the ATS to switch on the generator. There is a short lag of up to five minutes before the electrical supply from the generator is at full voltage. Therefore to use these generators for demand management, the generators need to be isolated from the network. If these generators were connected to the network, they would disrupt the flow of power to the customer.

A synchronised closed transfer trip (SCTT) prevents the loss of power by creating a smooth transition from the network to the generator. To achieve this, the site can activate the SCTT while still connected to the network and for a short time the generator and the network operate in unison until the generator is synchronised to the network. Once synchronisation has occurred the network is disconnected and the site has its electricity delivered by the generator without disruption to the customer.

Further demand management is available when the site's standby generation system has 'full parallel capability' with the network. This requires additional wiring and controls, but gives the site the capacity to export surplus power to the network without any disruption to the customer.

Full parallel capability generators have 100% of their rated capacity available because the generator is connected to the network. However, SCTT and typical standby generators respond to the site load that they are connected to. This is usually equal to about 60–75% of the generator's capacity.

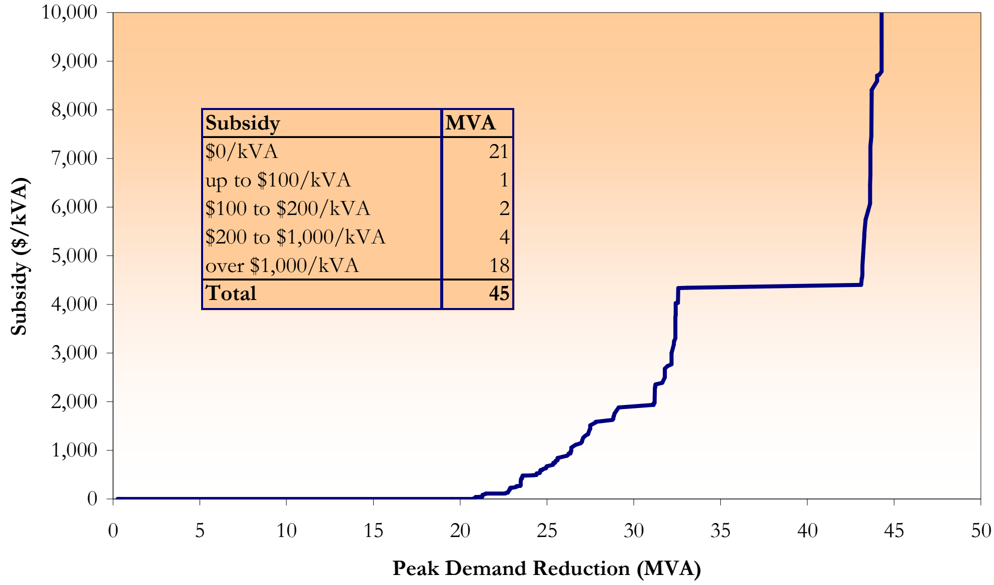
All hospitals have significant standby generation capacity, reflecting the nature of their activities. In the 5MVA Investigation, hospitals account for more than 30% of the total standby generation capacity identified.

ENERGY EFFICIENCY

5MVA Investigation consultants were asked to determine the potential benefits and costs of installing energy efficiency measures capable of reducing peak network electrical demand. These measures should be best-practice solutions or alternative solutions (where best-practice solutions do not meet the needs of the business). Energy efficiency improvement is defined as the provision of an equivalent level of service or an equivalent quantity of production for less electrical energy than is currently used.

Improvements in energy efficiency account for more than 80% of commercially viable demand reduction opportunities, but only 30% of total opportunities. Just over 40% of the energy efficiency demand reduction opportunities require over $1,000/kVA to be commercially viable. Nearly 3 MVA of the commercially viable opportunities are process opportunities in manufacturing businesses where specific engineering skills are also required to assist them with implementation. These process opportunities need to be verified to address issues of complexity and reliability.

FIGURE 3: 5MVA ENERGY EFFICIENCY OPPORTUNITIES BY SUBSIDY REQUIRED TO BE COMMERCIALLY VIABLE

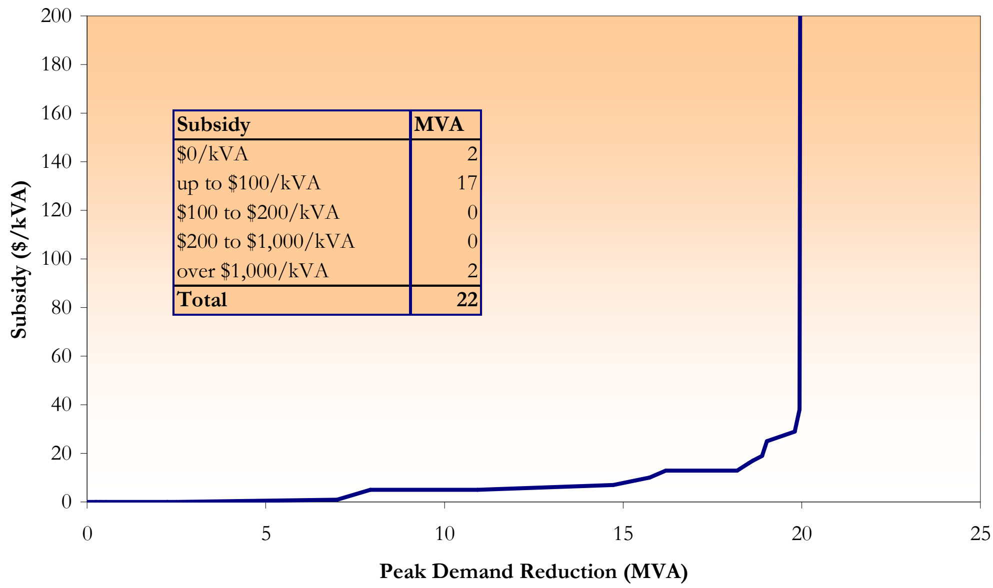


Surprisingly, some large users of electricity do not have modern control systems, and large demand reduction opportunities were identified from either installing new systems or upgrading existing systems.

LOAD SHIFTING/INTERRUPTIBILITY

5MVA Investigation consultants were asked to assess the potential for summer peak demand reduction from interruptible and curtailable loads in excess of 20 kVA, including whether there is scope to permanently curtail the load or whether the site requires notice and time to activate an interruption.

FIGURE 4: 5MVA LOAD SHIFTING OPPORTUNITIES BY SUBSIDY REQUIRED TO BE COMMERCIALLY VIABLE



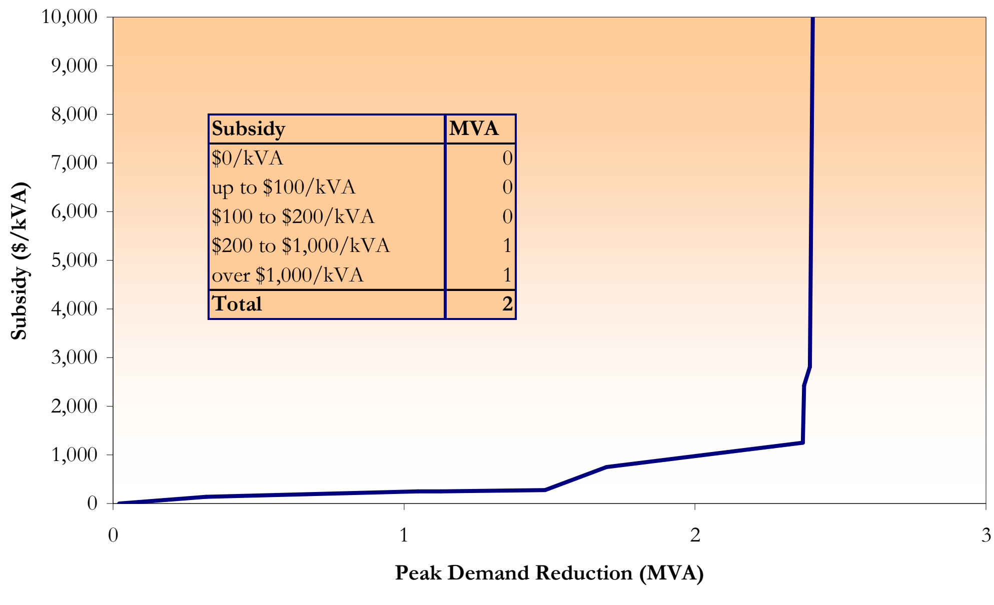
The 5MVA consultants identified more than 8 MVA of permanent load shifting opportunities. Load shifting contributes less than 10% of commercially viable demand reduction opportunities, but nearly 40% of those that require a subsidy of less than $200/kVA. Further, nearly 90% of the load shifting demand reduction opportunities only require a subsidy of less than $30/kVA to be commercially viable.

There are significant peak load reductions available in manufacturing and services where processes can be interrupted on request for a nominal subsidy. The best opportunities are found in 'batch' processes rather than 'continuous' processes where interrupted production is 'lost'. For continuous processes, manufacturers need to be compensated for this lost production. In all cases, a feasibility study would need to be undertaken to assess plant capacity, contractual obligations and associated production schedules prior to any potential implementation.

FUEL SWITCHING

Fuel switching involves substituting one energy source with another, typically natural gas instead of electricity. This involves savings in electricity costs but adds to gas costs, and consultants were asked to take this into account in their assessments.

FIGURE 5: 5MVA FUEL SWITCHING OPPORTUNITIES BY SUBSIDY REQUIRED TO BE COMMERCIALLY VIABLE

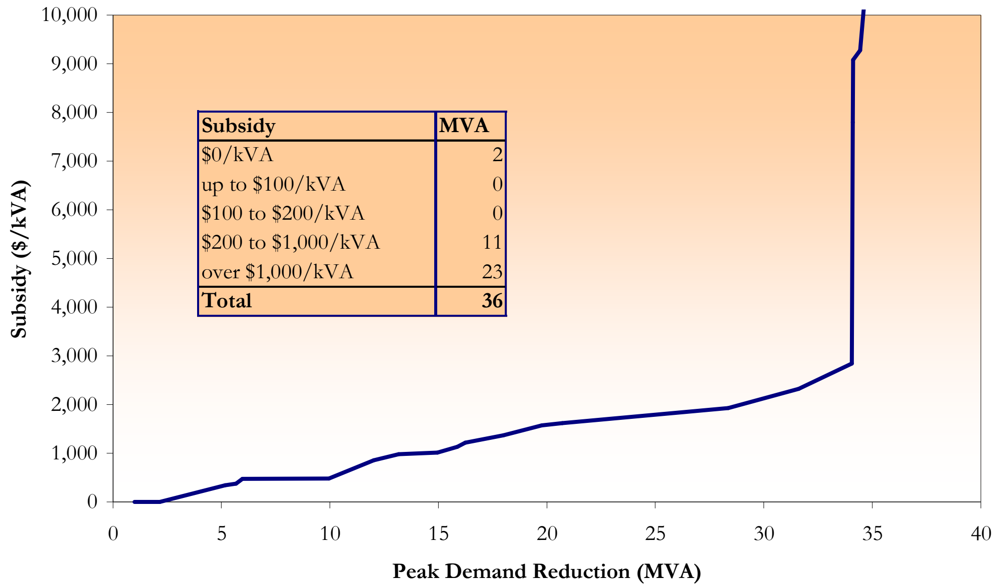


The few significant fuel switching demand reduction opportunities identified at 5MVA sites encompass hot water, heat recovery, process, and HVAC (heating, ventilation and air-conditioning). It is likely that businesses have already identified and implemented the obvious opportunities. In general, the remaining opportunities to switch to gas are usually more expensive in terms of both capital and maintenance costs. Reliability can be compromised if maintenance schedules are missed, and gas-fired systems have a range of other issues including noise, ventilation and exhaust management. These issues mean that costs also vary widely. There are only limited opportunities to replace electric chillers with gas chillers in air-conditioning systems as there is often not sufficient space in existing plant rooms. Further, financial viability depends on whether chillers are due for replacement.

EMBEDDED GENERATION

Embedded generation involves generating electricity on site to reduce dependence on the electrical network. 5MVA Investigation consultants identified embedded generation opportunities from cogeneration, solar, wind and micro hydro power generation.

FIGURE 6: 5MVA EMBEDDED GENERATION OPPORTUNITIES BY SUBSIDY REQUIRED TO BE COMMERCIALLY VIABLE



Cogeneration accounts for 90% of the embedded generation peak demand reduction opportunities, and the most promising opportunities are in hospitals and factories that have a constant demand for heat. Two commercially viable cogeneration opportunities were identified, and the other cogeneration opportunities identified only become viable with a subsidy of at least $500/kVA. In order to ascertain the potential for cogeneration, the DMPP recommended a thermal analysis be undertaken at some 5MVA sites. Thermal analysis is an analytical tool for optimising heating and cooling in large facilities with processes that generate heat and require cooling. Table 2 lists some of the cogeneration opportunities.

TABLE 2: COGENERATION OPPORTUNITIES AT SELECTED MANUFACTURING SITES

5MVA Investigation Site	Peak Demand Reduction (kVA)	Capital Cost ($'000)	Annual Savings ($'000)	Payback Period (years)	Implied Subsidy ($/kVA)
Manufacturing site #1	7,640	$17,000	$1,131	15	$1,929
Manufacturing site #2	3,974	$5,500	$1,195	5	$482
Manufacturing site #3	3,011	$3,565	$844	4	$343
Manufacturing site #4	2,080	$2,200	$211	10	$855

Solar PV (photovoltaic) accounts for only 2% of the embedded generation peak demand reduction opportunities. Five sites were identified to have sufficient roof space and orientation to install solar PV collection panels and, of these, only three have sufficient space to generate more than 100 kVA of electrical power. The capital cost is so high and the peak demand reductions so low that the subsidy required for these three to be financially viable ranges from $9,000–22,000/kVA. A larger peak demand reduction (1,770 kVA) is possibly available by installing wind turbines at one location.

BOX 4

Cogeneration and Trigeneration

Cogeneration is the simultaneous production of two forms of energy — electricity and heat — usually in a gas-fired reciprocating engine or turbine. Cogeneration is classified as 'embedded' because it makes use of an on-site unit. For example, the heat from the reciprocating engine is recovered from the engine's jacket cooling water, lubricating oil circuits and exhaust through heat exchangers. This heat can be used to generate steam and/or hot water for heating or industrial processes. Therefore, cogeneration is applicable at sites with large and constant thermal loads such as hospitals and some factories. An on-site cogeneration system is more efficient than the combination of electricity from the network and natural gas for the on-site boilers. As a result, cogeneration is very effective in reducing peak electrical demand.

The heat can also be used to produce chilled water for cooling in an absorption chiller which uses heat instead of a compressor to maintain the pressure differences in the refrigerant circuit. In the past, absorption chilling was best suited to very large constant cooling loads. However, advances in design and control technology have improved the flexibility of absorption chillers in recent years. The simultaneous production of three forms of energy — electricity, heat and chilled water — is called trigeneration. Although stand-alone absorption chillers are less efficient than conventional chillers, trigeneration systems are very efficient and can reduce peak demand even further than cogeneration systems by replacing part of the HVAC load that tends to dominate the summer peak.

Hospitals are ideal candidates for installing cogeneration systems because of their large thermal loads and centralised heating systems. Consultants noted that the trend towards decentralised steam units in some hospitals might greatly reduce the capacity to use the waste heat from a cogeneration plant. They also identified a trend towards outsourcing hospital laundry services. This creates excess gas capacity which can be used for cogeneration, but shutting the hospital laundry reduces the steam load, adversely affecting the financial viability of cogeneration at the site.

Even with large savings in energy consumption and other benefits, cogeneration is rarely viable without subsidy, often requiring a very large subsidy to be commercial. In some instances the opportunity had been considered and rejected in the past by participants, and was noted but dismissed by consultants.

Key Lessons

A COMPLEX CHALLENGE

The 5MVA Investigation process and reporting revealed that identifying realistic opportunities to reduce peak electrical demand was much more complex and challenging than expected.

The largest energy users and therefore those with the largest potential peak demand reduction are public sector entities, and most of the large public sector sites in the study area participated in the 5MVA Investigation. The DMPP 5MVA Investigation revealed that these entities have particular issues to deal with in respect of demand management. The DMPP had difficulty finding the decision makers responsible for energy issues in the public sector. It seems that the people spending the capital budget are not the same people responsible for finding ways to improve energy efficiency and reduce greenhouse gas emissions. This dilemma is inherent in management structures. The complex public sector structures also mean that entities are best investigated in their entirety rather than site by site.

Surprisingly, public sector investment criteria include relatively short financial paybacks compared to the long lives of public assets. Even when peak demand reduction projects are financially viable, there are other barriers to identification and implementation. These include the availability of funding in competition with other projects; long approval processes; reduced internal engineering capacity; and the focus of management on its core activities. These issues could be addressed through changes to the NSW Government's policies and practices. The government has a number of policies and programs to improve energy efficiency and reduce greenhouse gas emissions through DECC.

The private sector companies, mostly in manufacturing and services, were much more open to the 5MVA Investigation process and findings. They were more comfortable with external parties analysing their operations, partly due to their being accustomed to scrutiny as large energy users. Most of the 5MVA participants are also 'designated' high energy users required to prepare ESAPs in 2006 and many are participants in the EEO scheme. For some participants, being subject to three investigations simultaneously was confusing and disruptive, while for others the synergies allowed them to incorporate a complimentary range of projects in their forward energy plans.

5MVA Investigation participants identified the DMPP's unique approach as the main reason for their cooperation and enthusiasm. There were two important features of the 5MVA Investigation that the DMPP found were particularly effective in identifying opportunities — facilitation and partnership, and time and money.

FACILITATION AND PARTNERSHIP

A number of participants in the 5MVA Investigation commented that the DMPP approach was effective from the outset because the initial meeting gave them confidence in the process and the opportunity to explain any issues they had with the investigation, and demand management generally. In particular, they appreciated the DMPP's emphasis on working with them to achieve mutually beneficial objectives while minimising business disruption. The DMPP approach was characterised by ongoing facilitation to make sure participants were comfortable with the process and that any issues were addressed. The effectiveness of personal communication was demonstrated when the DMPP team visited some of the smaller (less than 5MVA) investigation sites and found many more opportunities through discussion with site managers. Ongoing facilitation and a 'partnership' approach also carried through to implementation of some of the opportunities identified in the 5MVA Investigation.

An important element in the partnership approach was the joint selection of the consultants to undertake the investigations, in particular finding specialist consultants that understood the specialised processes of the participants. Where this was effective, it was very effective. Some of the 5MVA sites are unique, with distinctive electrical demand profiles and unique issues to be taken into consideration in making changes to those profiles. The 5MVA investigations were undertaken across different industries and, in many of the businesses, more than 70% of the electricity consumed was directly consumed in the production process. As a result, the DMPP sought to engage a consultant that could add value to the business by reviewing these processes. If the consultant could not contribute to the review of processes many opportunities would be missed.

Even with the more effective DMPP approach, outcomes were mixed across participants. This provides important lessons. Some consultants were already familiar with the participants. In some cases this made for a more effective investigation; in others familiarity led to consultants being complacent and conservative. They missed the big picture and the big opportunities. In some cases, the consultant was the same as the consultant undertaking the ESAP. This also had mixed results. Where consultants did not use the DMPP methodology and approached the task as just another energy audit, they missed many peak demand reduction opportunities. It was important that the DMPP made it clear that the focus was demand not energy, although often projects that reduce demand also reduce consumption. In hindsight, it may have been more effective to train a team of DMPP staff to undertake initial investigations, then to use consultants to assist with specialised processes.

TIME AND MONEY

The 5MVA Investigation process meant the DMPP team spent time individually with the sites under review, and the consultants spent time getting to know the organisations and their processes.

By being a facilitator, and not a regulator, the DMPP was also able to find out important information from customers; information they might not normally reveal to government bodies, including their electricity tariff and investment plans. This is critical information for developing realistic opportunities for the customer. For example, money comes into the equation in different ways:

- The importance of government funding support
- The cost of electricity and the importance of demand charges
- The complexity of investment decisions.

The DMPP found that funding support can be critical in the very early stages of identifying projects and undertaking feasibility studies. Energy-related projects have to compete with safety, regulatory and growth objectives and if the initial assessment is marginal, further assessment will not be funded internally. However, if funding is available at the early stages of assessment and the project can then demonstrate its viability, it will be considered by senior management.

The case for funding investigations, feasibilities and actual implementation of demand management projects is partly determined by the cost of electricity, in particular the extent to which large users pay network charges. The bills of large electricity consumers include energy charges (peak, shoulder and off-peak), network charges (peak, shoulder, off-peak, peak capacity and access), market charges (for the operation of the National Electricity Market) and other charges. Market and other charges usually account for less than 10% of the bill, so energy and network charges are the most important. As part of the overall investigations, the DMPP commissioned a review of the electricity bills of 10 large users and found some perverse situations, such as three sites paying less at peak periods than at shoulder and one site paying the same during all periods. The aim of network charges is to provide a price signal to encourage lower demand on the electrical distribution network during peak periods. However, network demand charges ranged from 26% to 36% of the total bill for the 10 large energy users. The review found that the proportion of a large consumer's electricity bill that might be able to be reduced by reviewing their load profile and undertaking demand management activities could range from as much as 18% to as low as 3% of the total bill. Of course, if a project also reduces energy consumption as well this would result in a lower bill through the energy charge. However, Australian businesses enjoy some of the lowest electricity tariffs in the world. Further, increases in electricity tariffs may not necessarily lead to lower consumption. The DMPP is aware of one instance where a long-term energy contract had expired and the tariffs were increased in the order of 20%. This was equivalent to a tariff increase of 1c/kWh or a carbon tax of approximately $10/tonne of CO_2. The DMPP was informed that the business decided not to investigate the potential to reduce energy usage but to simply pass on the cost to consumers. This attitude is a significant hurdle for energy efficiency and demand management projects, even though the electricity bills of large users range from hundreds of thousands to millions of dollars per month.

It is surprising that only a few customers have an energy manager dedicated to the task of managing demand and energy consumption as opposed to just negotiating contracts with energy providers. It could be expected that electricity bills greater than $100,000 per month would justify a role for an energy manager to reduce demand and energy consumption and this cost to the business.

The 5MVA Investigation revealed that even when opportunities are technically and financially feasible, they may not be identified because energy is not a core activity and there are few spare internal resources available to address energy related issues. This is particularly so now that many organisations have 'de-engineered' to the extent that strategic opportunities to reduce demand and energy consumption are no longer identified, let alone considered. This is compounded by the complexity of investment decisions. For example, companies tend to have different criteria for investing in 'core' equipment, such as new plant, compared to investing in 'peripheral' equipment such as the electrical system. Some organisations, such as hospitals, have operating budgets but no capital budgets. Therefore, even projects with short payback periods are not likely to be implemented.

The other key factor is timing. 'Timing is everything' in more ways than one:

1. The nature of the businesses of 5MVA sites means that their peak demand period does not necessarily coincide with that of the distribution system.
2. Some pieces of equipment have very long lives. Even if an opportunity is identified, the equipment is unlikely to be changed until the end of its useful life. For example, many of the compressed air opportunities identified in the 5MVA Investigation will not be implemented until new equipment is installed some years hence.
3. Projects need to be timed to fit with the site's capital expenditure schedule.
4. Things change over time and, if management changes, the process may need to start all over again.

Beyond Investigating and Reporting

When the demand site management reports were completed, the 5MVA Investigation had achieved its aims. However, the DMPP was also charged with the task of funding feasibility studies for some of the projects that were identified in its investigations. Such studies could be of particular value for opportunities based on production processes. Although specialist consultants were engaged for the 5MVA Investigation, the DMPP knew that feasibility studies would provide a greater level of understanding and give business owners a higher level of confidence that the demand management projects were viable, and that they could realise the benefits estimated by the consultant. Other, non-process opportunities, such as general lighting and HVAC are more easily understood by all parties, involving lower risk and a greater chance for implementation. In some cases, where the 5MVA participant went ahead with an identified opportunity on its own account, the DMPP provided measurement and verification services to confirm the demand reduction. In the case of standby generation, some opportunities were confirmed through participation in the DMPP Load Shifting Trial.

When the DMPP looked for the reasons why some projects went ahead and others floundered, one common factor was the extent to which there was in-house technical expertise and resources in energy management. The DMPP concluded that there needs to be at least one dedicated person, either from within the organisation or brought in as a consultant, whose sole task is to manage energy in all its aspects. Otherwise there is no-one in place to sustain any momentum in demand management and, by implication, energy efficiency and greenhouse gas emission reduction. It is clear that it is not enough to 'throw money at' projects or alter relative tariffs through, for example, a carbon tax. What use is a carbon tax on its own if production sites have lost their internal expertise to identify and implement process-related opportunities which reduce demand and energy consumption? What is primarily needed is cultural change. Government facilitation of increased awareness would lead to empowerment and implementation. In demand management, this includes building bridges between the electricity network providers and business owners. So, offers of typical financial incentives such as $/kVA for peak load reductions are unlikely to be effective on their own. If barriers cannot be overcome, then regulation may be needed.

This begs some big questions:

At what point will carbon taxes change the cultural outlook of an organisation?

Will the organisation change, or will the business decide to relocate or even shut down?

As the DMPP draws to a close in 2008, a key recommendation is for the NSW Government to provide facilitation by establishing a dedicated, full-time, technically-skilled and business-savvy 'Demand and Energy Management Team' with a mandate and funding access to continue exploring and initiating large-scale and/or widespread opportunities for viable demand reductions and energy efficiencies across the entire state. It appears that, in many cases, facilitation needs to be ongoing and indefinite. This recommendation is not intended to reflect negatively on the participants in the 5MVA Investigation. Quite the contrary, the DMPP team found plant-level managers to be very cooperative and keen to make improvements. Rather (as evidenced by the 2007 study by Proudfoot Consulting), it is an indictment of the lack of vision by some businesses at a very senior level and a lack of recognition of the value of internal technical energy and engineering expertise to their organisations.