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SKM

dmpp Demand Management & Planning Project

Standby Generation for Demand Management

ROLL-UP REPORT

- Final V.2
- 7 April 2008

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Executive Summary

SKM has prepared this report to investigate the opportunities for using standby generation for demand management in the Sydney region and to amalgamate the findings from the Demand Management and Planning Project's (DMPP) preliminary feasibility studies on the subject.

The DMPP has compiled an extensive database of 450 standby generator units from 228 Sydney sites, with a total generation capacity of approximately 450 MVA. The potential standby generation capacity which is actually viable for demand management is much smaller than this figure due to factors such as the standby generator unit age, maintenance history and willingness of the owner to provide the generator for demand management. Table 1 compares the potential standby generation capacity of each region when these factors are taken into consideration.

Table 1 Standby generation capacity (MVA) – by location

	MODE of OPERATION	CBD	Inner West	East Sydney	North Sydney	St George
Total	Island Mode	182	37	85	65	19
	SCTT	10	22	0	2	0
	Full Parallel	2	15	8	5	0
Excl. by Age	Island Mode	75	27	55	22	13
	SCTT	4	22	0	1	0
	Full Parallel	0	5	3	2	0
Excl. by Age & Maintenance	Island Mode	71	26	52	19	8
	SCTT	4	22	0	1	0
	Full Parallel	0	5	0	0	0
Excl. by Age, Maintenance & Willingness	Island Mode	44	17	25	11	0
	SCTT	0	16	0	1	0
	Full Parallel	0	5	0	0	0

There are several issues that need to be taken into account when considering the use of standby generation for demand management. These include the environmental implications of using diesel-fuelled engines, technical considerations such as whether the generator connection will compromise distribution network protection, and economic considerations of whether or not the use of standby generation is financially attractive, both to the generator owner and the distribution network service provider.

SKM has estimated the capital and operational costs that are associated with using standby generation for demand management based on several site inspections that were carried out for the DMPP by Econnect. Average capital costs per kVA of generation capacity have been estimated to range from around $250 to $600 depending on the connection mode chosen for the generator and whether network augmentation is necessary. Average operational costs for all implementations are around $60 per kVA of generation capacity. Table 2 displays the average overall cost estimates for using standby generation for demand management through several implementations. It is prudent to note however that every site is unique and it is advisable to investigate the feasibility of using standby generation for demand management on a site-by-site basis.

- **Table 2 Average cost for using standby generation for demand management ($ per kVA of generation capacity)**

	Cost ($ per kVA of generation capacity)
SCTT	$333 per kVA
Full parallel (no network augmentation)	$405 per kVA
Full parallel (with network augmentation)	$673 per kVA

* The cost of retrofitting a dispersion-efficient roof-level exhaust has not been included in estimates as this cost is strongly site specific, and can vary by orders of magnitude and hence it is not possible to provide a representative average figure.

** It should be noted that if a site's standbys are to be used for demand management for consecutive days, it may be necessary to refill the bulk fuel tank overnight. Hence it may be necessary for the site to engage in a 'guaranteed' fuel delivery arrangement so as to ensure the diesel supply is secure. The cost for such an arrangement has not been allowed for in the cost estimates.

SKM also carried out three site surveys in the Sydney CBD to estimate their costs for using standby generation for demand management and to compare these with the Econnect site inspection cost estimates. SCTT was found to be the most viable demand management solution at the three sites. The costs are shown in Table 3.

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- **Table 3 Average costs for using standby generation for demand management in an SCTT configuration at the three sites surveyed**

Capex Costs	
SCTT conversion (typical)	$262 per kVA
Roof level exhaust	Not estimated*
Opex Costs	
Fuel, O&M	$43 per kVA
Refuelling guarantee	Not estimated*
Total Costs	**$305 per kVA**

Table 4 uses the suitable and available island mode capacity per region found in Table 1 and the $333 per kVA SCTT option from Table 2 to extrapolate an indicative cost estimate for a region-wide rollout of a standby generation demand management program.

- **Table 4 Costs for region-wide rollout**

	CBD	**Inner West**	**East Sydney**	**North Sydney**	**St George**
Island Mode Capacity (MVA): (satisfies the age, maintenance and willingness criteria)	44	17	25	11	0
Total Costs: (based on $333/kVA of generation capacity)	$ 14,800,000	$ 5,600,000	$ 8,200,000	$ 3,700,000	$ -

* Note: roof-level exhaust costs and refuelling guarantee costs were not included in the cost estimates. This will affect the cost of a region-wide rollout.

From the extrapolation it can be estimated that the rollout of a Sydney-wide (97 MVA) standby generation demand management program may cost in the order of $32M.

However a final and most critical consideration of whether standby generation is actually feasible for demand management is whether or not the potential standby generation capacity is located in reasonable proximity to the areas of network constraint. Potential standby generation capacity in areas where network capacity is not an issue has no value in a demand management sense.

Contents

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1. Introduction

1.1 Background

The Demand Management and Planning Project (DMPP) under the NSW Department of Planning was established to identify and explore opportunities to reduce peak electricity demand in Sydney, in order to defer the need for costly grid capacity expansion.

In accordance with the Conditions of Consent placed on the DMPP, standby generation has been investigated extensively to gauge its effectiveness as a means of reducing peak demand. The investigations involved several hundred site visits and interviews with facilities managers, culminating in the issue of several reports and the formation of an extensive database containing the technical specifications of the standby generator units of 228 Sydney sites which currently use the units as for emergency backup purposes.

1.2 Scope

This report will amalgamate all of the DMPP findings on the use of standby generation for demand management, as well as:

1) Identify the technical requirements for using standby generation for demand management;
2) Analyse the economic and regulatory issues involved with using standby generation for demand management;
3) Present case studies of several sites where standby generation opportunities have be investigated; and
4) Discuss barriers to the uptake of standby generation demand management opportunities

1.3 Structure of the Report

The remainder of this document is structured as follows;

Section 2 identifies all of the documents considered in the preparation of this roll-up report.

Section 3 presents an overview of the technical aspects and considerations that need to be assessed when investigating the viability of using standby generators for demand management.

Section 4 contains the analysis of the documents and reports related to standby generation, including the desktop analysis and individual case studies.

Section 5 discusses the high level findings and recommendations from the analysis.

Section 6 is a list of documents referenced throughout the report.

2. Documentation Considered

Several documents have been considered in this rollup report. A list and description of each is as follows:

- ***CBD – Standby Generator Integration Project Preliminary Feasibility Study* – Econnect** – This report investigates the demand management benefits and the technical, environmental and economic issues associated with using standby generation for demand management in the Sydney CBD area. The report includes case studies of five potential demand management sites, addressing their potential connection options, associated network issues and their respective budget costs
- ***St George / Sutherland – Standby Generation Project Preliminary Feasibility Study* – Econnect** – This report investigates the feasibility of using standby generation for demand management at six different sites in the St George / Sutherland area. Potential connection options and environmental, technical and risk management issues are all addressed on a site-specific basis, with budget costs given for each connection option.
- ***Quay West Suites Sydney – Grid Connection of Diesel Generator Preliminary Feasibility Study* – Econnect** – This report explores the technical issues and costs associated with connecting a standby generator in a full parallel configuration at the Quay West Suites in Sydney. The report considers site loads and generator capacities; protection and control requirements; and distribution network augmentation.
- ***Air Quality Impact Assessment: The Integrated Generators Project* – Holmes Air Sciences** – This report considers the impacts that standby generator use has to air quality The report uses a computer-based dispersion model to predict the concentrations of carbon monoxide (CO), oxides of nitrogen (NO_x) and particulate matter (PM_{10}) emissions that would result from generator use according to its capacity and time of operation These model predictions are then compared with regulatory air quality criteria, with consideration given to potential cumulative impacts.
- ***DECC Comments on the Integrated Generators Proposal* – The Department of Environment and Climate Change NSW** – This document examines the Air Quality Impact Assessment and provides a recommended approach to managing air quality impacts from standby generator use for demand management. The document discusses NSW clean air targets, regulatory framework and pollution controls.
- ***DECC Requirements for Diesel Electricity Generation Using Internal Combustion Engines* – The Department of Environment and Climate Change NSW** – This document discusses the health implications of excessive diesel particulate matter (PM_{10}) emissions and NSW government clean air policy. The document also recommends using a similar approach for

managing standby generation NO_x emissions to that of gas fired power stations in Sydney and the Illawarra.

- ***Proposed Standby Electricity Generation Station, Cessnock Road, Weston – Supplementary Information 10 April 2007* – Infratil Energy Australia –** This paper compares the use of diesel fired reciprocating engine technology with gas reciprocating engines and gas turbines for providing a fast response to short term spikes in electricity demand.
- ***Case Study – ECI NOx Abatement System* – Exhaust Control Industries Pty. Ltd –** This case study provides indicative costs for pollution control systems.
- ***DMPP – Partial Load Standby Potential* – Sinclair Knight Merz** – This report communicates the findings of three site surveys that were carried out on behalf of the Demand Management and Planning Project (DMPP). The purpose of the site surveys was to determine the practicality, costs and implications of using existing standby generation for reducing electricity demand.

3. Technical Overview of Standby Generation

Standby generators are generally designed for relatively short term operation with the aim to ensure continuity of supply during the loss of power from the network. The generator provides the ability to run essential services such as lifts, fire services and critical electronic equipment whilst the power from the network is restored. As such, the fuel supplies, cooling systems, operability and versatility of the generator are designed around this functional requirement.

In many areas, there may also be requirements in development approvals and/or EPA licence conditions that restrict the use of the generator. The conditions may involve the use of the generator as an emergency backup only (i.e. in the loss of the network) or restrict its operation for short periods only (i.e. typically less than 200 hours per year). There are various reasons for the restrictions including noise pollution and environmentally sensitive emissions.

In the DMPP database there are 228 sites containing a total of 450 standby generator units with an average capacity of 1 MVA. The potential to use this generation at times of peak load to support the network represents a significant resource for improving system security and peak demand management.

The most likely situation in which a standby generator would be used is when demand is high, the spot market price is high and the distribution or transmission network is approaching full capacity. Peak demand is generally of short duration, with the top 10% of loads occurring for less than 1% of the time (around 100 hours per year). At these times, the spot price is typically well above the average price. Due to this profile of short operating times and high cost, the use of standby generators to provide network support is potentially viable.

In terms of market support (influence on electricity price) and system backup, the level of support that the standby generators can provide is largely immaterial. This is primarily due to the scale of the national market and the comparatively small size of the generators. The most feasible implementation of standby generators is for network support, primarily at the distribution level.

Due to the low utilisation of emergency backup diesel generators, emissions and low energy efficiency were not of significant concern. The use of standby generators for demand management purposes will increase their utilisation to the point where the impact on air quality and energy efficiency needs to be considered. These considerations are addressed in the following sections.

3.1 Generator Considerations

A number of technical constraints can limit the suitability of standby generators for grid support, including the configuration of the site switchboard, site loads, control and protection equipment installed with the generator, configuration of the network and surrounding grid, and the protection schemes in operation in the surrounding grid. Parallel generators can also increase the “fault duty” at the site and nearby sites, and this may exceed the rating of switchboards or protection devices.

3.1.1 Modes of Operation

The switchboard configuration, versatility and flexibility at each site is of primary significance in determining the effectiveness of each approach of operation. In simple terms, the ability of the generator to support the local network during peak periods and therefore provide tangible benefits of quality, reliability and security of supply relate directly to how the sites electrical loads can be managed through the switchboard.

There are three connection modes in which a standby generator can operate: Island mode (standby); Synchronise Close Transfer Trip (SCTT); and Full Parallel.

Island mode (standby) can be employed when the generator is of sufficient capacity to supply the entire site load or at least the essential services load. Island mode requires a brief supply interruption to the site in order to transfer from the network supply to the standby generator supply. Due to the supply interruption, this mode would most likely not be suitable for supplying sensitive loads.

The SCTT mode of operation can be employed when the generator is of sufficient capacity to supply the total building load or alternatively, with switchboard modifications, to supply part of the building load. In the event that the generator cannot supply the full load, the remaining load can be supplied by the network provided that the switchboard allows for a separation (disconnection) of the standby generator and the network. Essentially in this configuration, the generator would be supplying part of the site load in island mode.

The full parallel mode provides the most flexible operation; however, it is the most costly and technically challenging. The standby generator can be used both when the capacity is larger and smaller than the peak site load. In the case where the capacity is larger, the surplus generation can be exported to the network. In the case where the generator cannot supply the total site load, the network can provide the additional requirements. A detailed cost benefit analysis for each site being considered for this mode should be undertaken to determine its practicality.

3.1.2 Operation and Maintenance

The majority of diesel generators are rated for standby or emergency use. This designation is for generators that will be used typically for short periods of time when the main supply fails. Typically, the generator is fuelled from a small “day” fuel tank that is replenished from a larger storage tank. More frequent operation of the generator for longer periods of time would require the replacement of the day tank with a larger unit or more frequent refilling.

Using the generator for more hours than it was originally intended will result in higher temperatures and reduced engine life. Regular scheduled servicing will be required to maintain the engine performance. The maintenance timeframe is approximately every 200 – 250 hours.

3.1.3 Environmental Considerations

Diesel-fuelled reciprocating engines are high emitters of NOx and particulates, which contribute negatively to air quality. The use of a standby generator for demand management purposes will increase the generators utilisation, resulting in increased emissions.

From air quality modelling undertaken for the DMPP by Holmes Air Sciences, the use of diesel generators within the CBD has the potential to result in the DECC's criteria for NO_2 and PM_{10} emissions to be exceeded in some operating profiles. It was anticipated that due to the infrequent simultaneous operation of the generators, the probability of maximum impact from the generators occurring with maximum impact from background sources was low. As a result, compliance with air quality criteria was likely to be achieved dependent upon which generators were operating simultaneously.

Due to the higher level of emissions from diesel driven generators when compared to other types of generation, appropriate management of the carbon and NOx emissions will be required.

3.1.3.1 DECC Considerations

The Department of Environment and Climate Change (DECC) assessment of the Integrated Generators Project (IGP) raised a number of concerns regarding air quality and the ability to achieve the environmental targets set for NSW.

Due to the sensitivity of emissions, DECC would have to approve the use of diesel standby generators totalling 1MW or greater that are used for demand management purposes. To illustrate the concern with emissions, DECC noted that without the installation of Selective Catalytic Reduction (SCR), the hourly NOx emissions from 40MW of standby diesel generation is more than the hourly emissions from a 600MW gas fired power station. DECC estimated that the diesel particulate emissions could have a health cost of around $14,000 per hour of operation. This provides a basis on which to work from when assessing the cost of installing the Best Available Control Technology (BACT) to reduce emissions.

3.2 Network Considerations

Network considerations are important when assessing the ability to connect a standby generator to the distribution network. The following considerations are only relevant when the generator is coupled to the network in full parallel mode or during the short time that the SCTT mode has the generator connected to the network (approximately 10 seconds).

3.2.1 Fault Levels

The distribution network fault levels and ratings need to be considered when connecting distributed standby generation into the network. The safe operation of the electrical network is of paramount importance, not only in terms of network security, but more importantly, in terms of safety to people.

For this reason, the full parallel configuration may not technically be achievable without significant modifications to the LV distribution network.

According to the findings of an EConnect study, "*Fault levels in Sydney CBD distribution network are generally close to the design fault levels on the LV system*". Of the 53 sites studied by EConnect, only seven sites were identified as feasible for LV connection. Five sites were selected to be case studies for network issues investigations and generator connection and conversion cost estimation.

There are a number of methods to resolve the fault level issue and therefore allow the connection of the generator. These include:

- Current limiter fuses;
- High impedance transformer or series reactor;
- Network configuration alteration; and
- Other generator connection solution (HV Connection)

The most effective method to address the fault level issue from a technical and economic perspective will depend on the attributes of the system, and the generator, at the connection location. As such, one approach cannot be identified as more suitable than another as the solution will need to be determined on a case by case basis.

3.2.2 Quality of Supply

Studies undertaken by EConnect suggest that there are unlikely to be quality of supply issues (voltage levels, harmonics, etc) associated with the connection of a standby generator in full parallel mode, however, case by case studies would be required to confirm this.

The inherent issue associated with connecting a generator in SCTT (island) mode is that the fault level is low and therefore power quality could be an issue, especially if there are any distorting or fluctuating loads at the LV switchboard. Work by Econnect suggests that this is not expected to be a problem when the generator is operated infrequently, however, under peak lopping operation the generator would be expected to operate for longer periods of time and more frequently. As a result, the SCTT operation option of the generator may reduce the power quality and it could be a concern when the load is sensitive to power quality issues (voltage levels, harmonics, etc)

3.2.3 Thermal Limits

Connecting a generator at LV level as proposed for the connection of standby generators will generally have a beneficial effect on the thermal limits within the distribution network as a result of the net load reduction of main feeder load. In full parallel mode, the export that results from maximum generation and minimum local load may exceed the thermal limits of the distribution system depending on the rating of the generator. A case by case study for each implementation will be required to determine the materiality of thermal limit issues.

4. Analysis

The DMPP undertook a number of studies to determine the potential use of standby generators as a means of providing demand reduction. These studies included the following:

- Site audits;
- St George Preliminary Feasibility Study;
- CBD Preliminary Feasibility Study; and
- CBD Case studies

The results of these studies are analysed in the following sections.

4.1 Site audits and desktop studies

The DMPP has undertaken audits of 770 large energy consumption sites in Sydney. The information obtained during the audits has been compiled into a database of standby generator units in the Sydney region. The audits identified a total of 450 potential standby generator units from 228 sites, with a total capacity of approximately 450 MVA.

4.1.1 Potential Standby Generation as a result of the Desktop study

The DMPP undertook a high level desktop study to determine the generators that could potentially be used for demand management purposes. The study considering the following factors:

- The age of standby generators;
- The routine maintenance schedule; and
- The willingness of managers/owners to participate in DM.

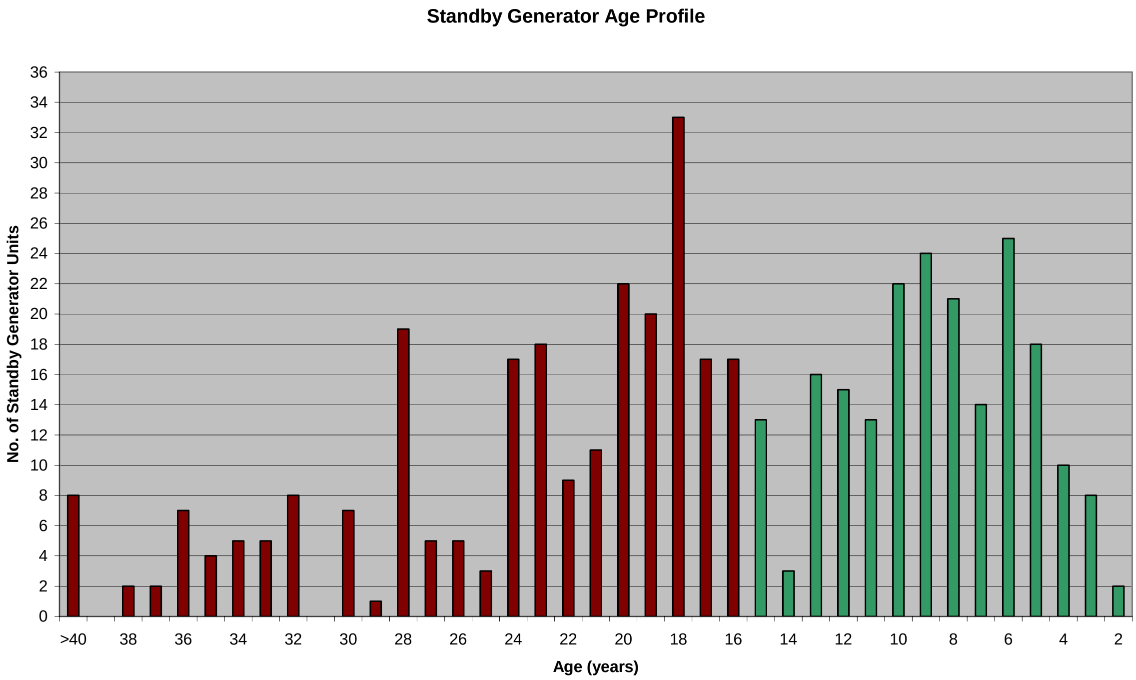
4.1.1.1 Generator Aged and Maintenance

To ensure that demand reduction can be reliably achieved at times of system peak, it is important to ensure that any proposed standby generator is capable of generating between 4 and 10 hours per day. As reliability can be linked to both generator age and regular servicing, the DMPP have excluded all generators that are older than 15 years and/or have not been maintained on a twice yearly basis.

SKM in principle agrees with the exclusion of a generator based on age and/or routine maintenance. The life of a standby generator is typically 15 to 20 years dependent upon duty, utilisation, maintenance and obsolescence. With respect to the maintenance periods, the information collected by the DMPP does not stipulate the type of maintenance undertaken. As such, it is difficult to determine whether maintenance refers to an inspection of the generating unit or a more extensive undertaking including oil and filter changes etc. The frequency of maintenance is dependent upon a number of factors including the age, history, criticality of connected load, duty and utilisation. Given the uncertainty of the term maintenance and the other factors that affect the maintenance frequency, SKM is unable to comment on the suitability of excluding a generator that is not maintained twice yearly.

Figure 4-1 shows the age profile of all 450 standby generators recorded during the site audits. The units highlighted in green are less than 15 years old. Of the total standby generator capacity of 450 MVA, 224 MVA fails the age criteria alone and 50 MVA fails the maintenance criteria alone. 31 MVA failed both the age and maintenance criteria.

- **Figure 4-1 Age profile of all 450 standby generator units**



After excluding the generators that were considered unsuitable for network support based on age and maintenance, 175 generators with a total of 207 MVA remained. This equates to approximately 46 per cent of the total capacity determined in the audit. Of this total capacity, 176 MVA is configured for island mode, 26 MVA is configured for SCTT, and 5 MVA can operate in full parallel.

4.1.2 Willingness to Participate in DM

During each of the site audits, the site owners/managers were asked whether or not they would be willing to provide their standby generators for demand management. A summary of their responses categorised by their respective area can be found in Table 4-1.

- Table 4-1 Summary of customer willingness to provide generator for DM by Location

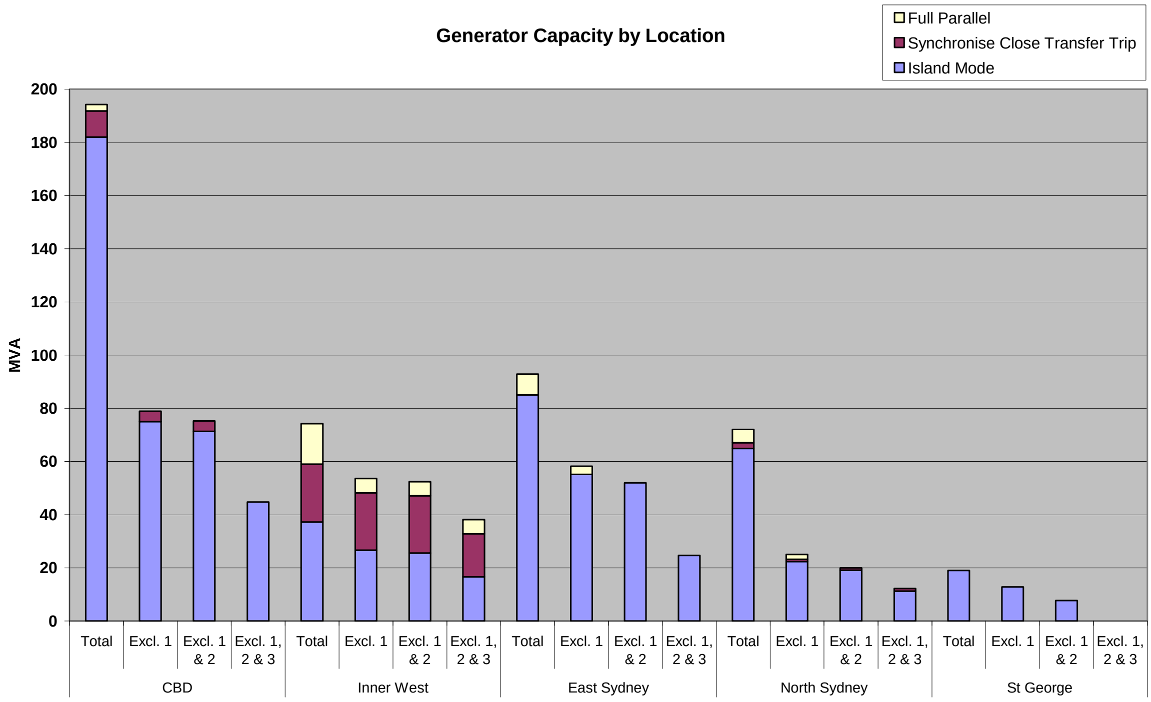
LOCATION:	Technical MVA capacity	Willing to participate	Unwilling to participate	No response	Generator capacity of sites that are willing to participate in DM
CBD	75	59%	27%	14%	44
Inner West	52	73%	27%	0%	38
East Sydney	52	47%	43%	9%	25
North Sydney	20	61%	39%	0%	12
St George	8	0%	0%	100%	0

When considering only the standby generators from owners that are willing to provide them for demand management, the available standby generation capacity is 119 MVA. This equates to 57 percent of the potential generating capacity based on the above exclusions and only 26 per cent of the total standby generation capacity of 450 MVA. Generators in which their respective facilities manager failed to give a response to this question have been disregarded in the capacity calculations (23 MVA).

4.1.3 Desktop potential by location

Figure 4-2 shows the break-up of potential generation capacity by location following the desktop study.

- **Figure 4-2 Standby generation capacity – by location**



Total – Total standby generation capacity

Exclusion 1 – Excludes standby generator units that are greater than 15 years old.

Exclusion 2 – Excludes standby generator units that are not maintained at least twice yearly.

Exclusion 3 – Excludes standby generator units in which their owners are not willing to provide them for demand management.

4.1.3.1 Central Business District (CBD)

It can be seen that the CBD (the area with greatest distribution network capacity constraints) contains the most potential generating capacity with 45 MVA. These standby generators are backup supplies for commercial buildings and are only configured for island mode operation.

As discussed in section 3.1.1, if these generators were used for demand management, an interruption to supply would occur to facilitate the changeover from network supply to standby generator supply. It is improbable whether this would be acceptable in many of the sites that the generators are located due to the business and commercial operations that take place in those sites. A possible solution would be to convert the switchboards to the SCTT mode of operation, thereby allowing a seamless transfer of load from the network to the generator. The viability of this would need to be determined on a case by case basis.

4.1.3.2 Inner West

The Inner West has 38 MVA of possible capacity, of which 16 MVA is configured for SCTT operation and 5 MVA is configured for full parallel operation. The sites presently connected to the network are listed below:

- Australia Post, Lidcombe (SCTT – 3.3 MVA);
- Bankstown District Sports Club (SCTT – 4.2 MVA);
- Foxtel (SCTT – 2.6 MVA);
- Fairfax Printers (SCTT – 6.0 MVA);
- Compaq Computers (full parallel – 4.4 MVA); and
- North Ryde RSL (full parallel – 1.0 MVA).

In addition to the SCTT and full parallel units, the Inner West has 17 MVA of standby generation configured for island mode operation.

This represents a considerable capacity that is readily available from a technical perspective for demand management purposes. Considerations associated with emissions and the location of capacity constraints would need to be addressed to determine whether these generators represent real potential.

4.1.3.3 East Sydney

East Sydney's entire potential standby generation capacity of 25 MVA is configured for island mode operation. As discussed in section 4.1.3.1, the viability of using this generation for demand management is improbable in its current configuration.

4.1.3.4 North Sydney

The North Sydney region contains 11 MVA of island mode configured standby generation capacity and a single site of SCTT configuration with a generating capacity of 1 MVA. The viability of using this generation for demand management is identical to the comments made in the preceding sections.

4.1.3.5 St George

The St George region has no suitable standby generation capacity in which its owners are willing to provide for demand management.

4.2 Preliminary Feasibility Studies

Following the desktop study, the DMPP commissioned Econnect to assess the technical feasibility and associated costs of using standby generation for system support. Econnect considered generators in two areas, the CBD and St George & Sutherland. The key objectives of the studies were to identify the following:

- The total available generation capacity that can be dispatched and the demand reduction (MVA) based on a preliminary assessment of the technical constraints;
- Estimate the capital costs of implementation for each of the identified connection options:
  - Low Voltage (LV) connection with parallel operation;
  - LV connection with synchronous close transfer trip operation (SCTT);
  - High Voltage (HV) connection with parallel operation; and
  - LV connection with sequential switch
- Outline a conceptual technical framework that would enable central dispatch of the generators by the Distribution Network Service Provider (DNSP); and
- Identify other strategies for Demand Management to enhance the development of the renewable energy and distribution generation projects.

4.2.1 Preliminary Feasibility Study Recommendations

4.2.1.1 CBD

The Econnect studies concluded that the fault ratings of the Low Voltage (LV) switchgear in Sydney's CBD is within 10% of it's design rating and that a prospective fault contribution from proposed standby generation in most cases would increase the fault level past the design rating. Therefore connecting generation in full parallel mode to the LV switchgear is not desirable.

Econnect go on to discuss the possibility of a High Voltage (HV) connection to overcome the fault level issues, however, due to the requirements of additional space for step-up transformers this may be a barrier at some sites. It has also been discussed that the DNSP operational switching philosophy to implement sequential switching will significantly increase the level of generation available for LV connections.

It has been proposed by Econnect that a DNSP central control room be established for the dispatching of generators to relieve potential network over load and provide ancillary services. The costs have been estimated at AU$ 2.9m (excluding communication infrastructure between sites and zone substations).

Based on the above, Econnect recommends a combination of both LV and HV connections would be required to achieve the largest demand reduction. With the average capital cost (excluding air pollution control equipment) being AU$296 per kVA. Detailed costs are shown in Appendix A.

The study considers LV connection with SCTT operation to be the most cost effective option for customers. The recommendations also discusses the requirements for the appropriate management of air pollution (CO_2 and NOx), with selective catalyst reduction devices (SCR) costing between AU$ 150,000 to AU$200,000, depending on the size of the generator.

4.2.1.2 St George & Sutherland

The St George & Sutherland study discusses the increased probability of generator failure with a higher rate of utilisation. This higher rate of failure may result in generators not being available for emergency supply should an interruption occur.

The costs of converting the sites considered for network support varied from AU$150 per kVA to AU$1,432 per kVA. The large spread in costs is due to the variation in existing equipment and the capacity of the generators considered. However, in general terms the costs associated with converting to full parallel operation are significantly greater then those of SCTT conversion.

As with the CBD study, the Econnect study highlights the requirement for the appropriate management of air pollution.

4.2.2 Preliminary Feasibility Study Costings

The preliminary feasibility studies conducted by Econnect investigated the potential for using standby generation for demand management at five sites in the CBD area and six sites in the St George / Sutherland area. All of the eleven sites currently have standby generators on-site configured for island mode operation. Econnect investigated the potential to upgrade the standby generator configuration at each of the sites to either SCTT or full parallel, as these configurations will allow the generator to be utilised for demand management without a supply interruption.

Econnect only considered SCTT a feasible option at sites where the generating capacity exceeded the maximum site load, as using SCTT at a site where this isn't the case would require the reconfiguring of switchboards which was not possible with the space constraints at the sites.

In terms of full parallel configuration, Econnect only considered sites in the CBD which had enough fault level 'headroom' in the adjacent substation to accommodate the additional fault levels from the generator so as to remove the need for local distribution network augmentation. In the St George / Sutherland area however, none of the sites that Econnect investigated had enough fault level headroom to accommodate the additional fault level contributions from a full parallel configuration, so Econnect considered the extra costs associated with local distribution network augmentation in these cases. The capital costs for full parallel arrangements in the St George / Sutherland area are therefore significantly greater than those from the CBD.

It should be noted that Econnect only provided capital costs for connection upgrades / grid augmentation in the preliminary feasibility studies. SKM has therefore estimated the associated operational costs at the eleven sites for using the standby generators for demand management based on a utilisation of 100 hours per year. In addition, Econnect did not consider the costs associated with retrofitting a dispersion-efficient roof-level exhaust to minimise accumulation of concentrated fume ‘pockets’. These costs are strongly site specific and can vary by orders of magnitude and hence it is not possible to provide a representative average figure. Also, the cost of a fuel delivery guarantee to ensure diesel supply security was omitted from the Econnect costs. Please refer to Appendix A for detailed costs.

4.2.2.1 The Business Case

4.2.2.1.1 Capital Costs

The capital costs for using standby generation for demand management vary from site to site but include electrical works such as modifications to generator control and synchronisation panels, mechanical works such as tank system upgrades, environmental upgrade costs and engineering costs and overheads. In the case of the St George sites, the capital cost estimates also include the local distribution network augmentation costs.

The average capital cost estimates for using standby generation for demand management at the sites from the preliminary feasibility studies are shown in Table 4-2:

- **Table 4-2 Average capital costs ($ per kVA of generation capacity)**

	CBD Sites	St George / Sutherland Sites
SCTT	$256 per kVA	$276 per kVA
Full parallel	$350 per kVA	$610 per kVA

* Roof-level exhaust costs not included

4.2.2.1.2 Operational Costs

The operational costs associated with using standby generation for demand management include the diesel fuel costs and generator maintenance costs.

The average operational costs for using standby generation for demand management at the sites from the preliminary feasibility studies are shown in Table 4-3:

- **Table 4-3 Average operational costs ($ per kVA of generation capacity)**

	CBD Sites	St George / Sutherland Sites
SCTT	$59 per kVA	$68 per kVA
Full parallel	$55 per kVA	$63 per kVA

* Refuelling guarantee costs not included

A significant proportion of the operational cost is comprised of a fixed maintenance amount of $16,000. This estimate is based on SKM's experience with operating cost estimates associated with similar capacity diesel-fuelled generating sets. The difference between the average operating costs above is due to the difference in individual generator capacities in the CBD and St George / Sutherland areas.

4.2.2.1.3 Environmental Upgrade Costs

Exhaust Control Industries Pty. Ltd (ECI) has provided indicative costs for a NOx abatement system per kW of diesel generation capacity in Appendix B. There are four components to the ECI system:

1) SCR NOx Reduction System ($33/kW)
2) Diesel Oxidation Catalyst ($10/kW)
3) Diesel Particulate Catalyst ($19/kW)
4) Diesel Soot Filter ($45 kW)

ECI have indicated to the DMPP that an installation at a normal site would consist of items 1), 2) and 3); costing approximately $62/kW of generation capacity. An installation at a sensitive site such as a hospital, or a site near parklands or where the exhaust is close to street level, the installation should consist of items 1) and 4), making it a 'worlds best practise' system. Such a system costs approximately $78/kW of generation capacity. Assuming a power factor of unity, the cost of the system for a standby generator with capacity of 1 MVA at a normal site and a sensitive site would be $62,000 and $78,000 respectively.

4.2.2.1.4 Overall Costs

The average overall cost estimates for using standby generation for demand management at the sites from the preliminary feasibility studies are shown in Table 4-4:

- **Table 4-4 Average costs ($ per kVA of generation capacity)**

	CBD Sites	St George / Sutherland Sites
SCTT	$315 per kVA	$344 per kVA
Full parallel	$405 per kVA	$673 per kVA

* Roof-level exhaust costs not included

** Refuelling guarantee costs not included

It is important to note that all of the investigated sites already had suitable standby generator units on site, and therefore these estimates do not consider the costs for purchasing a new standby generator unit for demand management. The costs associated with registering the generator (if required) and environmental licences have not been included in the above estimates.

4.2.2.2 Regulatory Framework

4.2.2.2.1 National Electricity Market Management Company (NEMMCO) Registration

For generating plant with a capacity of less than 5 MW, registration is not required with NEMMCO. This is the situation for the vast majority of sites in the DMPP database. For generating plant with a capacity greater than 5 MW but less than 30 MW, registration with NEMMCO as a non-scheduled generator is required. The cost for registration consists of a one-off fee of $3,600 +GST. Of the standby generators that were identified in Section 4 and satisfying the reliability and willingness criteria for demand management; the only sites with a standby generation capacity of greater than 5 MW are:

- 1 Farrer Place;
- 1 Martin Place;
- Equinox Australia; and
- Fairfax Printers

It is unknown, but unlikely that these generators are registered with NEMMCO.

4.2.2.2.2 Environment Protection Licence

DECC have indicated that due to the fact that standby generation use for demand management cannot be classified as emergency supply backup, then an Environment Protection licence maybe required. DECC did not indicate the cost of this licence.

4.2.2.2.3 Contractual Agreements

There are a number of possible contractual arrangements that can be established between the DNSP and the generator owner. These were not discussed in any detail in the Econnect report. EnergyAustralia has had experience with connecting standby generators for demand management purposes and most likely have a policy regarding payments / contributions to the generator owner. The reports commissioned by the DMPP and reviewed as part of this report have not addressed the agreements between the DNSP and the generator owner in significant detail.

4.2.2.3 Cost of Sydney-Wide Implementation

SKM believes that an SCTT standby generator configuration is the most viable option for demand management at sites that are currently configured in island mode for the following reasons:

- SCTT does not require a supply interruption that island mode requires

- SCTT avoids the issues associated with exceeding LV network fault levels when connecting in full parallel mode; and
- SCTT is significantly cheaper than a full parallel connection.

Therefore to estimate the cost of a region-wide or Sydney-wide rollout program for standby generation demand management, SKM has used the average SCTT costs from the sites considered in section 4.2.2. Table 4-5 shows the indicative capital cost, operational cost and overall cost per region that may be expected from such a rollout program.

- **Table 4-5 Costs for region-wide SCTT rollout**

	CBD	Inner West	East Sydney	North Sydney	St George
Island Mode Capacity (MVA): (satisfies the age, maintenance and willingness criteria)	44	17	25	11	0
Capital Costs: (based on $268/kVA of generation capacity)	$ 11,900,000	$ 4,500,000	$ 6,600,000	$ 3,000,000	$ -
Operational Costs: (based on $64/kVA of generation capacity)	$ 2,900,000	$ 1,100,000	$ 1,600,000	$ 700,000	$ -
Total Costs: (based on $333/kVA of generation capacity)	**$ 14,800,000**	**$ 5,600,000**	**$ 8,200,000**	**$ 3,700,000**	**$ -**

* Note: roof-level exhaust costs and refuelling guarantee costs are not included in the capital and operational cost estimates. This will affect the cost of a region-wide rollout.

The cost per region is directly related to the capacity of island mode standby generation within which is both suitable and available for demand management. Table 4-5 illustrates that a CBD-wide (44 MVA) rollout of SCTT could cost in the order of $15M, whilst a Sydney-wide rollout (97 MVA) may cost in the order of $32M. No costs have been estimated for an SCTT rollout in the St George / Sutherland region as there is no island mode capacity in this region that is both suitable and available for demand management. It should however be emphasised that these region-wide cost estimates are indicative only, and an inspection at each site within the region would be required to determine an accurate cost estimate of such a rollout.

4.3 *Sinclair Knight Merz* Site Surveys

SKM conducted three site surveys for the DMPP to verify the preliminary feasibility study findings and cost estimates of using existing standby generation for demand management.

The sites were selected according to the size of the standby generator capacity and the generator unit reliability. They are listed as follows:

- 363 George Street – CBA Building
- 88 Phillip Street – ABN AMRO Building
- 225 George Street – Grosvenor Place

As the existing standby generator connections at the three sites were island mode configurations, SKM consider that upgrading the existing standby generation for SCTT to be the most appropriate option for demand management purposes. Conversion to an SCTT configuration would avoid the need for an interruption in the power supply when switching from grid supply to standby generator supply. An SCTT configuration also avoids the distribution network fault level issues that are associated with a full parallel connection.

SKM has estimated the capital costs for upgrading to an SCTT configuration at the three sites. Estimates have also been made for the operating costs involved with running the standby generators for demand management for a total of 100 hours over a one year period. The average cost estimates for the three sites are shown in Table 4-6.

- **Table 4-6 Average costs for using standby generation for demand management in an SCTT configuration at the three sites surveyed**

Capex Costs*	
SCTT conversion (typical)**	$262 per kVA
Roof level exhaust	Not estimated*
Opex Costs***	
Fuel, O&M	$43 per kVA
Refuelling guarantee	Not estimated*
Total Costs	**$305 per kVA**

The capital cost estimates for the sites surveyed closely correlate with the preliminary feasibility study capital cost estimates. However, the operating costs at the surveyed sites are lower than those from the preliminary feasibility studies. This is because of the fixed maintenance cost component per generator and that the generator units at the surveyed sites had significantly larger capacities. The average generator unit capacity at the surveyed sites was 1,650 kVA compared with an overall DMPP database average of 1,000 kVA. Therefore, SKM considers the operating costs from the preliminary feasibility studies as a more realistic representation of an average site.

It should also be noted that if a site's standbys are to be used for demand management for consecutive days, it may be necessary to refill the bulk fuel tank overnight. Hence it may be necessary for the site to engage in a 'guaranteed' fuel delivery arrangement so as to ensure the diesel supply is secure. The cost for such an arrangement has not been allowed for in the cost estimates.

SKM also found that the three sites had generator exhausts that discharge horizontally at low levels in the building. As a horizontal discharge concentrates the exhaust emissions into a relatively small area, the emission levels – as a result – are quite intense. SKM believes it is likely that DECC will require the exhaust ducts be extended to discharge above the building roof level so that emission readings are more diluted. The cost of retrofitting such an exhaust has not been estimated as the site surveys were of a high level nature and the costs would need to be treated on a site-by-site basis. If these sites are further considered for demand management, a detailed cost assessment would need to be carried out.

The site surveys also highlighted the requirement of tenancy cooperation when considering a standby generation demand management program. In talks with the building manager, SKM were informed that concerns had been raised by the tenants of Grosvener Place at the increased risk to supply security associated with switching from grid supply to diesel generator supply. As a result, it is highly unlikely that Grosvener Place would participate in a standby generation demand reduction program. SKM believes that this issue may be a significant barrier to a Sydney-wide roll-out of a standby generation demand reduction program.

In addition, the DMPP encountered significant difficulties finding sites that were willing to participate in the study. This indicates that the take-up rate of standby generation demand management is likely to be low, even at sites that are technically suitable. It is therefore prudent that the DMPP's 'identified standby capacity' is not regarded as an indicator of 'practical capacity' for demand management purposes.

5. Findings and Recommendations

Demand management refers to any activities that lower the demand at peak times on the electrical network. The objective of demand management is to enable the cost-effective deferral of major new electrical infrastructure works and the end customers will be the beneficiaries of the deferred expenditure through lower electricity tariffs.

The purpose of this report was to investigate the opportunities and options associated with one possible activity in demand management, standby generation. Standby generation involves the use of emergency standby generators to provide network support during times of peak demand. There are a number of considerations that must be taken into account when determining the opportunity for and effectiveness of standby generation.

Typically, the implementation of standby generators for demand management only defers electrical infrastructure works for a short period of time (i.e. 1 to 2 years). EnergyAustralia quote a figure of 2.9% summer and 3.1% winter demand growth per year in the Sydney CBD over the next 5 years[1]. This equates to growth in the CBD network of up to 16 MVA per year. Due to the magnitude of this growth and the relatively small size of standby generators (1 MVA average size), long term deferral of network investment through this demand management solution is unrealistic. It is for this reason that the economic analysis of the standby generators considers a one year period only. The economic justification behind each project must be undertaken on a case by case basis and include such factors as; generator size, location, demand growth rate, network impacts, environmental impacts and modifications to plant. EnergyAustralia have developed detailed and comprehensive assessment criteria for determining the effectiveness of a demand management solution using standby generators and undertake this assessment prior to proceeding with or deferring network investment. EnergyAustralia's demand management process is available on their website.

The environmental considerations associated with connecting diesel-fuel standby generators to the network at times of peak demand are important. Diesel-fuelled engines are high emitters of NOx and particulates and this combined with their location (i.e. inner city) make their use for demand management purposes less desirable. The environmental analysis undertaken for the DMPP identified a number of issues with regard to the ability to meet NSW environmental targets with the implementation of the standby generator project. Technologies are available to reduce environmentally sensitive emissions; however, these come at a significant cost, which would need to be considered as part of the economic analysis for the viability of each site.

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[1] EnergyAustralia: Investing in Future Generations: Our Five Year Plan 2007 – 2012

The DMPP identified a large number of sites with standby generation capacity that is potentially viable for use in demand management. A number of sites were selected and case studies undertaken to determine the modifications and costs associated with reconfiguring the plant so that it could be connected to the network. It appears that the most viable option from the case studies is to modify the site switchboards to allow for the Synchronise, Close, Transfer, Trip (SCTT) mode of operation. In principle, this mode removes the site load from the electrical network and transfers it to the standby generator, thereby reducing network demand. It is important to note that this mode is not applicable to sites where the site load is larger than the capacity of the standby generator, without significant modification to the site switchboard.

Connecting the generators in the SCTT mode avoids the issues associated with exceeding LV network fault levels when connecting in full parallel mode and does not require a supply interruption that island mode requires. One of the drawbacks of using SCTT mode is the possibility of a reduction in the quality of supply due to the lower fault level contribution of the generator compared to the network supply. This is only a concern when using certain types of load and would need to be assessed on a case by case basis. In discussions between EnergyAustralia and the DMPP, EnergyAustralia has indicated that the LV network fault level issues would not be a significant concern during the time that the SCTT mode has the generator connected to the network.

The location of the standby generation and its proximity to network constraints is a critical aspect to the viability of using standby generation for demand management purposes. The work currently undertaken for the DMPP has a greater focus on the feasibility and costs associated with connecting the standby generators to the network, than on identifying locations within the electrical network that are experiencing constraints at high demand. Both aspects are important to consider when discussing the feasibility of using standby generation for demand management. Standby generation is largely a redundant resource if the area in which it is located does not have a capacity constraint.

An incentive scheme to encourage the take-up and rollout of a standby generation approach to demand management has not been robustly addressed. It would not be unreasonable to assume that site owners and managers would expect some compensation or incentive to undertake the work necessary on their equipment considering that is intended to provide a benefit to the network provider. In addition to having modifications made to their site, the generator owner is taking on additional risk in terms of supplying their own site load at times of high demand, complying with strict environmental emissions and aging of the equipment. A network provider could potentially benefit by around $450,000 in the case of investing $50,000 in a standby generation project that allows the deferral of a $5 million network project by 1 year. The site owner will see some benefit of this saving through a lower fixed electricity distribution tariff, as will the rest of the customers connected to the network, however, it is doubtful whether the network provider could rely on this alone to entice site owners to participate.

6. References

- *CBD – Standby Generator Integration Project Preliminary Feasibility Study* – Econnect
- *St George / Sutherland – Standby Generation Project Preliminary Feasibility Study* – Econnect
- *Quay West Suites Sydney – Grid Connection of Diesel Generator Preliminary Feasibility Study* – Econnect
- *Air Quality Impact Assessment: The Integrated Generators Project* – Holmes Air Sciences
- *DECC Comments on the Integrated Generators Proposal* – The Department of Environment and Climate Change NSW
- *DECC Requirements for Diesel Electricity Generation Using Internal Combustion Engines* – The Department of Environment and Climate Change NSW
- *Proposed Standby Electricity Generation Station, Cessnock Road, Weston – Supplementary Information 10 April 2007* – Infratil Energy Australia
- *Case Study – ECI NOx Abatement System* – Exhaust Control Industries Pty. Ltd
- *DMPP – Partial Load Standby Potential* – Sinclair Knight Merz

Appendix A

Appendix B