Camel Chiropractics: The New South Wales Demand Management Code And Mapping Demand Management Opportunities

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ABSTRACT

Electricity utility-based demand management (DM) has traditionally been based on "least cost planning" and/or dedicated funds. In both cases, the assessment and selection of DM options has been centralised in the hands of the utilities themselves, their regulators or the fund administrators. Market participants and other stakeholders have been dependent on these bodies to decide and disclose when and where DM opportunities arise and what they are worth.

The New South Wales (NSW) Government is supporting an alternative, market-based approach to DM through the NSW **Demand Management Code of Practice** (DM Code) which requires the monopoly distribution network businesses annually to disclose detailed data about capacity, load and investment proposals throughout their service territory. The DM Code also requires the network businesses to adopt a transparent, competitive process for assessing and procuring network and non-network (DM) solutions to emerging network constraints.

These data, published in annual "Electricity System Development Reviews", can be summarised to produce highly informative network constraint and DM opportunity maps. These maps allow DM services providers and other interested parties to identify, at a glance, areas of emerging constraint, the relative marginal cost of network capacity and therefore the potential for, and value of, DM in different areas. Such maps can be invaluable to network businesses for planning and to regulators for reviewing network investment prudence.

This paper reviews the development and performance of the DM Code, presents DM opportunity maps for metropolitan Sydney and suggests options to improve the DM Code.

Introduction: What's the Big Deal About Network-Focussed DM?

- **DM born of campaigns against power stations**. Demand management (DM)[2] can be defined as "any action undertaken by the supplier of a good to influence the level or timing of demand, rather than simply supplying the good." Electricity DM emerged in the context of the 1970's oil crises, particularly as a response to proposals to build controversial new nuclear power stations, and in some cases damming rivers for hydro-electricity. More recently, DM has been promoted as a means of avoiding greenhouse emissions from fossil fuel based power stations. While DM advocates emphasize its cost effectiveness, they usually do so because it undermines the key argument for the power stations they oppose.
- **Australia's limited activity in DM**. This background to DM in North America helps explain why the practice of DM has been less extensive in Australia's electricity industry. Australia has huge, cheaply accessible coal deposits. Coal is Australia's most valuable

[1] GIS mapping services provided by Mr Chris Loty, the assistance of my colleagues on the DM Code of Practice Working Group and suggestions by Dr David Crossley and my peer reviewers are gratefully acknowledged.

[2] In Australia, the term Demand Management is more prevalent than its American synonym Demand Side Management (DSM). For this paper, I use a broad definition of DM encompassing any energy efficiency, peak load management or distributed generation that is intended to as an alternative to centralised generation and/or network infrastructure. [For further definition of DM refer to IPART (Oct, 2002). p. 3.]

export commodity and Australia is the world's biggest coal exporter[3]. Consequently, Australia has the highest proportion of coal fired power generation in the OECD. A side effect of this heavy reliance on coal-fired power stations is that Australia has not encountered the sort of controversies over nuclear power stations experienced by many other industrialised countries. Occupying the world's driest inhabited continent, Australia has also had relatively limited controversy over hydro-electric power stations[4]. Moreover, following massive investment in coal fired power stations in the early 1980's, there has been little need for additional generation of any kind, at least in the most populous states of NSW and Victoria. Hence, this key driver for DM of opposition to new power stations has been largely missing in Australia for the past two decades.[5] While the debate over new power stations is likely to re-emerge over the next few years as Australia's electricity demand catches up with installed generation capacity, this paper argues that DM is crucial even in the absence of major new power station proposals.

- **Two and a half reasons why networks are crucial to DM.** While DM as an alternative to power station investment has received much more attention, network-focussed DM is central to any DM strategy for two key reasons (and probably a third)[6]. **First**, as network costs make up about half the average electricity bill and two thirds of the capital cost of electricity supply, any analysis that neglects network will seriously underestimate the potential benefits of DM. **Second**, even in "restructured" markets, electricity networks tend to remain monopoly suppliers. This reduces the likelihood of cost reflective prices and innovative alternative service providers emerging spontaneously to stimulate DM. The **third** reason is the threat of stranded investment. This is currently only a "half a reason" as it depends on how technology and markets evolve. However, the rapid development of small-scale distributed generation and related technology (including fuel cells and hybrid electric vehicles), creates a real risk that major network augmentations may become redundant long before reaching their economic life expectancy.

Spikes and Lumps: Understanding Network Costs Drivers

As competitive electricity generation and retail markets have been established in many jurisdictions, the phenomenon of energy "price spikes" has become familiar. These occur where, as demand approaches the level of available generation capacity, the price in the market escalates dramatically so that, for some period of time, the spot (or market clearing) price may be tens or hundreds of times the average price. The same factors which cause "price spikes" in competitive generation markets also drive network costs, but with two fundamental differences:

- Network prices are seldom set through competitive market processes and prices seldom directly reflect spikes in marginal network costs; and
- Unlike individual power stations whose capacity is pooled to service large areas, network elements generally service much smaller areas and so the marginal costs of network capacity can vary enormously from place to place.

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[3] These facts may interest to those who regard Australia's current position on the Kyoto Protocol as having more in common with the major oil exporting countries of OPEC than with most developed western democracies.
[4] There have however been some high profile exceptions to this rule, such as the controversy over Tasmania's proposed Gordon-below-Franklin dam in the early 1980's.
[5] By contrast, two severe droughts since 1990, has made water demand management a focus of national attention.
[6] For a detailed discussion of the benefits of DM see Lovins et al (2002)

Electricity network costs are also influenced by a number of other characteristics.

- **Building for peaks.** The suppliers of most goods and services are not expected to meet the full level of demand at every instant. Consumers may be disappointed, but not surprised, if they cannot always purchase football finals tickets, fresh mangoes or an immediate doctor's appointment. In contrast, electricity is generally regarded as "an essential service" to be provided on demand "24/7". Given the impracticality of storing electricity, Distributors must build capacity to cater for the highest plausible forecast peak demand.
- **Capital intensity.** Capital costs represent a high share of Distributors' expenditure. In NSW, capital costs account for about 60% of distribution costs [IPART (2004), p.61].
- **Widespread dispersion**. By their very nature, networks span wide areas. The circumstances and conditions of the network vary throughout the network. In general, surpluses in one area cannot easily be used to offset constraints in other areas.
- **Economies of scale**. The cost of providing networks per unit of installed capacity declines as the capacity increases. So for example, a 20 MW substation will be significantly less expensive than two 10 MW substations on comparable sites. Investment in network infrastructure, therefore, tends to be made in large infrequent "lumps", rather than regular, small increments.

Peak Load Straws and Networks' Camel Backs

The above factors mean that marginal network costs vary widely from time to time and place to place. In parts of the network where there is significant spare capacity, the marginal cost of servicing an additional KW of peak demand is likely to be small or zero. On the other hand, in areas where peak demand is approaching network capacity, the marginal cost of servicing additional peak demand can be much higher than the average cost of network services.[7] In the extreme case, if peak demand is gradually approaching the firm rating for that part of the network, there will be one small increment in peak demand that crosses the relevant "reliability criteria" line and triggers the decision to augment the network – a last straw that breaks the camel's (in many cases, multi-million dollar) network investment back.

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Applying DM to reduce demand growth can potentially delay this last straw, avoiding or at least deferring major investment costs. In practice, where growth in peak demand is ongoing, it is usually a matter of **when** not **whether** the line is crossed and therefore the savings tend to represent deferral of capital expenditure rather than their complete avoidance. Nevertheless, the savings available through deferring multi-million dollar capital expenditure projects for several years can be substantial. Targeting DM at impending network constraints can deliver savings in network capital expenditure well in excess of the average cost (or average price) of network service. These principles are illustrated in the following case study (see Figures 1, 2 and 3).

Castle Hill network augmentation and demand management project. **C**astle Hill is a mainly residential area with a large shopping centre in Sydney's north-western suburbs. The local distribution network is owned and managed by Integral Energy, a State Government owned

[7] For a deeper discussion of these principles see Moskovitz (2001).

distribution network service provider ("Distributor") that serves the western half of metropolitan Sydney and rural areas west and south of Sydney. While Castle Hill itself is well established, it borders areas of new urban development. Summer peak demand in Castle Hill is growing by about 0.6MW, or 2 %, per annum and approaching the firm network rating of local distribution network of 35 MW (see **Figure 1**).

In order to ensure reliable supply, given current growth forecasts, Integral Energy considers it prudent to augment the network by 2005/06. It proposes to do this by increasing the capacity of the lines supplying the local zone substation at a cost of $1.5 million[8] [Integral Energy (2003), pp.182-188, 201]. Integral Energy has contracted the NSW Government's Sustainable Energy Development Authority's (SEDA) to deliver 1.35 MW of peak load reduction by December 2005 in order to achieve a one-year deferral of the $1.5 million investment. (While the objective is peak load reduction, SEDA has in this instance found end use energy efficiency to be the most cost effective option to achieve this.)

Assuming a weighted average cost of capital of 7% p.a. and a depreciation rate of 3% p.a., the cost of providing this additional network capacity is $150,000 per annum ($1.5 million x (7% + 3%)). Integral Energy has calculated that it would need to reduce peak demand by 0.3 MW by 2005/06 in order to defer the need for this augmentation by one year.[9] The value of such a deferral is therefore $500,000/MW.year (i.e. $150,000/0.3MW) in the first year (or $500/kW.y), as illustrated in **Figure 2**. This value of deferral is much higher than the revenue associated with providing the network capacity.

In other words, the network would be better off if it spent up to $500/kW per year (the value of deferral) on DM in order to achieve this investment deferral. This point is underlined by **Figure 3**, which compares the value of deferral when distributed over the number of hours for which the augmentation is required ($/kWh), with the average actual price of distribution services. In the first year of forecast overload, peak demand is forecast to exceed the current firm capacity for a total of 3 hours. This means that the value of deferral ($150,000/yr) is required to service a peak overload of 0.3 MW for up to 3 hours, or about $167,000 per MWh or $167/kWh (this compares to an average price for distribution network services of about **4 cents** per kWh). The value of deferral (in $/kWh) falls away quickly as the forecast hours of over load per annum increase exponentially. Nevertheless, there is a significant window of opportunity for the distributor to benefit financially by offering to purchase DM for many times the average retail price of electricity in order to facilitate a deferral of investment.

A Stitch (or Straw) in Time…

Of course, the procurement of DM is not instantaneous. For DM to be effective and reliable when required, networks must initiate the process of seeking out DM well in advance of when a decision on network augmentation is due. On the other hand, implementing DM too far in advance of the augmentation decision also risks wasting resources that could be better applied to DM elsewhere.

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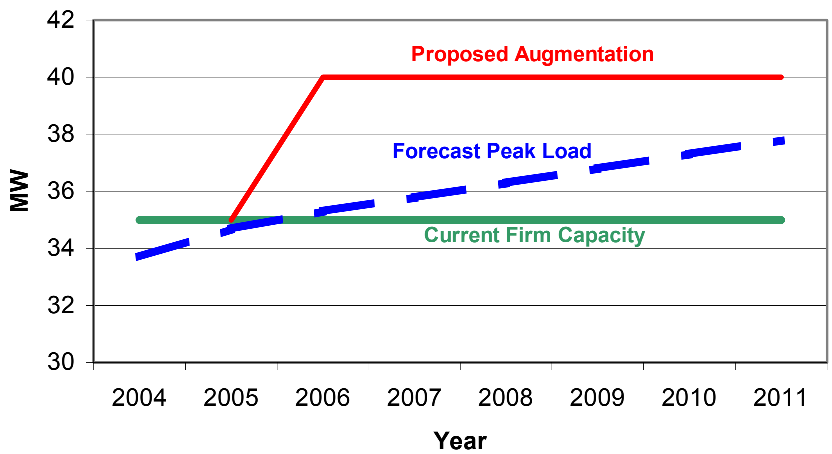
8 Integral Energy proposes to follow this in 2007/08 with a new zone substation at a cost of $12 million to offload both the Castle Hill and West Castle Hill zone substations. Note that for simplicity, the following analysis **only** includes the value of deferring the smaller $1.5 million investment and not the later, larger $12m investment.

9 Where the forecast level of overload is not specified, the same analysis can be undertaken for avoiding a full year of forecast load growth, in this case, 0.6 MW.

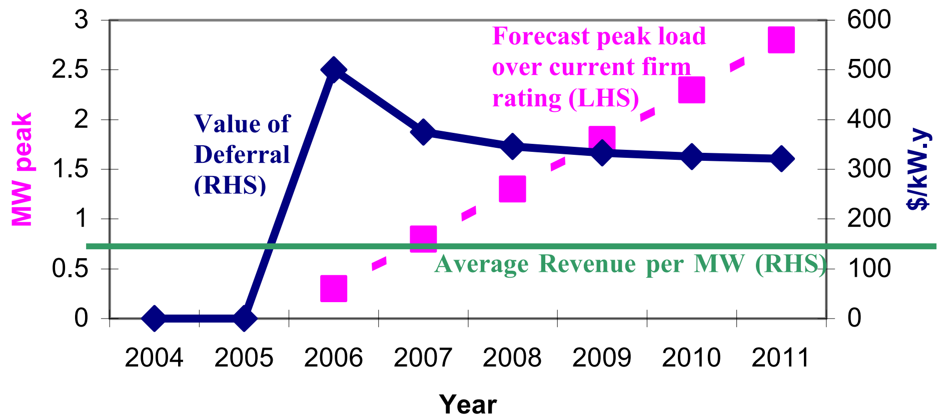
Figure 1. Forecast Network Peak Demand and Proposed Augmentation



As forecast peak demand exceeds network firm capacity…

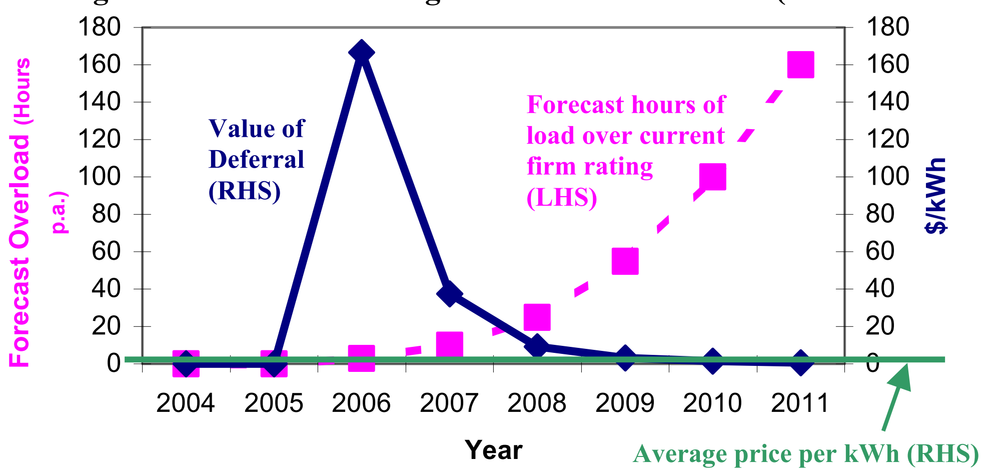
…the network plans to invest in new capacity.

Figure 2. Costs of Servicing Incremental Network Peak Demand (vs. Size of Overload)



The marginal cost of providing network capacity (and therefore the value of deferral) jumps from near zero before augmentation required to well above the average revenue following augmentation.

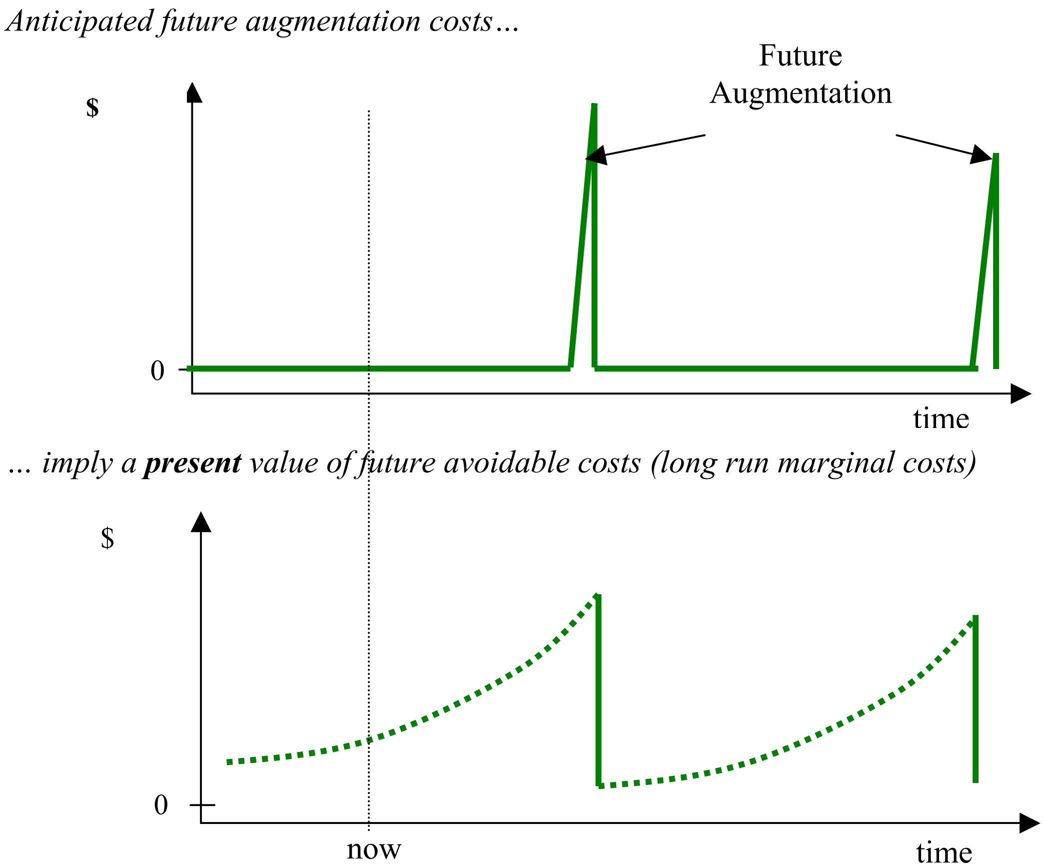
Figure 3. Costs of Servicing Network Peak Demand (vs. Hours of Overload)



In the early years of the new investment, when the hours per year of utilization (i.e. hours where peak load exceeds the previous firm capacity) is low, the cost of providing new capacity far exceeds the average selling price of network capacity (about $0.04/kWh).

As illustrated in **Figure 4**, the direct financial value of network DM is maximised by undertaking it as close as possible to the time that it is required to defer investment, but early enough to maximise the use of cost-effective DM. In short, you want to remove straws from the camels back as late as possible to maximise camel utilisation, but not so late that your camel buckles under (or you need to buy a new camel). As noted above, such timely use of DM has not been the rule for network development in NSW in the past. On the contrary, the Distributors have tended to disregard DM in times of surplus network capacity, so that when constraints emerge, Distributors have often concluded that sufficient cost-effective DM is either not available, not available quickly enough, or too risky given the lack of proven DM precedents.

Figure 4. Value of Avoidable Network Augmentation Cost



So What About Pricing?

An obvious implication of the above analysis would be for Distributors to reflect in their prices the dramatic long run marginal cost variations from place to place and from time to time. There seems to be great scope for implementing more cost-reflective network pricing, through local "congestion tariffs", seasonal tariffs, time-of-use tariffs, etc. Making the adoption of such restructured tariffs voluntary could help to allay any concerns about adverse impacts on consumers. However, while efficient pricing is essential to any effective DM program, there are practical limits to how far tariff reform alone can assist DM. While the information technology is available to handle a wide range of locational and time-specific tariffs, the administrative complexity and the customer relations and marketing challenges involved will likely make a heavy reliance on tariff reform impractical. If such tariffs are voluntary, the adoption rate may be low, but if compulsory their political and equity impacts may be intractable. In this context, non-price based DM can play a crucial role. There is likely to be much greater flexibility for locational and temporary targeting through offering DM incentives than through pricing alone.

In either case, pricing or non-pricing DM, there is a crucial need for information on which to base these prices or DM offers. DM is a relatively new concept for Distributors and their shareholders and customers. In the absence of either clear regulatory/policy drivers or successful precedents, it is unlikely that these businesses will rapidly depart from past practice. It was precisely to break out of this "trend equals destiny" cycle that the Demand Management Code of Practice for Electricity Distributors was developed in NSW.

The DM Code and Market Based Electricity Network Development

The electricity transmission and distribution network businesses in NSW are monopoly service providers owned by the State Government. As part of the 1995 electricity industry restructuring reforms, each Distributor is required,

> "…before expanding its distribution system … to carry out investigations … to ascertain whether it would be cost-effective to avoid or postpone the expansion by implementing DM strategies) ...[where it] would be reasonable to expect that it would be cost-effective,"
>
> *[NSW Electricity Supply Act 1995 , Sch. 2, cl. 5]*

The DM Code of Practice for Electricity Distributors (DM Code) provides guidance to electricity Distributors in implementing this provision. The first version of the DM Code was published in October 1999 and focussed on the circumstances in which the Distributors should investigate DM. The current, significantly revised DM Code, published in May 2001, adopted a radically different approach. Its focus shifted to supporting a market-based approach to network development. (The Code has been developed by a working group of the Distributors and stakeholders and provides excellent case study of effective voluntary policy collaboration)[11].

This market based procedure is intended to ensure, through the use of open competitive processes, that all supply and demand side options developed by customers or third parties and by the Distributor itself can be developed and evaluated *at the same time* and *in the same manner* as network augmentation.

There are two key aspects to this use of market mechanisms in network development:

- Detailed network planing information disclosure to improve information gathering and identification of options; and
- Competitive procurement of network support (i.e. network augmentation *and* DM).

[11] The author participated on the Working Group which undertook both the 2001 and the 2003/04 reviews.

The DM Code requires Distributors to undertake the following steps:

- Publish information that makes transparent the underlying assumptions and decision-making process relating to investments that expand their distribution networks;
- Inform the market about the current and future state of the electricity supply system by publishing appropriate detailed information in a way that enables interested parties to identify likely locations of forthcoming constraint;
- Consult customers and other interested parties in relation to specific forecast constraints;
- Specify forthcoming constraints in their network and proposals for network expansion;
- Adopt a transparent process to determine whether DM investigations are warranted for identified emerging constraints;
- Test the market by calling for proposals for DM network support in constrained areas;
- Evaluate DM and network expansion options on an equal basis and publish the results;
- Implement DM options where they are determined to be cost-effective; and
- Publish reports on these activities annually.

The requirements of the DM Code are summarised in Figure 5, which comprises three columns. The shaded boxes in the left-hand column summarise generic steps to be undertaken. The flow chart in centre details the required procedure. The group of boxes on the upper right hand side refer to the Protocols that inform the procedure at each key step. The boxes in the lower right hand corner indicate the arrangements through which the Distributors report to their regulators on their activities relating network augmentation and DM.

The DM Code places obligations on Distributors for greater transparency and consistency of approach in developing their networks. On the other hand, it also clarifies the requirements on Distributors and should streamline the development process and provide greater certainty over the recovery of investment in both DM and network augmentation.

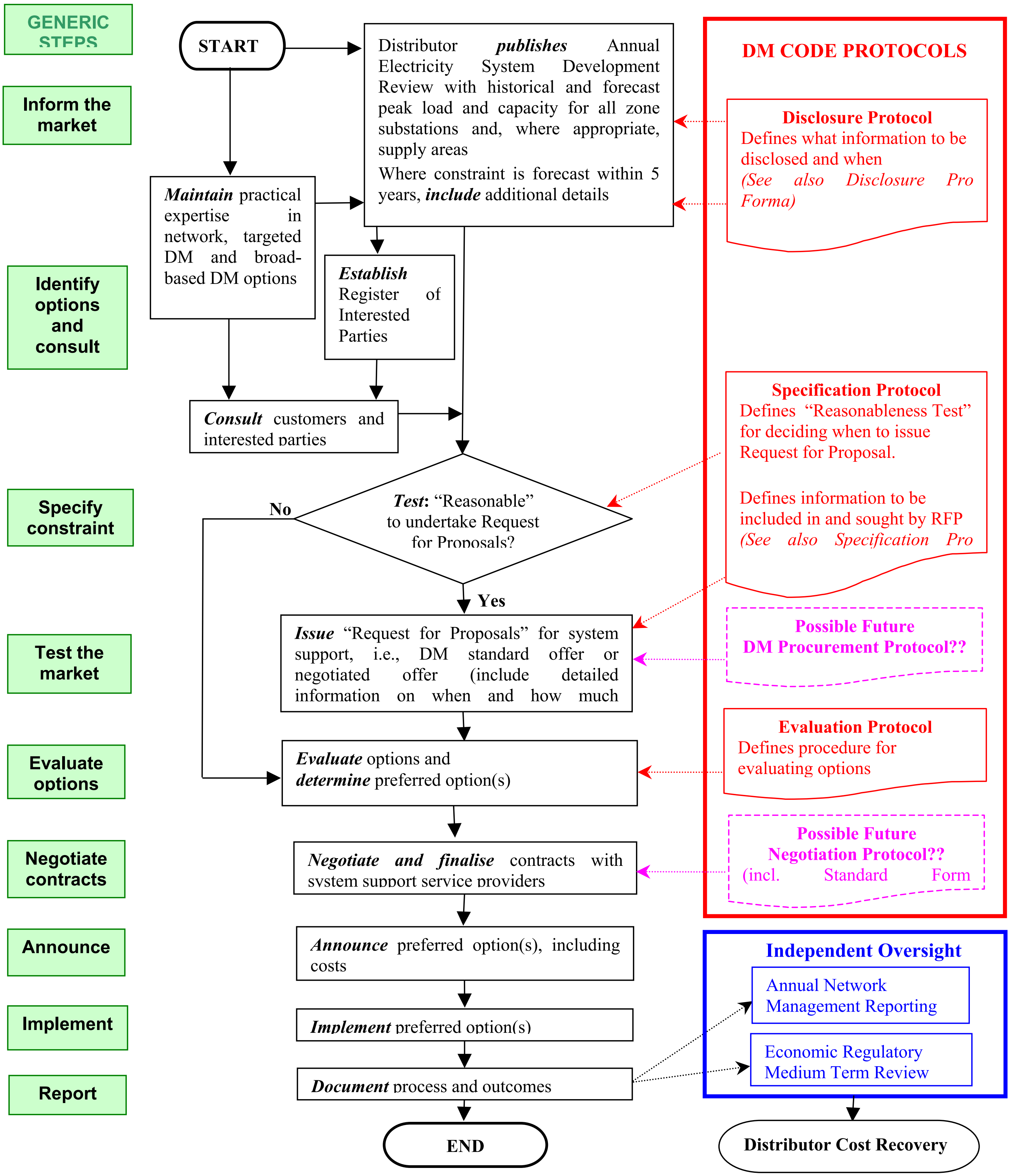
Performance to Date of the DM Code

In developing the DM Code there was an expectation that network augmentation (and DM developed and implemented by the Distributors) would to continue to provide the bulk of new system support for the near future. However, it was also expected that non-network solutions and market provided DM would gain an increasing share of the investment available for addressing network constraints.

First the Good News

Since the adoption of the Revised Code in May 2001, there has been significant activity in reporting of network conditions, investigating DM and inviting market participation in providing DM services. This has yet to translate to a significant increase in DM implementation, but there are a number of positive signs. The Distributors have published Annual Electricity System Development Reviews (ESDRs) that are available on their websites. There have been numerous Requests for Proposals (RFPs) issued for urban and regional areas, inviting interested parties to offer DM services. There have been numerous responses to these RFPs and Energy Australia and Integral Energy are in negotiation over a number of these proposals.

Figure 5. Electricity System Development Procedure for Distributors
Source: NSW DM Code of Practice (with amendments)



Now the Bad News

While the DM Code has strengthened the market and the capacity of the Distributors to analyse and develop DM opportunities, the pace of this development since 2001 has been slow. There are a number of deficiencies in the DM Code that should be addressed to accelerate this development. These deficiencies include:

- **Much data; not enough information**. The Electricity System Development Reviews (as required under the Disclosure Protocol) provide a rich mine of data. For example, the 2003 Energy Australia ESDR runs to 400 pages. However, given the relatively undeveloped state of the DM market, few market participants are either equipped or motivated to delve deeply into this mine. It would be helpful for the ESDR's to include more accessible information, such as summary tables and maps (as discussed in detail in section 5).
- **Lack of market confidence** While there have been numerous RFPs issued in NSW over the past three years, anecdotal evidence suggests that the level of interest and number of responses to these RFPs are waning. This may be a natural response on the part of DM service providers who have neither won work from the process themselves, nor seen their competitors win contracts. Some DM service providers have expressed scepticism about the commitment of the Distributors to procuring DM. Some earlier RFPs requested and received detailed offers of DM network support from the market. More recent RFPs have tended to be met with offers to undertake ***investigation*** of DM options on a fee-for-service basis. Distributors accepting some of these offers of investigation would probably represents a reasonable sharing of risk between Distributors and DM service providers, at least until a sizeable track record of DM implementation has accrued.
- **Complexity of negotiation.** Another reason for slow uptake of DM despite numerous RFPs being issued is that even when attractive offers are made, the process of negotiating a contract for DM services can be long and complex. For example, the North Ryde RSL Club offered to provide network support through a 1 MW standby generator in response to the first DM RFP issued by Energy Australia in 1999. The contract for this project was put in place in 2003. There is a clear need to streamline the negotiation process for DM. An explicit "Negotiation Protocol" including standard contracts for DM services may help streamline this process. Simpler RFPs such as Standard Offers that detail the specific contractual conditions under which DM will be procured, may also help.
- **Exclusion of transmission networks.** Distribution networks are regulated at a state level, while transmission is regulated nationally. This has meant that the transmission network in NSW has not been subject to the DM Code. As transmission represents about 20 per cent of network costs, this represents a major lost opportunity.
- **Regulatory uncertainty.** While not a deficiency of the DM Code itself, NSW Distributors have expressed some hesitancy to embrace DM due to uncertainty over how DM will be treated by their economic regulator, the Independent Pricing and Regulatory Tribunal (IPART). In particular, there has been concern that Distributors may not be permitted to recover expenditure on DM or retain the capital expenditure savings achieved through DM. IPART has recognised the potential benefits of DM for many years and has sought to remove identified regulatory barriers to DM. (See for example its Report into Demand Management [IPART 2002]). In its recent landmark Distribution Network Pricing

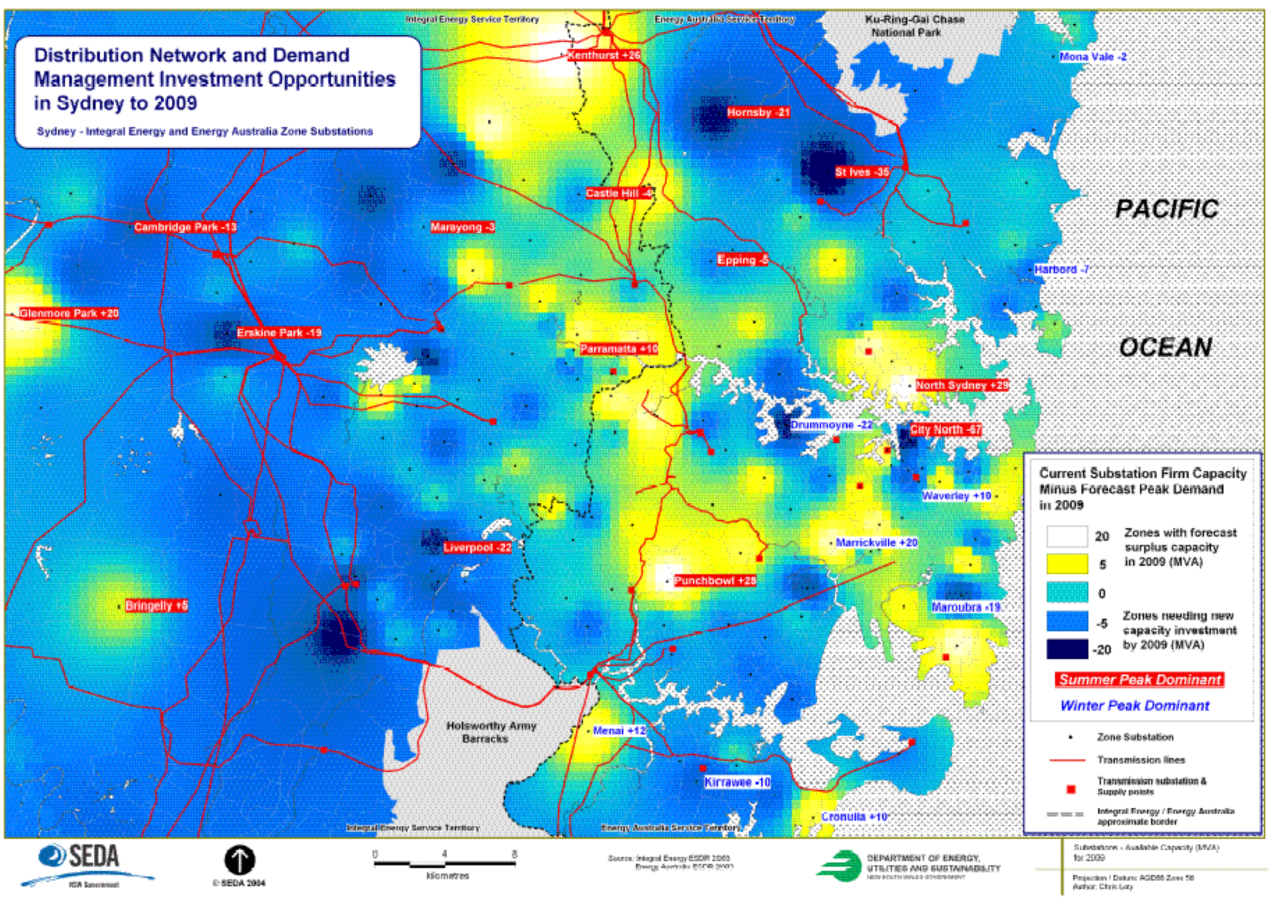
Determination, IPART has explicitly permitted Distributors to ***both*** recover expenditure on DM ***and*** retain the capital expenditure savings achieved through DM at least for the next regulatory period 2004/05 to 2008/09. This should provide a strong stimulus for Distributors to expand their DM activity.

The 2003/04 revision of the DM Code is expected to be published soon. At least some of the above opportunities to improve the DM Code are expected to be addressed in this revision.

Where to Next? Mapping Network Constraints

A map is worth a thousand data points. As noted above, one key means of improving accessibility is to map the information disclosed in accordance with the DM Code. While the DM Code does not currently require the Distributors to include maps, some have chosen to include simple schematics of network configuration. In order to illustrate how maps might be used to interpret data from the ESDRs, SEDA has created maps, as shown below, of: Forecast network capacity and DM investment opportunities (Fig 6). Proposed network augmentation investment (Fig 7); and Marginal network investment deferral value (Fig 8).

Figure 6. Sydney Suburbs requiring DM or Network Augmentation by 2009

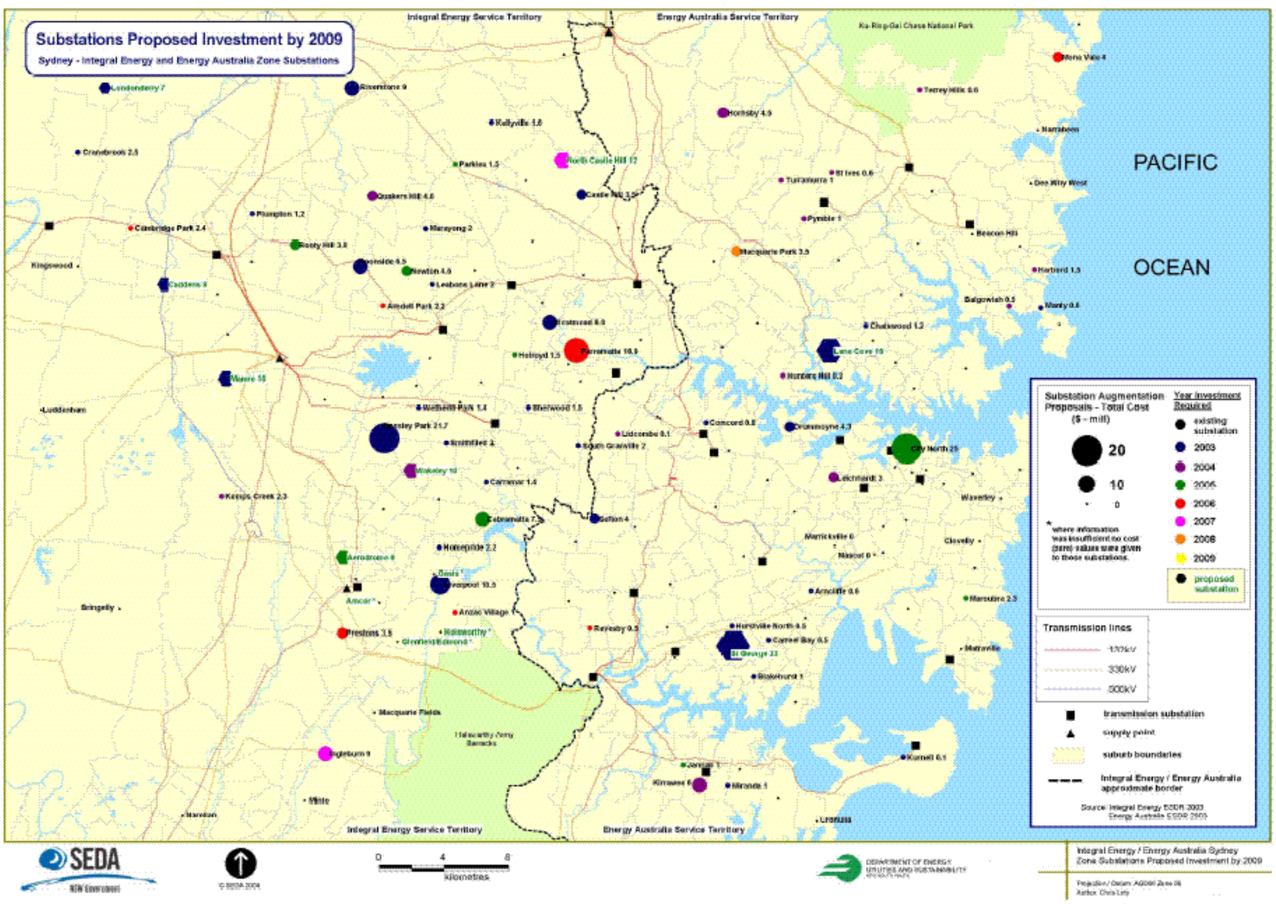


Source: Data derived from Energy Australia and Integral Energy Electricity System Development Reviews

At a glance, it is possible to discern in Figure 6 key aspects of the current and emerging state of the network. Dark (blue) areas indicate areas where current network capacity is insufficient to meet forecast demand by 2009 unless further investment is undertaken. These areas offer the greatest potential for effective network-focussed DM. Lighter (yellow and white) areas indicate adequate network capacity through to 2009. Dark(blue)-text-on-white titled suburbs indicate areas of winter peaking demand. These tend to be clustered in coastal suburbs that catch the cool sea breeze in summer. White-text-on-dark(red) titled suburbs are summer peaking, and these tend to be inland in Sydney's "AirCon Belt" and in the CBD dominated by commercial HVAC.

Figure 7 illustrates where the Distributors are proposing to invest in network augmentation if DM cannot be applied to reduce the forecast growth in peak demand. The larger the dot, the larger the proposed investment is. The dots are colour coded to indicate the year in which investment decision is forecast to be required. Darker dots indicate more imminent investment than lighter ones. Areas with larger proposed investment will be, other things being equal, more attractive for DM as they imply larger investment deferral values. Round dots indicated enhancements to **existing** infrastructure. Hexagonal dots indicate proposed **new** zone substations to offload neighbouring constrained zone substations.

Figure 7. Proposed Network Augmentation Investment in Metropolitan Sydney to 2009

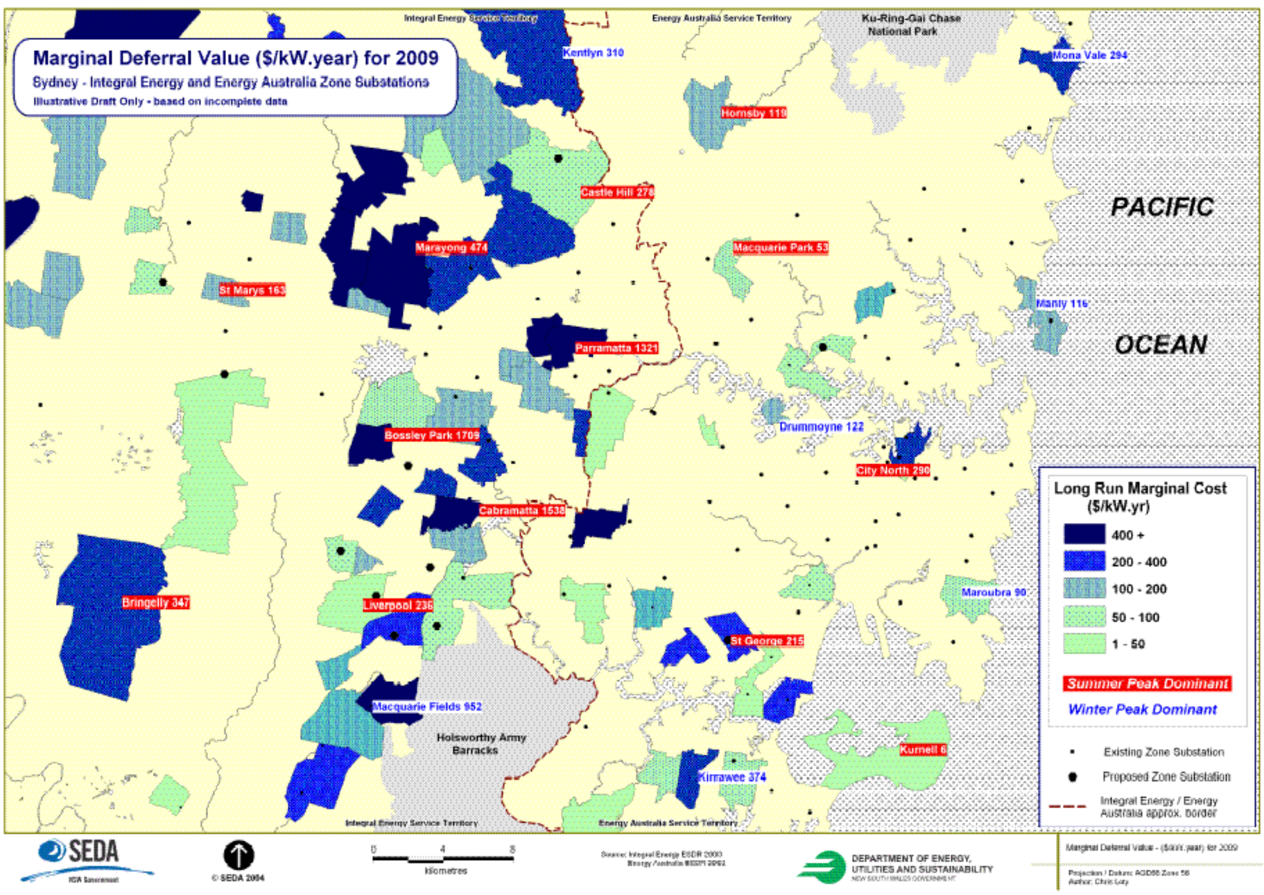


Source: Data derived from Energy Australia and Integral Energy Electricity System Development Reviews

Figure 8 is perhaps the most powerful of the three network maps. It draws on the load growth and proposed investment data of the ESDRs to illustrate, suburb by suburb, the value of deferring network augmentation investment as calculated in section 2 above. It thereby illustrates the potential value of undertaking DM in these areas. The darkest (blue) areas indicate a deferral value of over $400/kW.y while the next darkest indicates a value of between $200/kW.y and $400/kW.y. As discussed above, these can amount to very attractive offers for DM.

These three maps highlight the potential to inform customers and DM service providers in an accessible and compelling way. However, these specific maps should be treated with some caution. Firstly, as the ESDRs do not include details of actual service territories for particular zone substations, the service territories have been approximated using suburb boundaries. Secondly, these maps have been developed by SEDA for illustrative purposes using Distributors' published data, but they have not been reviewed or endorsed by the Distributors themselves. There may be specific circumstances relating to specific network elements that mean the information in these particular maps is misleading. However, both of these issues should be overcome if the Distributors themselves develop and publish such maps.

Figure 8. Marginal Cost of Proposed Network Augmentation Investment in Metropolitan Sydney to 2009



Source: Data derived from Energy Australia and Integral Energy Electricity System Development Reviews

Conclusion: Network DM - the Key to a Sustainable Energy Future?

The past 15 years have witnessed reform across the globe to introduce competition to the electricity generation and retail sectors. Electricity networks have remained largely immune to these processes on the assumption that they are natural monopolies. The NSW DM Code challenges this assumption by illustrating how introducing transparency and competitive procurement to network development can provide a major stimulus to DM. However, for such processes to be effective they must be accessible to market participants. The network constraint and DM opportunity maps in this paper dramatically illustrate the powerful information that can be presented to customers, DM service providers, regulators and Distributors themselves when appropriate economic analysis of DM and information disclosure are combined with well-designed maps.

This paper suggests that appropriate development of network-focussed DM may be able to save Distributors, consumers and the wider economy tens, if not hundreds, of millions of dollars worth of capital expenditure in NSW alone. More importantly, this approach has the potential to help usher in the age of creative DM, small distributed generation, and more sustainable energy use.

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