The Nexus between Smart Grids and Fuel & Energy Usage

Opening Statement and Submission by Robin Eckermann representing Smart Grid Australia before the Senate Select Committee on Fuels and Energy Canberra, 26th February 2010

Senator Cormann, Members of the Committee - thank you for the opportunity to contribute to your deliberations.

I note that your terms of reference are broad and encompass a wide range of issues relating to fuels and energy. I propose to focus on just the major areas where Smart Grids have the potential to have a material impact on your area of interest.

Efficiency of Australia's Electricity Distribution Networks

Electricity distribution networks operate – for the most part – in much the same way that they have operated for decades. It has been said that if Thomas Edison were to visit today's networks 130 years after inventing the first commercially deployable electric light bulb, he'd be right at home with the infrastructure!

There is a modest level of computer-based monitoring and control in the "upper layers" of most distribution networks, but this typically extends down only to major nodal points called zone substations. These are the facilities from which electricity is distributed out to communities of many thousands of customers. Once electricity leaves the zone substation, the utility essentially has no visibility as to how their network is performing. The first they hear of an outage is usually when a customer calls to report the loss of supply – and then it is often a case of sending a crew to check where power is and isn't flowing and visually inspecting for possible causes of the outage. There may be significant inefficiencies, imbalances and losses – but today's utilities are essentially blind to these.

Smart Grid technology involves deploying sensors, communications and computer-based intelligence deep into the distribution network, enabling the utility to monitor the operation of its assets in real-time and to control and optimise their operation.

What does this mean for Fuels and Energy use?

(a) The evidence from early Smart Grid deployments[1] together with other studies indicates that by optimising the operation of distribution networks, the same amount of energy can be supplied to end-customers whilst reducing the amount that needs to be generated by 3-5%. Incidentally (but importantly), this achieves a similar reduction in carbon dioxide emissions[2] whilst ever the bulk of generation comes from fossil fuels.

(b) Enhanced monitoring allows utilities to anticipate and avoid many faults, to pin-point their cause and extent when they do occur and to definitively resolve problems before the crew leaves the site. In many cases, Smart Grid technology will allow a distributor to "switch around" faults and thereby restore supply to the majority of customers within minutes rather than hours. The resulting operational efficiencies impact positively on service reliability (with major flow-on economic impacts[3]) and reduce the overall cost of energy delivered to customers.

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1 For example, Xcel Energy's deployment – see http://smartgridcity.xcelenergy.com/index.asp

2 The Climate Group estimates that 85% of the carbon reduction benefits of a Smart Grid come from grid optimisation and the integration of renewables – with only 15% coming from end-user energy management (see "SMART 2020: Enabling the low carbon economy in the information age", 2008)

3 See "Assessment of the Value of Customer Reliability (Final Report)", CRA International, August 2008 – p.6. The charge for energy supplied may be only 10-15c kWh today, but the economic cost of its non-availability through outages was assessed at average of $47.85 per kWh across all sectors.

(c) Being able to "see" and deal with hotspots in the network makes it possible to operate assets within their design tolerances and thereby extend their life expectancy. The resultant capital savings impact positively on the cost of energy delivered to customers.

Demand-Response

Electricity distribution networks have to be designed and built to cope with peak loads, even though such loads only occur for a small percentage of the time. The term "demand response" refers to methods of reducing load at peak times in order to smooth the demand profile.

One way of discouraging demand is through consumer engagement and differential pricing – and this has been one of the focal points of Australia's initiatives in the Smart Metering arena. "In home displays" can help to educate consumers about their energy usage and the energy efficiency options within their household and recording usage in half-hourly intervals over the course of the day allows different prices to be applied at different times – providing an economic incentive to avoid discretionary use in peak periods. However, this method of demand-response relies on humans changing their usage patterns in order to moderate demand, and as such, it has limits. One opinion is that very high peak pricing would be needed to achieve enduring changes in customer behaviour – but this is not necessarily a politically acceptable or publicly palatable option.

Evidence from Australian demand response trials suggests that cost-reflective pricing *does* provide a significant peak demand reduction and still leads to satisfied consumers *so long as* home comfort levels can be maintained. Seeking a balance between peak demand reduction and home comfort will lead to more sophisticated solutions involving small adjustments that are not noticeable to consumers but which provide the aggregated load reduction that is needed by the distribution network.

Smart Grids go a whole lot further than Smart Metering! They provide the foundation for "dynamic" demand-response, where demand-response methods can be applied as, when and where "hot spots" appear in the network. Further, they lay the foundation for supporting the expected future generation of "energy smart" appliances that will automate interaction with the grid to decide when to draw electricity for non-critical purposes (pool pumps, hot water systems and the like). As such, Smart Grids unlock new levels of opportunity in terms of demand-response.

What does this mean for Fuel and Energy Use?

(a) If loads can be smoothed to reduce peaks, the level of investment in generation, transmission and distribution infrastructure can be reduced accordingly. The resultant capital investment savings impact positively on the cost of supplying energy to consumers.

(b) Since supply and demand *must* always be kept in balance in an electricity network, the ability to shed (or time-shift) demand can allow continued operation during critical peaks and avoid the risk of black-outs or brown-outs. The result is more reliable supply for consumers.

(c) Smart Grids allow voltage to be tightly controlled during peak periods, assuring that only the necessary amount of power is consumed to service the load and maintaining power quality to the end-customer.

Large-scale Renewable Energy Sources

Some renewable energy sources – like wind and sun – are inherently volatile. Generation can fall quickly if a bank of clouds rolls over a solar farm, or if the wind suddenly drops. The increasing percentage of "green" energy presents challenges for the electricity industry that can be solved in one of two ways. Either it must back up the renewable capacity with conventional capacity that can be quickly brought on-stream to meet demand, or it must have improved ways of shedding non-critical demand.

Backing up renewable capacity with conventional capacity means *duplicating* capital investment. Renewable generation plants may eliminate the cost of fuel and thereby reduce the cost of energy, but the duplication of investment could erode most of the savings.

What does this mean for Fuel and Energy Use?

(a) The *dynamic* demand-response and voltage control capabilities that Smart Grids can support allow much improved real-time shaping of demand to match volatile supply sources, thereby reducing the need for duplicated investment. Already the technology is available to pass energy through to appliances only when the level of renewables on the grid reaches a certain threshold, thus automatically reducing demand when supply from renewable sources drops.

Distributed Generation

The widespread uptake of distributed renewable generation sources (like roof-top photo-voltaic systems) is fundamentally changing the nature of the electricity grid. Historically there was radial distribution only (from large centralised generation sources to customers), but in the future energy flows will appear much more as a mesh. The transition is similar to what has happened with data flows in the wake of the advent of the Internet.

This poses new issues for distribution utilities. As load decreases and generation increases, voltages rise at various points in the network – risking damage to customer appliances. Also as the direction of power flow reverses (due to distributed generation resulting in a net export of energy), vital network fault-protection schemes may fail and lead to damage to network infrastructure in the event of a distribution network fault. Research indicates that significant challenges can be anticipated when the percentage of renewable energy on the grid exceeds 20-30%[4] unless utilities have “granular” visibility and control through Smart Grid technology. It should be noted that because of the irregular distribution of micro-generation sources, some areas within the network will reach 30% distributed generation even though the overall level of penetration may be considerably lower.

Utilities either need the visibility and control to harness the distributed generation capacity that is coming on-stream, or they need to blindly overprovision the network with the capacity to satisfy all demand from conventional sources.

Smart Grids have a vital enabling role to play in giving utilities visibility of all the energy flows in their networks plus the tools to be able to optimise performance, ensure grid stability and maintain worker safety in all operating conditions. They also provide dynamic demand-response capabilities to help regulate demand as volatile distributed generation sources come to play a bigger part in the overall supply mix.

What does this mean for Fuel and Energy Use?

(a) Promoting distributed generation can moderate the demand for centralised generation from conventional fuel sources. Generating supply “close” to the locations where electricity is used also avoids the losses that occur in transmission over long distances.

(b) As Smart Grid technology evolves, distributed energy generation (or storage) resources may in the future be integrated into “virtual” sources of supply that can be dynamically dispatched in the national energy market.

Electric Vehicles

The coming wave of electric vehicles promises to start reducing dependence on oil in the transport sector, but at the expense of increasing electricity demand. Without the sort of intelligence that Smart Grids bring into electricity networks, electric vehicles that arrive home from the daily trip to the office and are plugged in to recharge risk creating massive new peaks in demand. A high concentration of electric vehicles in any particular geographic area could put the grid under a level of strain for which it was not designed.

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[4] “Network Power-Flow Analysis for a High Penetration of Distributed Generation”, Thomson & Infield, 2007.

Smart Grids provide a framework for intelligently managing this demand. In most cases, vehicles have all night to recharge before they are used again – or if plugged in at an office car park, all day to recharge before the trip home. By appropriate communication between vehicles and the grid, the recharging load can be staggered to avoid peaks that would be damaging. In addition, non-essential vehicle recharging could be deferred during critical peaks – as an extension of demand-response capabilities.

The potential goes further! A fleet of electric vehicles stores a substantial amount of energy – and in extreme circumstances, the grid could draw on this store to help in balancing supply and demand.

What does this mean for Fuels and Energy?

(a) The rising use of electric vehicles need not drive a commensurate demand for investment in new electricity generation, transmission and distribution infrastructure.

(b) Electric vehicles can ultimately serve as a distributed energy store than can be invoked when demand cannot be satisfied from available generation assets.

The Bottom Line

Affordable energy is a vital input to all forms of social and economic activity, and Australia needs to improve its power reliability, quality and capacity whilst playing its part in global efforts to reduce greenhouse gas emissions. One recent study has estimated[5] that the large-scale deployment of Smart Grids could contribute to an 18% reduction in CO2 levels in the US electricity sector by 2030.

Smart Grids have an important role to play in the modernisation of Australia's electricity industry. They will also underpin the transition to renewable energy sources, reducing Australia's reliance on fossil fuels. Many of Australia's Asian neighbours are moving quickly, and accelerated investment is needed if Australia is to remain globally competitive.

Smart Grid Australia welcomes the Federal Government's goal of a national program of Smart Grid deployments and the $100m "Smart Grid Smart City" initiative. Continuing bi-partisan support will ensure that Australia does not become a laggard in this vital area.

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Smart Grid Australia (SGA) is a non-profit, non-partisan alliance dedicated to an enhanced, modernised electricity distribution and consumption system. The alliance holds regular meetings, organises working groups to focus on particular issues, assists with government initiatives and facilitates communications around the topic of Smart Grids in order to accelerate progress. It serves as an important source of contacts, ideas, inspiration, and influence for organisations interested in doing for the electricity industry what the Internet has done for the telecommunications industry.

SGA has a broadly-based membership that includes many of Australia's electricity distribution utilities, telecommunications companies, energy-sector investors, leading industry suppliers of smart grid and related technology, systems integrators, consultants and researchers as well as a number of government agencies. Through the overseas connections of its multi-national members and its affiliation with the Gridwise Alliance (US) and Smart Grid Europe, it is able to inform its members on international developments in the field of Smart Grids.

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[5] "The Smart Grid: An Estimation of the Energy and CO2 Benefits", Pacific Northwest National Laboratory, January 2010 – see Table S.1.