22nd September 2009

Eckermann & Associates
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Ms Alison Kelly
Secretary
Select Committee on the National Broadband Network
SF61.1 Parliament House
Canberra ACT 2600

Dear Ms Kelly

NBN and Smart Grids

Thank you for your invitation to appear before the Senate Select Committee on the National Broadband Network to discuss the relationship between the NBN and Smart Grids.

I have prepared a brief submission (attached) to provide some background on the subject ahead of the Committee hearings on 1st October.

Please don't hesitate to give me a call if you require anything further prior to my appearance.

Yours sincerely
Eckermann & Associates

Robin Eckermann
Principal

Communications – a Foundation for Smart Grids

Smart Grids promise to transform the electricity distribution and consumption industry in much the same way that the Internet has transformed the telecommunications industry. In addition to delivering immediate benefits in the form of greater operating efficiency, reduced carbon impact and improved asset management, Smart Grids will lay the foundation for a profound change in the way energy is generated, transported and consumed. In fact, a significant increase in renewable energy generation will not be possible without them.

The key to this wave of modernisation lies in the infusion of sensing, communications and information technology into networks that for the most part, still operate today in much the same way that they did when Thomas Edison invented the light bulb some 130 years ago.

A recent Climate Group study concluded that deploying a Smart Grid is the largest single global information technology solution to climate change – more than investing in smart buildings, smart transportation systems or improvements in motors and industrial processes.[1] The report estimated that 85% of the carbon benefit of a Smart Grid came from better optimization of the electricity system and from the integration of renewables with the remaining 15% coming from end-user energy management.

Sophisticated cost-benefit modeling indicates a strong return a Smart Grid investment – with benefits flowing to the utility, to its customers and to the community. The theoretical estimates are increasingly being overshadowed (and reinforced) by real-world evidence from key pilot projects and early deployments – such as in Boulder, Colorado. An exposition of the benefits of Smart Grids could easily make for a substantial paper in its own right, but that not the purpose of this submission.

This submission focuses on the communications aspect of Smart Grids, and the potential linkages with the National Broadband Network. *Why is communications so important?* Some of the answers are immediately apparent and others require one to look at the trends that we can anticipate moving into the future.

Grid Optimisation

One of the most immediate opportunities for grid improvement lies in better monitoring and control of the distribution network.

To understand the role of communications, it is important to appreciate the limited visibility that utilities have into what is happening in their networks. Most have deployed a degree of automated monitoring and control in the "back-bone" of their networks – typically in the form of Supervisory Control and Data Acquisition (SCADA) technology – down to the level of zone substations. These are the locations where electricity received at high voltages (eg: 132 kV) from transmission networks is transformed into medium voltage electricity (eg: 11 kV) ready to inject onto the distribution network. In general, utilities can monitor what is happening down to this level in their network.

[1] The Climate Group – "SMART 2020: Enabling the low carbon economy in the information age", 2008 – available at http://www.theclimategroup.org/assets/resources//publications/Smart2020Report.pdf (see p.9, 70 in particular).

However, moving "deeper" into the grid – beyond the zone substations – the utilities are typically blind to what is happening in their distribution networks. Medium voltage electricity is pumped into feeder routes, and along these feeders, distribution substations are deployed at regular intervals to further break voltage down to the 240V level that is supplied to consumers. In urban areas, each transformer typically serves a comparatively small "cell" of 50-150 residential customers.

Utilities have little information as to how energy flows beyond the zone substations and to the optimal level of voltage needed within their networks. They often operate their systems at the higher end of the voltage threshold to assure that the minimum required voltage is being achieved at each customer. While this has historically assured quality service, the opportunity exists to monitor and adjust this voltage on a continual basis to reduce excess voltage and thus reduce the power needed in the system.

In addition, because the utilities lack monitoring, they may not be aware of inefficiencies resulting from the way the network was constructed. By monitoring power flow, utilities are able to identify such problem areas and make adjustments, further increasing the potential for system optimisation. Studies in the United States have estimated such system optimisation could reduce 3- 5% of electric power requirements and related carbon on a 24x7 basis without requiring any change in consumer behavior.[2]

Distribution Monitoring and Control

In addition to the ability to optimise power flow, continuous monitoring of the grid can significantly improve reliability.

When problems occur deep in the distribution network, utilities *may* pick up indications of a fault in the form of disturbances on the feeder network – but more commonly the first real evidence comes when customers start complaining about the loss of power. At this point, the utility has little insight into the root cause, nature or extent of the problem and often has to send repair crews to physically inspect infrastructure in an effort to hunt down the fault. On finding a problem and making a repair, there is no instant way of knowing whether all services have been restored, or whether there are further faults that still need to be repaired before the network will be fully back into operation.

What a contrast with telecommunications networks! Carriers typically monitor and control the health of their networks from network operation centres where automated systems maintain constant communication with every active element (switches, routers etc) in the network. Graphic displays show when links are becoming congested, and operational staff can take action in real-time to re-route traffic or bring more capacity on-stream. When faults occur, they are promptly isolated and in many cases, action can be automatically initiated to reconfigure the network so that the impact on customers is minimised. Field staff can then be sent to exactly the right location with the right tools and replacement parts to make a permanent repair.

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[2] RW Beck for Northwest Energy Efficiency Alliance, Distribution Efficiency Initiative, December 2007. Available at: http://rwbeck.com/neea/

CURRENT's Smart Grid solution can be thought of as a network management solution for utilities – the key difference being that the focus is on managing the flow of electrons rather than the flow of bits. It involves installing a small module of technology at every distribution transformer (and at other active elements in the grid) to monitor voltages, current flows and various other environmental parameters. This equipment is "clip on" so there is no need to replace existing infrastructure. Local intelligence built into the technology looks for faults and anomalies. Information about all significant events is then communicated back to a network management centre where sophisticated software is used to further analyse the situation and instigate the appropriate action.

The visibility that this gives the utility into the operation of their network is the key to the first tranche of benefits from Smart Grids. These include:

- rapid fault recognition – long before the first customer reports a problem;
- immediate insight into the precise nature and location of the underlying cause of the problem;
- as a result of the above, the opportunity to remotely reconfigure other elements in the grid to remedy the situation – or at least, limit the impact of the fault on customers;
- the ability to verify that services are fully restored when field crews have dealt with the problem;
- advance warning of looming failures – indicated by disturbance patterns – so that preventative maintenance can be taken to avoid unplanned outages;
- the ability to see when network elements are operating outside of their design tolerances, allowing the utility to make the necessary configuration changes to avoid the overloads and stresses that lead to premature failures; and
- the ability to identify and correct imbalances and inefficiencies in the network, thereby reducing the energy that is wasted in the form of losses.

In Australia's recent catastrophic bushfires, numerous distribution transformers went up in flames – not because they were in the path of the fires, but because they were heavily overloaded with excessive demand, much of it from air-conditioners. With Smart Grid technology, the looming problems would be apparent long before equipment failed, and a range of actions could be taken to avoid transformer loss and all of the flow-on consequences.

Clearly communication between network elements and the operation centre is a vital underpinning for improved distribution monitoring and control. This can take many and varied forms including wireless transmission, broadband over power lines – and of course, optical fibre. Where the National Broadband Network uses overhead cabling, the cabling is likely to pass close by many of the distribution transformers to which communication would need to be established in a Smart Grid deployment. This represents the first area of potential synergy between the NBN and Smart Grid modernisation of the electricity industry.

There are non-trivial issues that will need to be worked in order assess and harness this potential. As the experience of creating TransACT demonstrated, there are poles that won't support the weight of additional cables, poles that don't have sufficient ground clearance for more cables, poles that have been reinforced after termite attack and which unions have deemed unsafe to climb and poles carrying encumbrances like un-insulated street light cabling that needs to be relocated to create a safe zone for communication cables.

The primacy of the utility's need to protect public safety will mean that in some situations there is no choice but to cut communication cables. Security needs particular attention so that the deployment of Smart Grid technology serves to enhance security of supply rather than to create new vulnerabilities. And of course, any public opposition to additional overhead cabling needs to be dealt with sensitively. This is just a sample of the issues!

Whilst the issues are complex, the potential is real – and in due course discussions between the NBN Company and utilities are likely to expose some mutually beneficial opportunities.

Demand-Response

The benefits of a Smart Grid multiply when visibility and control are extended beyond the distribution transformer to the customer's premises and a smart electricity meter becomes another managed element in the grid. *Real-time* communication with the meter is the key to unlocking the potential for the utility to dynamically influence demand when there are pressures on supply. This general capability is called "Demand Response".

Whilst Smart Meters have a vital role to play in the Smart Grid, the deployment of Smart Meters on their own will deliver only a small subset of the possible Smart Grid benefits. Even worse, the choice of a communications capability that may be optimised for Smart Metering purposes could serve as a road-block for later grid upgrades (or necessitate a premature and expensive replacement program).

By way of explanation, the *major* requirement driving many Smart Metering initiatives (including those in Australia) is the introduction of time-of-day usage recording – creating the opportunity to use differential pricing to shape consumer behaviour.

An in-home display that shows current usage, costs etc can also be provided to give consumers information about the energy they are using, its costs and its carbon impact. Communications is required for reading meters and for occasional spot-checks – but the process is not especially time critical. As long as usage information can be captured in time to issue the next monthly or quarterly bill, the primary objective will have been achieved.

As a method for regulating consumer usage patterns, there is a growing view that Smart Metering may not be the most effective tool. Commissioner Butler, a member of the New Jersey Board of Public Utilities (NJBPU) and President of the United States National Association of Regulatory Utility Commissioners (NARUC) recently expressed his concern about focusing initially on the consumer in his testimony to the United States Senate Committee on Energy and Natural Resources: *"This means that we should not focus immediately on the end user and demand response; rather, we must start with the backbone—the transmission and distribution systems—while proceeding carefully to go inside consumers' homes."*[3]

The early novelty of monitoring usage quickly wears off, and unless the price premium during peak hours is *extreme*, the motivation to adjust lifestyles is not compelling.

One has to look just a little further over the horizon to see how Smart Grids can provide the framework for much more effective and dynamic demand response. Since 1965 when Gordon Moore predicted that there would be a doubling of silicon densities (or a halving of costs) every 24 months, there has been of the order of a 10 million-fold increase in computing power. It is now common for appliances to feature embedded computer chips and LCD displays that are making appliances truly "intelligent".

In an era where climate change concerns are rife, when the electricity industry is the biggest culprit in greenhouse gas emissions and when electricity prices are forecast to rise steeply, it is inevitable that the some of the growing intelligence in appliances will be applied to smarter energy management. During a critical peak of demand, utilities may not be able to expect customers to jump in their vehicles and drive home to turn off the washing machine. However, the grid may be able to electronically negotiate with that washing machine to pause its cycle until the crisis has passed.

The potential for this sort of electronic negotiation is even more apparent with an appliance like a plug-in electric vehicle. When sitting parked for many hours at a time, there can be great flexibility as to when recharging takes place. It makes sense for the grid to be able to control the timing to smooth demand, or suppress it during critical peaks. The potential goes further. The owner could give the vehicle permission to sell surplus energy back into the grid (if the price is high enough during a critical peak) so long as it is not drained below the level to get home at night.

This sort of future relies critically on electronic communications throughout the grid – from generation to consumption. At most times, it will be more of a trickle than a torrent in terms of data volumes – however, speed and reliability are crucial. During critical events in the grid, actions to balance supply and demand need to be taken in seconds – a very different requirement from the leisurely collection of billing information for which the communication systems in many Smart Meters are designed.

Can the NBN play a role here? Victoria's mandatory Smart Meter deployment is already underway and will be substantially complete before the NBN has a large impact. Time will tell whether the communication options that the Victorian utilities have selected will be adequate for Smart Grid purposes.

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[3] Written Testimony of Honorable Frederick Butler, Commissioner, New Jersey Board of Public Utilities on behalf of the National Association of Regulatory Utility Commissioners to the U.S. Senate Committee on Energy and Natural Resources, '*Smart Grid*', March 3, 2009.

Utilities in the rest of the country have the opportunity to look at metering communications in the context of broader Smart Grid requirements – and the NBN certainly has the *technical* potential to fulfill the utilities' emerging requirements for real-time communications with Smart Meters and Smart Appliances.

However, there are some practical issues that need to be resolved in order to harness this potential:

- The Optical Network Termination (ONT) unit that will be used by the NBN to convert optical signals from the network into electrical signals for reticulation through the premises would need to be powered *upstream* of the meter. This is necessary in order to satisfy the utility requirement to be able to send instructions to remotely disconnect *and reconnect* supply at the premises.
- Some communication link between the electricity meter and the ONT would need to be established. Whilst this could be wireless, if the ONT and meter are a long way apart, there could be costs and challenges in making the connection.
- For customers not wanting any other communication services, an NBN optical fibre connection would be a very expensive communication channel given the comparatively low volume of information required for Smart Grid purposes.
- The ONT would need to be in a sufficiently secure location to prevent user interference with the energy management functionality that it provides.

All of these requirements can be satisfied *by design* in greenfield areas. Where fibre-to-the-home solutions are provided, the ONT is commonly installed in a cabinet right next to the electricity meter. Accordingly providing an unmetered power service and a communications link is trivial. Furthermore, all homes are routinely connected to the fibre – because there is no other cabled communication alternative and the cost is essentially built into the price of the house-and-land package.

As in the case of Distribution Monitoring and Control, early dialogue between the NBN Company and utilities will be helpful in capturing the synergies that may exist.

Distributed Generation, Renewables and Plug-in Electric Vehicles

Historically electricity networks have served to distribute energy "radially" – that is, from central generation sources to users. The character of the grid is now fundamentally changing with the rising uptake of solar cells, co-generation plants, wind turbines, vehicles that can discharge their energy back into the grid and so on. Increasingly the grid will be characterised by a "mesh" of dynamically changing energy flows – much like the Internet is a mesh of information flows.

Many of the renewable energy sources are volatile. Clouds can roll over a city in a matter of minutes and wind gusts can vary by the second. As the proportion of energy in the grid from such sources rises, utilities will face new challenges. The need for real-time monitoring of complex energy flows will become critical – as will the ability to either quickly bring reserve sources of energy on-line, or use demand-response techniques to quickly shed load in order to balance supply and demand.

The flip-side of this is the opportunity that may be presented in the future when supply outstrips demand. In these circumstances, the grid may want to stimulate increased discretionary use (for instance, by charging electric vehicles), in effect to “store” energy in the network rather than discard it.

The communication requirements here are no different from what has already been covered. Once again, grid-wide real-time communications is a critical foundation if the potential of renewable energy resources is to be tapped.

Summary

A national Smart Grid will strengthen and reinforce the security, efficiency and capacity of Australia’s electricity supply – a resource on which our national economy and our lifestyle vitally depends. It is also an essential foundation for the transition to a low carbon future, something that is increasingly recognised as a critically urgent step towards mitigating the potentially catastrophic effects of climate change.

In this context, the Government’s budgetary allocation of $100m funding for Smart Grid trial and demonstration activities is a welcome means of accelerating progress towards a cleaner, more efficient and more reliable electricity grid in Australia.

The NBN has real potential to support *some* of the communication needs that are at the heart of a Smart Grid. The extent to which this potential can be realised will become apparent as and when the NBN Company engages with electricity utilities to work through the key issues.

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About Robin Eckermann (the author of this submission)

Robin Eckermann is an independent consultant specialising in advanced broadband infrastructure. He is widely known for his role in leading the establishment of TransACT and serving as its Chief Architect during the rollout of an advanced fibre-to-the-kerb architecture passing some 65,000 homes and businesses in Canberra. This network required the deployment of an entirely new cabling regime in established areas, and accordingly TransACT could be seen as a "micro" version of the NBN, having had to confront many of the issues that are now on the NBN agenda.

Since progressively withdrawing from TransACT as it transitioned into an operational company, Robin has been advising clients on advanced broadband infrastructure projects throughout Australia and overseas. He has been the lead advisor in pioneering the model for fibre-to-the-premises in locations such as Whittlesea and in some 30 other residential and commercial greenfield projects. More recent work includes developing technical and commercial models for providing wireless broadband in some of the most challenging terrain in Australia – addressing the needs of rural Australians who are not destined to benefit from the NBN FTTP deployment.

Amongst his consulting activities, Robin has been providing casual assistance to the CURRENT Group to assess the Australian market for Smart Grid technology. In this context, CURRENT has become a founding member of Smart Grid Australia (SGA) and Robin has been appointed as one of the SGA's Directors. Robin's professional interest in Smart Grids stems from their inherent dependence on communications as one of the key enabling technology.

As a parent and grandparent, Robin is deeply concerned by the weight of scientific evidence on anthropogenic climate change and the threat that this poses to the quality of life for future generations. Smart Grids represent not only some of the "low hanging fruit" in terms of early opportunities for moderating the carbon impact of our energy-intensive lifestyles, but also the foundation for more profound changes in the longer term. He was the instigator and founding sponsor of what has become an annual Challenge for innovative ideas on using broadband for the benefit of the environment.

Robin has been an Adjunct Professor (Network/Communications Technologies, Business Models and Project Management) at the University of Canberra since 2005.

The views expressed in this submission are those of Robin Eckermann and they may or may not align exactly with those of the CURRENT Group or Smart Grid Australia.

About the CURRENT Group[4]

CURRENT is a Smart Grid technology provider with solutions in commercial operation today. CURRENT's approach combines advanced sensing technology with low-latency IP-based communications, enterprise analysis software and related services to provide location-specific, real-time actionable data that is easily integrated into a utility's existing IT infrastructure. The technology is being used by utilities around the world including in several of the largest Smart Grid deployments.

President Obama recently highlighted[5] one of the projects using CURRENT's technology as an example of a Smart Grid to be funded on signing the American Recovery and Reinvestment Act of 2009 (ARRA). CURRENT is also a participant in several European Union-sponsored projects, including one led by Iberdrola, the world's 4th largest electricity utility, to expand the use of Smart Grid technology to benefit utilities and residents of the European Union. Most recently CURRENT was honored by the World Economic Forum as a 2009 Technology Pioneer.

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[4] Further information about CURRENT is available at http://www.currentgroup.com.

[5] President Obama's remarks upon signing the American Recovery and Reinvestment Act of 2009, February 17, 2009: *"The investment we are making today will create a newer, smarter electric grid that will allow for the broader use of alternative energy. We will build on the work that's being done in places like Boulder, Colorado."* (Xcel Energy SmartGridCityTM project)

As the US Congress has recognised in both the Energy Independence Act of 2007 and the American Recovery and Reinvestment Act of 2009, the application of technology to electric power is a key component of reducing carbon emissions. In the United States, the Electric Power Research Institute (EPRI) has estimated that a Smart Grid could reduce carbon from electric power by 25% or roughly 10% of overall US CO_2 emissions.[6] It is estimated such a saving would have the same impact as removing 140 million cars from the road.[7] A recent Climate Group study concluded that deploying a Smart Grid is the largest single global information technology solution to climate change – more than investing in smart buildings, smart transportation systems or improvements in motors and industrial processes. They projected that a Smart Grid around the world could save over two Gigatons a year of carbon or roughly 5% of total global emissions.[8]

About Smart Grid Australia

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 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 including 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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6 Electric Power Research Institute. 2003 – "Electricity Sector Framework for the Future: Achieving the 21st Century Transformation" – available at http://www.epri.com, pg 42.

7 Energy Future Coalition – "National Clean Energy Smart Grid Fact"' – available at http://www.energyfuturecoalition.org/files/webfmuploads/Smart%20Grid%20Docs/Smart_Grid_Fact_Sheet.pdf., 2009.

8 The Climate Group – "SMART 2020: Enabling the low carbon economy in the information age", 2008 – available at http://www.theclimategroup.org/assets/resources//publications/Smart2020Report.pdf pg 9, 12.