SMART GRIDS: OPPORTUNITIES FOR CLIMATE CHANGE MITIGATION AND ADAPTATION

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This article assesses the contribution which the Smart Grid can make to climate change mitigation and adaptation. The Smart Grid amalgamates information and communications technology ('ICT') and electrical capabilities to improve flexibility, security, reliability, efficiency, and the safety of the electricity system. Demand side management ('DSM') is increased as consumers gain better control over their electricity use and respond to prices. At the same time, a smart grid includes diverse and distributed energy resources, including energy storage, and accommodates electric vehicle charging. Although much of the literature to date assesses the interface between the Smart Grid and climate change mitigation, there is barely any mention of the adaptation benefits emanating from Smart Grid technology. If the Smart Grid improves efficiency and DSM and encourages distributed energy sources its mitigation benefits are clear. Yet the fragility of electricity networks to climate change impacts suggests that the Smart Grid might also assist utilities to respond to blackouts, and other climate change induced crises, more effectively than is currently possible. The article also assesses the regulatory consequences which are attendant upon the adoption of a Smart Grid in Australia.

I INTRODUCTION

When attempting to design a climate-friendly energy policy there are four key objectives: a secure, plentiful and diverse primary energy supply; robust reliable infrastructure for energy conversion and delivery; affordable and stable energy prices; and environmentally sustainable energy production and use.[1] Proponents of the Smart Grid claim that it enhances each of these objectives. By integrating many varieties of digital computing and communication technologies and services with electricity infrastructure to improve reliability, and, by assisting customers to adapt to a carbon-constrained future, the Smart Grid is poised to make a considerable contribution to the mitigation of climate change. Its ability to provide bi-directional flows of energy, and two-way communication and control capabilities, also provides new functionalities and applications that can assist

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1 See Douglas Smith et al, 'Designing a Climate-Friendly Energy Policy: Options for the Near Term' (Report Prepared for the Pew Centre on Global Climate Change, 2002) 45.

service providers to adapt more flexibly where electricity infrastructure has been impacted by climate change.[2]

II CLIMATE CHANGE THREATS TO ELECTRICITY INFRASTRUCTURE

The threats of climate change to electricity infrastructure have been well documented.[3] Maunsell Australia Pty Ltd provides seven climate scenarios, identified by CSIRO Marine and Atmospheric Research, to assess their impact on key infrastructure areas including electricity. Maunsell Australia Pty Ltd summarises its findings in terms of climatic variables, impacts and implications. The climate variables include: increase in intensity of extreme wind; increased frequency and intensity of storms and bushfires; increase in temperature, number of hot days and electrical storms; and decrease in rainfall. The impacts are predicted to be: damage to transmission and distribution above ground assets resulting in increased blackouts; reduced network capacity along with accelerated deterioration of assets; and an increase in the number and length of blackouts due to electricity demand exceeding supply.

The implications considered as economic impacts include: increased capital and maintenance expenditure on electricity transmission and distribution infrastructure; increased demand for skilled staff leading to shortages in this area; short term lost revenue to transmission and distribution companies; accelerated depreciation and deterioration of assets; and increased power prices to consumers. Additional demand side implications include: community security risk; increased insurance costs as a result of business and food loss; traffic congestion/accidents/no traffic lights and short term unemployment leading to hindered emergency responses; train service disruption; life support/health risk; deterioration in quality of home life; and building services disruption including elevators and lifts.[4]

Parons Brinckerhoff, meanwhile, has identified the highest risks to infrastructure as being bushfire, tropical cyclones and a change in the mix of generation, with

2 National Institute of Standards and Technology and US Department of Commerce, *NIST Framework and Roadmap for Smart Grid Interoperability Standards Release 1.0 (Draft)* (2009) 15; Department of the Environment, Water, Heritage and the Arts, *Smart Grid Smart City: A New Direction for a New Energy Era* (2009).

3 Australian Academy of Technological Sciences and Engineering, *Assessment of the Impacts of Climate Change on Australia's Physical Infrastructure*: *Report on a Study* (2008); Parsons Brinckerhoff, 'Energy Network Infrastructure and the Climate Change Challenge' (Report to Energy Networks Association, 2009); Ross Garnaut, *The Garnaut Climate Change Review*: *Final Report* (2008) Ch 19; Cleo Paskal, 'The Vulnerability of Energy Infrastructure to Environmental Change' (Briefing Paper, Chatham House and Global Energy & Environment Strategic Ecosystem, 2009); Mladen Kezunovic, Ian Dobson and Yimai Dong, *Impact of Extreme Weather on Power System Blackouts and Forced Outages: New Challenges* (2009); Maunsell Australia Pty Ltd and CSIRO Sustainable Ecosystems, *Impact of Climate Change on Infrastructure in Australia and CGE Model Inputs* (2008) Garnaut Climate Change Review <http://www.garnautreview.org.au/CA25734E0016A131/WebObj/02-AInfrastructure/$File/02-A%20 Infrastructure.pdf> at 18 February 2010.

4 Maunsell, above n 3, 4.

floods, drought and an increase in peak demand representing lesser risks. Bushfires are likely to affect electricity supply in all regions, as are severe thunderstorms, changes in peak demand and drought. Tropical cyclones and floods are likely to affect electricity supply in tropical regions, coastal southern Queensland and northern New South Wales, while changes in generation mix will affect New South Wales, Queensland and Victoria.[5] The costs to energy networks from climate change is estimated to be A$2.5 billion over the next five years with the largest proportion of this cost arising from the need to augment networks due to the increased use of air conditioning.[6]

III THE SMART GRID

The Smart Grid is an integration of advanced, two way communications systems and sensors with the transmission and distribution network, which enables utilities to optimise grid performance in real-time. Through demand responses it provides incentives to consumers for reducing energy consumption and it provides for a better integration of renewable energy sources into the grid. For the purposes of resilience the Smart Grid gives utilities an enhanced ability to identify the location of a failure and quickly re-route electricity to locations where demand is most critical. This could occur during times of climate change-induced crisis, or peak demand, and prevents outages through proactive diagnosis of the grid and its individual elements. Importantly, it enhances the ability of the grid to continue to provide power following a catastrophic event and to support vital emergency responses as well as military, economic and social activities during a crisis.[7]

Hendricks claims that a truly national clean-energy Smart Grid comprises two distinct components: an interstate 'sustainable transmission grid' which will transport clean utility-scale renewable energy to the market across long distances; and a digital 'smart distribution grid' to deliver this electricity efficiently to local consumers.[8]

A *The Sustainable Transmission Grid*

The electricity industry traditionally includes generators,[9] market customers (electricity retailers and end-use customers),[10] network service providers who

5 Parsons Brinckerhoff, above n 3, 41.

6 Ibid 57.

7 The Reform Institute, *The Smart Alternative: Securing and Strengthening Our Nation's Vulnerable Electric Grid* (2008) 2, 8.

8 Bracken Hendricks, *Wired for Progress 2.0: Building a National Clean-Energy Smart Grid* (2009) 10.

9 Generation is the process used to create electricity.

10 Market customers comprise both electricity retailers and end-use customers. Retailers purchase wholesale electricity through the spot market, or from local generators who sell their entire output to them. The electricity is then sold to customers, increasingly within a contestable retail market. End-use customers purchase electricity directly from the spot market which they then consume.

own, operate or control either a transmission[11] ('TNSPs') or distribution ('DNSPs') system,[12] market network service providers ('MNSPs'),[13] and special participants who may be appointed to perform various functions such as taking responsibility for operations during power system emergencies. Within this sector, large power plants are connected to the transmission system which supplies local distribution networks and large industrial users. Electricity flows down stream and primarily in one direction from high-voltage transmission network to low-voltage distribution feeders.

The Smart Grid, however, allows the interconnection of distributed generation at almost any point in the transmission grid. Distributed generation includes small-scale generation (including wind, landfill gas, biomass and hydro), cogeneration or combined heat and power plants, small stand-alone diesel generators and domestic or small commercial photovoltaic solar generation.[14] There are many benefits associated with distributed generation. These include:

- reducing demand from the grid by installing a distributed generation plant close to the point of consumption (this can reduce distribution and transmission losses, reduce constraints on power lines and defer the need to upgrade the grid);
- improving the security of supply during peak demand;
- improving power supply to remote communities;
- facilitating the uptake of large-scale new renewable energy sources (currently high-voltage transmission grids are not situated where many renewable energy sources are developed); and
- locating power supply closer to end users.[15]

B *The Digital Smart Distribution Grid*

Smart distribution grids involve:

- integrating new technology into local electricity distribution networks, such as smart meters at individual homes and businesses to improve energy efficiency;
- grid monitoring and control devices for improving the efficiency of electricity distribution within local networks by utility companies;

11 Transmission is the process of transporting electricity at high voltages from where it is generated, often over long distances, to groups of electricity consumers.

12 TNSPs control the high voltage transmission assets that carry electricity between generators and distributors, while DNSPs operate the low voltage substations and wires that transport electricity from these substations to customers. Distributors hold a franchise over the regions in which their poles and wires are installed but must also be given access to customers outside their regions by using rival distribution networks.

13 MNSPs are entrepreneurial interconnectors, with a minimum capacity of 30 MW, that offer their capacity to transport power into the market through a bidding process similar to that used by generators.

14 Nirmal-Kumar C Nair and Lixi Zhang, 'SmartGrid: Future Networks for New Zealand Power Systems Incorporating Distributed Generation' (2009) 37 *Energy Policy* 3418, 3421.

15 Ibid.

- better tools for information sharing with consumers;
- pricing and control systems to integrate distributed energy resources such as solar panels, energy storage devices; and
- electric vehicles. The electric vehicles would be charged off peak and then feed power back into the grid when they are parked either at work or at home during the day.[16]

IV PROPOSALS FOR A SMART GRID IN AUSTRALIA, THE EUROPEAN UNION, AND THE UNITED STATES

The development of Smart Grids has become a priority action in Australia, the European Union and the United States as part of each jurisdiction's commitment to reducing greenhouses gas ('GHG') emissions, improving energy efficiency and encouraging the uptake of renewable energy sources. Each jurisdiction has only recently, in 2009, released its policy platform for the establishment of Smart Grids. The policy documents provide encouraging signs that the Smart Grid is likely to become a reality within the electricity sector in these jurisdictions where they will play a meaningful role in delivering mitigation and adaptation climate change benefits.

A *Australia*

The Australian government has committed to a 5–25 per cent reduction in GHG emissions by 2020, depending on the outcome of Copenhagen negotiations, and a 60 per cent reduction by 2050. Given that the energy sector is responsible for 69.6 per cent (400.9 Mt CO_2-e) of Australia's emissions, the climate change mitigation benefits of the Smart Grid need to be taken seriously. The principal policy document for Australia's transition to a Smart Grid is *Smart Grid, Smart City: A New Direction for a New Energy Era*.[17] Consistently with the discussion above, the document envisages both *grid-side* applications to reduce line loss and improve fault detection and restoration, and *customer-side* applications to assist consumers to manage their energy consumption. It is estimated that the adoption of Smart Grid technologies could deliver at least A$5 billion of gross annual benefit to Australia.[18]

The customer-side applications would include:

- information — on energy use or GHG emissions provided by website or in-home display;

16 See Hendricks, above n 8, 12; see also Boston Consulting Group, 'SMART 2020: Enabling the Low Carbon Economy in the Information Age' (Materials Prepared for Global e-Sustainability Initiative, 2008).

17 Department of the Environment, Water, Heritage and the Arts, above n 2.

18 Ibid 7.

- controls — using in-home displays, automated controls for appliances and programmable thermostats with communications; and
- tariffs which fluctuate according to time of use, critical peak pricing and real time pricing.

These applications would be enabled using smart metering infrastructure.[19]

The grid-side applications would include: integrated Volt-VAR control;[20] fault detection, isolation and restoration; substation and feeder monitoring and diagnostics; and wide-area management. Other key elements would include distributed energy storage, distributed generation (such as solar panels on residential rooftops), and electric vehicle support.[21]

The Smart Grid communications network will comprise three key elements:

- Home Area Networks to connect smart meters and intelligent devices and appliances within residences;
- Wide Area Networks which allow for two-way communications between a residence and the distributor substation; and
- Backhaul Networks which links the distributor substation to the utility.[22]

As the policy document presciently notes, 'the increased data that such a communications network would produce requires careful consideration of the physical and cyber security measures required to effectively manage the smart grid'.[23] Synergies between Smart Grid deployments and the National Broadband Network ('NBN') program have also been noted given that the NBN will create a robust, high-bandwidth communication network to most homes and commercial premises.[24]

It is proposed that a pilot study be distributor-led and adopted in a single distributor's network, which could include urban, suburban and rural areas and which should provide a reasonable representation of the grid, customers, geography and climate. It should include approximately 9500 customers. The three modules that should be addressed in the pilot study include: application and technology demonstration; regulatory alignment; and standards development.[25]

19 Ibid 17.

20 Currently, utilities use on-line power flow estimates which rely on stale data. If utilities were to use an integrated volt-VAR control system they could determine the optimal settings for all distribution voltage regulating and control devices which would assist with their obligation to maintain a set voltage to their customers. By collecting feeder voltage measurements from selected advanced geospacial intelligence ('AGI') nodes at strategic feeder locations (for example, at feeder extremities), the nodes can report these measurements on a periodic basis. The integrated volt-VAR system can use this information to maintain the required level of service to customers.

21 Department of the Environment, Water, Heritage and the Arts, above n 2, 18.

22 Ibid 19.

23 Ibid.

24 Ibid 37.

25 Ibid 41.

B *The European Union*

Under the EU's Energy and Climate Policy, the EU has adopted the goals of reducing GHG emissions by 20 per cent by 2020 and increasing the proportion of renewable energy in the EU's energy mix by 20 per cent by 2020. In the longer term, the EU has committed to reducing its GHG emissions by 80 per cent by 2050 compared with 1990 levels. The EU's Strategic Energy Technology Plan ('SET-Plan') is the EU's response to the need to accelerate the development of low carbon technologies to ensure their widespread market take-up. Seven Technology Roadmaps 2010–20 have been developed for the implementation of the SET-Plan in the areas of wind energy, solar energy, bio-energy, Carbon Capture and Storage, the electricity grid, sustainable nuclear energy and Smart Cities.[26]

The EU has identified three interrelated challenges for electricity networks including: creating a real internal market; integrating a massive increase of intermittent energy sources; and managing complex interaction between electricity suppliers and consumers. The total public and private investment needed in Europe is estimated to be €2 billion over 10 years.[27]

The objective of the European Industrial Initiative on the electricity grid is to enable 35 per cent of the EU's electricity to be supplied from dispersed and concentrated renewable sources by 2020 and completely decarbonised electricity production by 2050. The Initiative will also develop a market-based pan-European network by integrating national networks and engage customers as active participants in energy efficiency while also anticipating new developments such as the electrification of transport. Twenty large scale Smart Grid demonstration projects, involving 1.5 million customers, will be supported initially whereby smart meters will be rolled out and the automation and control of whole networks will be trialled.[28] Other significant features include: electricity storage; dynamic pricing mechanisms; and appropriate Information and communication technology ('ICT') tools.[29] Local renewable energy sources, especially photo-voltaic ('PV') and wind applications, will also be fostered.[30]

Meanwhile, under the Smart Cities Initiative, the development and deployment of 10 Smart Grids in cities will be established while the large deployment of low carbon transport systems and alternative fuel vehicles will be developed and tested. The Smart Cities Initiative, which also includes provisions for zero energy buildings, is likely to cost €10–12 billion over the next 10 years.[31]

26 See Commission of the European Communities, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Investing in the Development of Low Carbon Technologies (SET-Plan)* COM 519 (2009).

27 Ibid 5.

28 See Commission of the European Communities, *Commission Staff Working Document: A Technology Roadmap, Accompanying Document to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on Investing in the Development of Low-Carbon Technologies* SEC 1295 (2009) 10, 39.

29 Ibid 39.

30 Ibid 49.

31 Ibid 12.

C *The United States*

Under the *Federal Power Act* ('FPA'), the transmission of electricity in interstate commerce by public utilities, and the reliable operation of the bulk-power systems across most of the United States, falls under the jurisdiction of the Federal Energy Regulatory Commission ('FERC').[32] The Commission also has a new responsibility under the *Energy Independence and Security Act of 2007* ('EISA')[33] to issue a rulemaking to adopt standards and protocols to ensure Smart Grid functionality and interoperability[34] in interstate transmission of electricity and in regional and wholesale electricity markets.[35] In March 2009, FERC released its proposed *Smart Grid Policy*[36] for comment.

The proposed policy points out that 'section 1301 of the EISA states that it is the policy of the United States to support the modernization of the Nation's electricity transmission and distribution system to maintain a reliable and secure electricity infrastructure that can meet future demand growth and to achieve each of several goals and characteristics, which together characterize a Smart Grid'.[37] These goals and characteristics are defined by the Act as:

- increased use of digital information and controls technology to improve reliability, security, and efficiency of the electric grid;
- dynamic optimisation of grid operations and resources, with full cyber-security;
- deployment and integration of distributed resources and generation, including renewable resources;
- development and incorporation of demand response, demand-side resources, and energy efficiency resources;
- deployment of 'smart' technologies (real-time, automated, interactive technologies that optimise the physical operation of appliances and consumer devices) for metering, communications concerning grid operations and status, and distribution automation;
- integration of 'smart' appliances and consumer devices;
- deployment and integration of advanced electricity storage and peak-saving technologies, including plug-in electric and hybrid electric vehicles, and thermal storage air conditioning;

32 16 USC § 824.

33 Pub L No 110–140, 121 Stat 1492 (2007).

34 According to the GridWise Architecture Council, the term 'interoperability' refers to the ability to: exchange meaningful, actionable information between two or more systems across organisational boundaries; assure a shared meaning of the exchanged information; achieve an agreed expectation for the response to the information exchange; and maintain the requisite quality of service in information exchange (ie, reliability, accuracy, security); see GridWise Architecture Council, *Interoperability Path Forward: Whitepaper* (2005) 1–2.

35 See Federal Energy Regulatory Commission, *Smart Grid Policy*, 126 FERC 61253 (2009) 6–7.

36 Ibid.

37 Ibid 5 quoting *Energy Independence and Security Act of 2007*, Pub L No 110–140, § 1301, 121 Stat 1492 (2007).

- provision to consumers of timely information and control options;
- development of standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid; and
- identification and lowering of unreasonable or unnecessary barriers to the adoption of smart grid technologies, practices, and services.[38]

FERC's *Smart Grid Policy* discusses each of these aspects and invites comments on the proposed policy. FERC also advises that s 1305(a) of the EISA directs the National Institute of Standards and Technology (the 'Institute') 'to coordinate the development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems'.[39] The Institute has developed a Smart Grid Conceptual Reference Model which will be further developed and maintained by a Smart Grid Architecture Board.[40]

Once the Commission is satisfied that the Institute's work has led to sufficient consensus on interoperability standards, FERC is directed through the rulemaking process to adopt the standards and protocols necessary to ensure smart-grid functionality and interoperability in interstate transmission of electricity, and regional and wholesale electricity markets.

While the further development of the *Smart Grid Policy* and the necessary protocols and model standards continues, Smart Grid provisions are making their way into recently drafted US legislation such as the *American Clean Energy and Security Act* of 2009[41] (the Waxman-Markey Bill) which was passed by the House of Representatives on 26 June with a vote of 219–212. In September 2009, the US Senate put forward its own climate change Bill known as the *Clean Energy Jobs and American Power Act* of 2009 (the 'Kerry-Boxer Bill').[42] While political negotiations between the House of Representatives and the Senate continue around the adoption of climate change legislation, this article assesses the Smart Grid provisions in the Waxman-Markey Bill simply to reflect the uptake of the Smart Grid philosophy by legislators in another jurisdiction. It will be some time before it becomes clear how many of these provisions survive the negotiated settlement between the House of Representatives and the Senate.[43]

38 *Energy Independence and Security Act of 2007*, Pub L No 110–140, § 1301, 121 Stat 1492, 1783 (2007).

39 Federal Energy Regulatory Commission, above n 35, 6 quoting *Energy Independence and Security Act of 2007*, Pub L No 110–140, § 1301(a), 121 Stat 1492, 1783 (2007).

40 National Institute of Standards and Technology and U.S. Department of Commerce, above n 2, 5.

41 HR 2454, 111th Congress (2009).

42 S 1733, 111th Congress (2009).

43 Note that the traditional forum used to resolve differences between the House and Senate on pieces of legislation is the House-Senate Conference. A conference committee, which is a committee of Congress appointed by the House of Representatives and Senate, will attempt to resolve disagreements on a particular bill. Conference committees operate after the House and the Senate have passed different versions of a bill to negotiate a compromise bill that both houses can accept but both houses of Congress must eventually pass the identical legislation for the bill to become law.

The Waxman-Markey Bill proposes that the US reduce carbon emissions from major sources by 17 per cent by 2020 and over 80 per cent by 2050 compared to 2005 levels as well as meeting a 20 per cent renewable energy and energy efficiency target by 2020. The Bill commits significant investment in new clean energy technologies and energy efficiency, all of which have a bearing on the adoption of a Smart Grid, including: energy efficiency and renewable energy (US$90 billion in new investments by 2025); electric and other advanced technology vehicles (US$20 billion), and basic scientific research and development (US$20 billion).

The Bill includes numerous provisions to deploy Smart Grid technology and enhanced transmission planning to deal with some of the problems associated with traditional transmission and distribution functions.[44] Peak demand reduction goals will be established and utilities must prepare peak load reduction plans. With regard to transmission planning, regional electricity grid planning should facilitate the deployment of renewable energy, electricity storage and other Smart Grid features, which should be harmonised between regions. Advanced Metering Infrastructure should be adopted to provide consumers with interactive 'smart meters'. Phasor Measurement Units must be adopted whereby Smart Grid communications can sample voltage and power at a given location by taking 30 samples per second instead of every two to four seconds. These real time grid responses will be able to anticipate peaks better, avoid blackouts and reduce the costs of peaks. Also distributed generation must be enhanced so that generation can occur closest to point of consumption, for example, through the uptake of rooftop solar panels.

With regard to the transport features of the Smart Grid, the Bill requires electricity utilities to provide electrical charging stations in public and private locations to support electric cars. Smart grid devices must be deployed; for example, each vehicle must be identified individually so that the use of electricity can be charged to the owner's electricity account. Vehicle manufacturers must be given assistance to manufacture plug-in electrical cars.

V A SMART GRID IN AUSTRALIA: HOW FAR HAVE WE COME?

A *The Need for a Climate Change Objective in the National Electricity Market*

While jurisdictions like the EU include within their policy platforms for a Smart Grid the creation of a real internal market, Australia has already made significant advances in this regard. The National Electricity Market ('NEM') was formally launched in December 1998. The NEM is a wholesale electricity market that operates across Queensland, New South Wales, Victoria, the Australian Capital

44 See, eg, HR 2454, 111th Congress (2009) §§ 121–3, 132(c)(4)(D), 143–6, 216A.

Territory, South Australia and Tasmania. Inter-regional trade between these jurisdictions is facilitated by interconnectors which transmit power between regions to meet energy demands which local generators cannot meet, or when the price of electricity in another region is sufficiently low that it displaces local supply.

In June 2004, the Council of Australian Governments ('COAG') signed the *Australian Energy Market Agreement* (the 'Agreement').[45] Following a regulatory reform process, the NEM is now governed by the *National Electricity (South Australia) Act 1996* (SA) ('NEL') and the *National Electricity Rules* (the 'Rules').[46]

The NEL introduces a new 'objective' of the national electricity market: to promote efficient investment in, and use of, electricity services for the long-term interests of consumers of electricity with respect to price, quality, reliability, safety and security. However, the objective makes no mention of the need to reduce greenhouse gas emissions, improve energy efficiency or increase the penetration of renewable energy sources into Australia's fuel mix. This is curious since the 2001 Council of Australian Government energy policy agreement,[47] which culminated in the 2004 reforms of the NEL, stated that one of the national energy policy objectives would be 'mitigating local and global environmental impacts, notably greenhouse impacts, of energy production, transformation, supply and use'.[48] No doubt, if a decision is made to roll out a Smart Grid across Australia, another process of regulatory reform of the NEM will be required. It seems appropriate, given that a Smart Grid is deliberately directed at the mitigation of greenhouse gas emissions in the electricity sector, that the objective of the NEL be amended at that time.

B *The Roll Out of Smart Meters*

The roll out of smart meters is taking place under the auspices of Australia's National Framework for Energy Efficiency ('NFEE')[49] which is administered by the Ministerial Council on Energy ('MCE'). In particular, the NFEE promotes demand-side energy efficiency in the residential, commercial and industrial sectors, and also seeks to overcome the barriers and challenges to energy efficiency measures.

45 Ministerial Council on Energy Standing Committee of Officials, *Intergovernmental Agreement and Legislative Framework* (2004) <http://www.ret.gov.au/Documents/mce/_documents/IGALegislativeframeworkfinal2004052516125820041124121008.pdf> at 18 February 2010.

46 See generally Rosemary Lyster and Adrian Bradbrook, *Energy Law and the Environment* (2006) ch 5.

47 Council of Australian Governments, *Council of Australian Governments' Communiqué* (2001) <http://www.coag.gov.au/coag_meeting_outcomes/2001-06-08/index.cfm#energy> at 18 February 2010.

48 Council of Australian Governments, *Council of Australian Governments' Communiqué: COAG Energy Policy Details* (2001) <http://www.coag.gov.au/coag_meeting_outcomes/2001-06-08/docs/energy.cfm> at 18 February 2010.

49 Department of Resources, Energy and Tourism, *National Framework for Energy Efficiency* <http://www.ret.gov.au/Documents/mce/energy-eff/nfee/default.html> at 18 February 2010.

In January 2007, the MCE,[50] following its cost-benefit analysis of the roll-out of smart meters,[51] resolved that there should be a national regulatory framework for smart meters with DNSPs being exclusively obliged to roll out smart meters to residential and other small customers in mandated jurisdictions. The MCE suggests that distribution network tariffs should enable the DNSPs to recover the costs associated with the roll-out of smart meters and pass on any resulting cost efficiencies to customers. The Victorian government has already adopted smart meter technology, but the MCE proposes that New South Whales will begin to deploy smart meters over the next few years. Other jurisdictions will conduct further reviews and assessments of the matter, with a further national review of deployment timelines to be conducted in 2012.

To further support the accelerated roll-out and trials of smart meters in participating jurisdictions the MCE Standing Committee of Officials ('SCO') has approved for public exposure and consultation changes to the NEL.[52] This is the first component of the national smart metering legislative framework being developed by MCE which includes cost recovery arrangements, consumer protection measures and safety standards for a national framework. The smart metering services which will be required under the NEL will be defined in accordance with the *National Electricity Rules*. These proposed NEL changes will define the scope and responsibilities of the roll-out and specify the mechanism by which the obligation to roll-out or trial smart meters in a jurisdiction will be facilitated. Technical and operational details for smart meters will also be included in the Rules and roll-out timing and geographical coverage requirements outlined in jurisdictional instruments. These NEL changes are to work alongside the existing roll-out arrangements in Victoria.

The proposed NEL changes provide:

50 The Ministerial Council on Energy ('MCE') was established by the Council of Australian Governments ('COAG') in 2001 and plays a key role in implementing COAG's national energy policy framework. The MCE is the national policy and governance body for the Australian energy market, including electricity and gas. It has played a key role in recent initiatives to continue with energy market reform. In addition to energy market reform, the kinds of issues with which the MCE has recently been engaged are energy efficiency, energy security and renewable and distributed generation. The Council comprises ministers with responsibility for energy from the Australian Government and all States and Territories. The MCE is assisted in its work by the Standing Committee of Officials of the Ministerial Council on Energy.

51 Ministerial Council on Energy, *Smart Meters: Information Paper on the Development of an Implementation Plan for the Roll-Out of Smart Meters* (2007) <http://www.ret.gov.au/Documents/mce/_documents/SmartMetersInfoPaper20070123163300.pdf> at 18 February 2010.

52 Ministerial Council on Energy Standing Committee of Officials, *National Electricity Law Changes for Smart Meter Roll-Outs and Trial: Explanatory Note* <http://www.ret.gov.au/Documents/mce/_documents/Explanatory%20note%20-%20smart%20meter%20NEL%20amendments20081224104911.pdf> at 18 February 2010. See also Ministerial Council on Energy Standing Committee of Officials, *National Electricity (South Australia) (Smart Meters) Amendment Bill 2009: Second Exposure Draft* (2009) <http://www.ret.gov.au/Documents/mce/_documents/smart_meters/second_exposure_draft_smart_meter_nel_amendments.pdf> at 18 February 2010; Ministerial Council on Energy Standing Committee of Officials, *National Electricity Amendment (Ministerial Smart Meter Roll Out Determinations) Transitional Rule 2009*: *Exposure Draft* (2009) <http://www.ret.gov.au/Documents/mce/_documents/smart_meters/exposure_draft_smart_meter_transitional_rule.pdf> at 18 February 2010.

- that a Minister of a participating jurisdiction may make a determination in relation to a regulated DNSP operating predominantly in that jurisdiction such that the regulated DNSP must provide customers, determined under the Rules, with smart metering services which meet the standards specified in the Rules and in accordance with a timetable prescribed by the determination;
- that the Minister may specify in a determination that a regulated DNSP operating predominantly in that jurisdiction must conduct such pilots and trials of remotely read interval meters of a nature and to timings, performance standards and service levels specified in the determination; and
- that the determination may specify: which businesses are involved; the customer numbers and types of customers covered by the determination; the type or functionality of remotely read meters or of associated processes and systems that would be trialled; relevant timeframes for the pilots or trials; and pilots or trials process requirements.

The link between the roll-out of smart meters and the Rules is that 'smart metering services' will be defined as services provided to a customer by means of a remotely read interval meter which, at the time it was installed, met the specifications of a smart meter in the Rules.

The making of a smart meter determination in respect of a DNSP by the relevant jurisdictional Minister will allow Ministers to reflect the differing jurisdictional circumstances affecting that DNSP such that the timeframe for roll-out to target customers or for pilots and trials can be set according to the requirements of that jurisdiction.

C *Facilitating the Uptake of Large-Scale New Renewable Energy Sources*

Barriers to the uptake of large-scale new renewable energy sources have long been acknowledged in Australia. While there have been a number of policy and legislative initiatives to ameliorate the situation, significant barriers remain. As mentioned above, some of the key enabling elements of the Smart Grid are: facilitating the installation of distributed generation plants close to the point of consumption; facilitating the uptake of large-scale new renewable energy sources; and introducing pricing and control systems to integrate distributed energy resources such as solar panels. The extent to which Smart Grid technology can overcome these barriers will be a key question for policymakers and regulators in Australia. What is useful, however, is to assess existing measures which may complement the establishment of a Smart Grid.

1 *Government Funding for Renewable Energy Programs*

In its 2008 Budget the Rudd government committed A$2.3 billion to implement a range of climate change measures and to support the development and use of new clean energy technologies. It is clear that these sources of funding will increase the deployment and commercialisation of energy efficiency and renewable energy technologies. This links to the Smart Grid in two significant ways. Firstly, the uptake of these technologies will be further enabled by the establishment of a Smart Grid and, secondly, the funding could also be regarded as creating an enabling environment for the establishment the Smart Grid. The budget measures include:

- Solar Hot Water Rebates (a rebate of A$1600 to install a solar hot water system that is eligible for at least 20 Renewable Energy Certificates ('RECs'), discussed below, at the time and place of installation);[53]
- National Solar Schools Plan (up to A$50 000 to schools which install solar and other renewable power systems, solar hot water systems, rainwater tanks and a range of energy efficiency measures);[54]
- Solar Cities program (integrates energy efficiency measures including smart meters, solar technologies and cost reflective pricing trials in an effort to identify and deal with barriers to energy efficiency, electricity demand management and the use of solar technology. Solar Cities have been established in Adelaide, Alice Springs, Blacktown, central Victoria, Moreland, Perth and Townsville);[55]
- Energy Innovation Fund (A$150 million over five years: A$50 million for the Australian Solar Institute, a significant expansion of solar thermal research capacity; A$50 million for photovoltaic research and A$50 million for general clean energy research and development, including energy efficiency and energy storage technologies);[56]
- Renewable Energy Fund (A$500 million over six years from 2009–10 for the development of solar thermal, geothermal, wave and biomass energy);[57] and
- Green Car Innovation Fund (A$500 million over five years from 2011–12 which could ostensibly include the development of electric vehicles).[58]

2 *Legislation Encouraging the Uptake of Renewable Energy Sources*

(a) Renewable Energy Targets

In 2000, the Howard government enacted the *Renewable Energy (Electricity) Act 2000* (Cth). The Act in its original form introduced a 2 per cent Renewable Portfolio

53 Department of the Environment, Water, Heritage and the Arts, *Solar Hot Water Rebate* <http://www.environment.gov.au/energyefficiency/solarhotwater/> at 18 February 2010.

54 Department of the Environment, Water, Heritage and the Arts, *National Solar Schools Program* <http://www.environment.gov.au/settlements/renewable/nationalsolarschools/> at 18 February 2010.

55 Department of the Environment, Water, Heritage and the Arts, *Australia's Solar Cities* <http://www.environment.gov.au/settlements/solarcities/index.html> at 18 February 2010.

56 Martin Ferguson, *Budget Boosts Clean Coal and Renewable Technology* (2008) Minister for Resources and Energy, Minister for Tourism <http://minister.ret.gov.au/TheHonMartinFergusonMP/Pages/BUDGETBOOSTSCLEANCOALANDRENEWABLEENERGY.aspx> at 18 February 2010.

57 Ibid.

58 Kim Carr, *Green Car Innovation Fund to Address Climate Change Challenge* (2008) Minister for Innovation, Industry, Science and Research <http://minister.innovation.gov.au/Carr/Pages/GREENCARINNOVATIONFUNDTOADDRESSCLIMATECHANGECHALLENGE.aspx> at 18 February 2010.

Standard ('RPS') for Australia which would be achieved by 2010. This target has been increased to 20 per cent by 2020 by the Rudd government.[59] The legislation is directed primarily at electricity retailers which are 'liable entities'[60] under the Act. They are required to achieve individual renewable energy targets based on their projected market share of consumption. Renewable energy certificates are generated by accredited power stations[61] when they generate power using eligible renewable energy sources[62] that exceed the 1997 baseline.[63] Certificates can also be created by installations of solar hot water heaters.

(b) 'Feed-In' Legislation

'Feed-in' legislation is a mechanism that requires an electricity utility to let independent producers of renewable power 'feed' their electricity into the grid against a guaranteed payment of a certain fee. Such legislation has been adopted, for example, in Victoria where a new Division 5A has been inserted into Part 2 of the *Electricity Industry Act 2000* (Vic) by the *Energy Legislation Amendment Act 2007* (Vic). The Act requires retailers to purchase electricity from small wind, solar, hydro and biomass energy generation facilities and to publish the prices and terms and conditions of the purchase (feed-in tariffs) in the *Government Gazette* and on the retailers' website. A small generating facility is one which has an installed generating capacity of less than 100kWs. The Essential Services Commission can review the prices, upon the Minister's request, if the Minister believes that the prices offered by a retailer are unfair or unreasonable. In March 2008, the Commission issued a Guidance Paper entitled *Methodology for Assessment of Fair and Reasonable Feed-In Tariffs and Terms and Conditions*.[64]

'Feed-in' legislation can also apply to small distributed solar systems such as solar panels on the rooftops of households, which is entirely consistent with the goal of the Smart Grid to facilitate this type of generation. The South Australian 'feed-in' legislation, enacted under the *Electricity (Feed-In Scheme—Solar Systems) Amendment Act 2008* (SA), places an obligation on holders of a distribution network licence, which distributes electricity to more than 10 000 customers, to allow customers to feed into the network excess electricity generated by a small photovoltaic generator. This means a photovoltaic system with capacity up to 10kVA for a single phase connection and up to 30kVA for a three phase connection. The account of the customer must be credited at the rate of A$0.44 per kilowatt hour for any electricity fed into the network.

59 See *Renewable Energy (Electricity) Act 2000* (Cth) s 40.

60 A liable entity is defined in *Renewable Energy (Electricity) Act 2000* (Cth) s 35.

61 *Renewable Energy (Electricity) Act 2000* (Cth) s 13. Certificates must be created electronically containing a unique identification code, the electronic signature of the person who created the certificate, the date on which the electricity was generated and the date on which the certificate was created. Certificates must be registered with the Regulator. Once registered the certificates can be transferred to any person subject to the Regulator being notified.

62 Eligible renewable energy sources are defined in *Renewable Energy (Electricity)Act 2000* (Cth) s 17.

63 *Renewable Energy (Electricity) Act 2000* (Cth) s 18.

64 Essential Services Commission, *Guidance Paper: Methodology for Assessment of Fair and Reasonable Feed-In Tariffs and Terms and Conditions* (2008).

The *Clean Energy Act 2008* (Qld), meanwhile, amends the *Electricity Act 1994* (Qld) by inserting a new s 44A to provide that a distribution entity must credit any electricity that is produced by a qualifying generator and being supplied to the network by a small customer in excess of his or her usage, against the charges payable by a small customer at the rate of A$0.44 per kilowatt hour. It also inserts a new s 55DB to prescribe that a retail authority must reduce the amount payable by a small customer by any credit given by the distribution entity under s 44A. Finally, the Act prescribes that both provisions will expire on 1 July 2028.

In 2009, the NSW government joined other states to establish a Solar Bonus Scheme by inserting s 15A into the *Electricity Supply Act 1995* (NSW). This scheme, unlike those in other states, is a 'gross feed-in' scheme which means that customers are paid for the total amount of wind and solar energy produced rather than simply their excess power. The scheme, which commences on 1 January 2010, applies to wind and solar photovoltaic generators with a capacity of 10kW where their electricity consumption does not exceed 160 megawatt-hours of electricity per annum. Similar 'gross feed-in' legislation has also been enacted in the ACT by virtue of the *Electricity Feed-in (Renewable Energy Premium) Act 2008* (ACT).

3 *Enduring Barriers to Distributed Generation*

Despite legislated RPSs and 'feed-in' tariffs, barriers to the uptake of renewable energy which were highlighted by the Parer Review seem to remain unresolved. In 2002, following the 2001 COAG energy policy agreement, COAG appointed The Hon Warwick Parer to chair an Independent Review of Energy Market Directions. The subsequent report, entitled *Towards a Truly National and Efficient Energy Market*,[65] found that there are barriers to embedded generation[66] and recommended that a mandatory code of practice governing arrangements between distribution companies and prospective embedded generators be introduced into the *National Electricity Law*.[67]

Further, in 2006 the MCE Standing Committee of Officials released a discussion paper entitled *Impediments to the Uptake of Renewable and Distributed Energy*.[68] Although there are different impediments to Renewable and Distributed Generation ('R & DG'), depending on the size of the generator, there are a number of impediments commonly faced by all generators. These are:

- approval processes for R & DG projects can be complex and inconsistent across jurisdictions;
- per-unit generation costs are generally higher than conventional technologies;

65 Ministerial Council on Energy, 'Towards a Truly National and Efficient Energy Market' (Final Report, Council of Australian Governments' Independent Review of Energy Market Directions, 2002).

66 Ibid 74.

67 Ibid 95–8.

68 Ministerial Council on Energy Standing Committee of Officials, Renewable and Distributed Generation Working Group, *Impediments to the Uptake of Renewable and Distributed Energy*: *Discussion Paper* (2006).

- there is no strategic regional focus on planning for R & DG technologies and current network planning tends to be incremental;
- it is often difficult for new technologies to obtain planning approval, financing and skilled labour while access to support infrastructure can be difficult;
- economic signals for distributed and close-to-load generation is often muted or lost because of a lack of locational and cost reflective pricing (and associated metering);
- incremental connection costs can be potentially prohibitive for new R & DG projects, particularly where projects require network augmentations or provision of major new line. Although the National Electricity Rules require connection agreements to be fair and reasonable but it may be necessary to development further guidance on what this amounts to. Network connection regulations can also be complex; and
- Network Service Provider concerns about the reliability of R & DG may be a barrier to active uptake.

The discussion paper states that these problems can only be overcome if emerging technology issues are adequately addressed, R & DG proponents and consumers are able to participate effectively in the market, and the network is capable of managing increased levels of R & DG in a cost-effective manner.

Despite the recognition of the barriers to distributed generation, it seems as though legislative reform in this area has stalled. The MCE notes that the Utility Regulators Forum was originally given the task of developing a consistent and comprehensive Code of Practice for distributors across the NEM. However, this work seems to have been integrated into the development of the national distribution framework which is the responsibility of the Energy Market Reform Working Group.[69] Although in 2007 the MCE SCO engaged NERA Economic Consulting ('NERA') and Allen Consulting Group ('ACG') to provide expert advice on the proposed electricity distribution revenue and pricing rules, with the aim of removing impediments to the uptake of Distributed Generation,[70] it seems that no further progress has been made in this regard.

VI THE WAY FORWARD FOR AUSTRALIA: REGULATORY REFORM AND GOVERNANCE

This article suggests that although a preliminary framework for the establishment of a Smart Grid has already been established in Australia through the 2008 Budget, the National Renewable Energy Target, 'feed-in' legislation in the states, and a decision by the MCE to roll-out smart meters, more work needs to be done.

69 Department of Resources, Energy and Tourism, *Renewable and Distributed Generation* <http://www.ret.gov.au/Documents/mce/rdg/default.html> at 18 February 2010.

70 Department of Resources, Energy and Tourism, *Distribution Network Incentives* <http://www.ret.gov.au/Documents/mce/rdg/network.html> at 18 February 2010.

It has been suggested that the National Electricity Law should include a climate change, energy efficiency and renewable energy objective. Reforms to remove the barriers to renewable and distributed generation seem to have stalled. It may be that the Smart Grid is the ultimate solution to this issue but in the meantime this issue deserves the attention of the MCE. Also, although there are state based 'feed-in' laws, such a law is conspicuously absent at the Commonwealth level. The Renewable Energy Amendment (Feed-in-Tariff for Electricity) Bill 2008 (Cth), a private member's Bill, was introduced into the Senate.

The object of the Bill is to support various renewable energy technologies by:

- providing additional tailored support for a range of renewable energy technologies that are not adequately supported by the NRET;
- requiring electricity distributors to allow small and large scale qualified generators to supply the grid as well as providing a payment or rebate to them; and
- establishing an effective monitoring regime to identify the extent of renewable electricity generation from qualifying generators.

The Bill was read twice but has not been enacted. If such legislation were enacted it could provide a national scheme which would incorporate all of the existing state schemes as has occurred under the Commonwealth's National Renewable Energy Target scheme.

The report, *Smart Grid, Smart City*, has come to the conclusion that regulatory frameworks require no major changes for the successful execution of the proposed *pilot* for a Smart Grid.[71] Although retail pricing flexibility, cost recovery and voltage levels were raised as potential issues interfering with this, they seem not to be of major concern. With respect to retail pricing there is a view that, with the introduction of full retail contestability in most states, pricing is flexible and customers are able to opt out. Since *government funding* will minimise the technological maturity and implementation risk of the Smart Grid, cost recovery is not regarded as a problem given that a pass through mechanism to customers will not be required. The issue with voltage levels is that Conservation Voltage Regulation ('CVR'),[72] which will form part of the Smart Grid, may require distributors to alter voltage to customers in breach of their standards. However, it seems that the current Standards Australia and state government voltage standards are broad enough to allow the modifications required to test CVR. In any case, it is likely that the deployment of *Smart Grid, Smart City* can contribute to identifying regulatory barriers that might affect an Australia-wide adoption of the Smart Grid.[73]

However, there do seem to be potential economic and technical regulatory challenges to the *broader adoption* of Smart Grid technologies that might impede

71 Department of the Environment, Water, Heritage and the Arts, *Smart Grid Smart City*, above n 2, 64.

72 Conservation Voltage Regulation ('CVR') is a technique for improving the efficiency of the electrical grid by reducing voltage on the feeder lines that run from substations to homes and businesses.

73 Department of the Environment, Water, Heritage and the Arts, *Smart Grid Smart City*, above n 2, 64–5.

a *market-led* adoption of the Smart Grid. For this to occur, clear signals need to be given to the electricity market participants. So, for example, the Australian Energy Regulator could publish a Demand Side Management Incentive Scheme to provide distributors with the necessary incentive to implement an efficient non-network alternative and manage expected demand.[74]

Finally, a limited set of agreed standards is identified as another potential barrier to the broader adoption of a Smart Grid in Australia as this increases the risk of stranded assets. It is proposed that a working group be established to work with Standards Australia, the National Measurement Institute, the US National Institute of Standards and Technology and the European Committee for Electrotechnical Standardisation (Comité Européen de Normalisation Èlectrotechnique) to identify the standards needed in Australia to roll out the Smart Grid.[75]

VII CONCLUSIONS

Given the level of policy development in Australia, the US and the EU in 2009, it is clear that in all of these jurisdictions the concept of the Smart Grid has taken hold. All jurisdictions acknowledge the mitigation benefits of the adopting Smart Grid technologies. Both the sustainable transmission grid and the digital smart distribution grid provide clear climate change mitigation benefits including encouraging energy efficiency, facilitating Demand Side Management, energy storage, the uptake of renewable energy sources and the adoption of electric vehicles. The Smart Grid delivers many of the key technological drivers for reducing GHG emissions from the electricity market which will also be driven by regulatory measures, such as an emissions trading scheme.

In addition to these mitigation benefits, the author proposes that the features of the digital smart distribution grid, with its sophisticated grid monitoring and control devices and energy storage and distributed generation features, may well also be regarded as an adaptation measure to cope with the well-documented climate change impacts to electricity infrastructure.

74 Ibid 66.

75 Ibid 69–70.