energy networks association

Smart networks position paper

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This document was prepared by the Energy Networks Association.

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1. Executive summary

This is a high level document aimed at generating discussion on the development and implementation of smart networks (smart grids). It canvases a range of issues all of which are thought provoking and designed to enable the discussion to commence.

The electricity industry is poised to make the transformation from a centralised, producer-controlled network to one that is less centralised and more consumer-interactive. The move to a smarter network promises to change the industry's business model and its relationship with all stakeholders, involving and affecting utilities, regulators, energy service providers, technology and automation vendors and all consumers of electric power.

The key drivers for this change are evident—the need to respond to climate change through the reduction of carbon emissions, and the need to maintain and enhance energy security. The involvement of energy users—consumers—is critical in responding to both drivers.

The smart network has several key objectives:

1. Change the relationship with customers, transforming their role from uninformed and non-participative to informed, active and involved, stimulating demand side response;
2. Accommodate connection of widely distributed, renewable energy sources across the network and in particular at customer premises, providing an 'energy clearing house' function;
3. Facilitate market interactions, providing customers access to products and services with choice, based on price and environmental concerns;
4. Accommodate new energy storage technologies, enabling customers to choose the source of their energy and optimise the efficiency of their use of energy; and
5. Continue to improve the performance of the network by:
    - using greatly enhanced data gathering capabilities;
    - automatically detecting and responding to problems;
    - strengthening interconnections; and
    - optimising replacement investment.

Delivery of those objectives involves a merging of the existing electricity network infrastructure—upgraded with sensing, monitoring and management devices—with a secure, robust, and reliable communications infrastructure, supported by relevant information technologies, resulting in two-way exchanges of energy and information.

Delivery of these objectives will also contribute significantly to the Federal Government's objectives of reducing greenhouse gas emissions and enhancing energy security.

Industry's policy positions

To ensure the efficient and timely delivery of the smart network, ENA is pursuing a number of policy positions as outlined in this paper. Industry's policy positions are:

- The Federal Government appoint a joint working group, comprising energy industry and National Broadband Network (NBN) representatives, to ensure the proposed investments in energy and communications infrastructure achieve the greatest possible synergies and therefore least cost outcomes.

- The Federal Government consider making a dedicated portion of telecommunications spectrum available nationwide for the purposes of implementing smart networks. The regulation of this spectrum should be aligned to the requirements of smart network infrastructure.

- Standards be developed by appropriate joint working groups, drawing on international experience, in the areas of:

    1. end-to-end cyber-security for smart networks;

    2. interconnection and interoperability standards for energy source and storage devices; and

    3. application-level data communication for enabling sensor-to-network consistent communications; home energy systems; home area networks; metering; exchange of meter data; and network to home energy management systems interactions.

- Industry work with the relevant bodies to develop inexpensive energy storage. This is particularly relevant with the emergence of plug-in electric vehicles.

- Increased consideration is given to funding and course development for the next generation of power and telecommunications engineers across Australia's tertiary education facilities.

- Industry continues to work with governments, rule makers and regulators to ensure appropriate commercial returns for network investment recognising upstream benefits, for example reduction of carbon emissions, deferment of investment in generation plant and reduced energy production costs.

- Industry continues to work with governments, rule makers and regulators to develop pricing structures over time which reflect energy costs and network constraints, providing consumers with the right incentives to become producers of renewable energy and to become more efficient users of energy particularly in peak demand periods.

- Industry will continue to work with governments, rule makers and regulators to ensure appropriate allowances for Research and Development investment in smart network technology.

- Education of all stakeholders to the benefits from and opportunities that will arise from the implementation smart networks. The Energy Networks Association represents gas distribution and electricity transmission and distribution businesses in Australia and should be recognised as the appropriate industry body to lead and coordinate the development of Australia's smart network.

2. Introduction

Energy network businesses deliver electricity and gas to over 13.5 million customers, employ more than 40 000 people and contribute approximately 1.25 percent to Australia's gross domestic product. Energy is delivered across Australia through approximately 48 000 kilometres of transmission lines, 800 000 kilometres of electricity distribution lines and 81 000 kilometres of gas distribution pipelines. Energy network businesses are valued at more than $50 billion and annually undertake around $6 billion in network operations, reinforcement, expansions and greenfields extensions. Importantly, ENA members are working together to transform Australia's network sector through the development and adoption of leading edge technology to ensure Australia has the most efficient and secure system for delivering reliable, affordable, clean energy in an environment the focus of which is to reduce greenhouse gas emissions from the generation, delivery and consumption of energy.

Industry is doing this through undertaking cutting edge research; developing, testing and adopting new technology and working with government agencies and other affiliated industries to introduce these new technologies. This new facilitating infrastructure is known as the smart network or smart grid.

Critical to the successful uptake of smart networks is the education of consumers and other key stakeholders to the opportunities offered by this new technology. With an understanding of this situation, this paper examines the challenges and opportunities facing the sector. It highlights the drivers for change, sets out the industry's vision for the future of the sector and discusses the barriers and challenges in delivering that vision. It also identifies the key issues that need to be addressed to allow for the development of the smart network and outlines ENA's policy positions in regards to the key areas.

3. Current and emerging issues

The electricity network underpins Australia's economic and social fabric—delivering the primary energy source to power homes, businesses and major industry. The network, consisting of substations, poles and wires, is extremely large and complex, with its value and contribution going largely unnoticed by the consumers it serves.

The way the electricity network functions has not altered significantly in the last 100 years, largely constrained by the physical characteristics of electricity and the way it is generated. However, that situation is beginning to change around the world, with the emergence of new technologies that promise a smarter electricity network that will assist in meeting the challenge of climate change while maintaining energy security.

As much of Australia's existing $60 billion energy infrastructure was built in the 1950's to 1970's, with an asset life of around 40 years, there is a national trend to upgrade the nation's network over the next decade. The replacement of aging infrastructure presents an opportunity to take advantage of new technologies and 'future-proof' the network, not only to meet the continuing growth in peak electricity consumption, but also to cope with a fundamental change in the delivery of electricity services in a carbon constrained environment.

One of the main limitations of the existing electricity production and delivery processes is that consumers are passive participants, with limited accessible information to demonstrate energy usage and costs, little or no choice about energy source and only receiving a bill weeks after using the electricity. In addition, the current design of the network is for a one way flow of both energy and information, and as such it will not meet the anticipated expectations of consumers and key stakeholders in the future, that require two-way energy and information exchange to support best practice asset management, customer enablement, and the range of emerging energy storage and renewable generation technologies.

While this future is dependent on the uptake of new technology, the greater dependence is on the need for consumers to fundamentally change the way that energy is used. A main objective of the smart network is to enable consumer choice, and as increasing awareness of climate change and the financial impacts of rising electricity prices take effect, consumers are beginning to show a willingness to become participants in the energy market and to make choices about their energy use.

The means by which the sector will deliver a smart network is to add an 'intelligence' layer to the core distribution systems. This intelligence will enable secure, reliable and cost effective two-way energy and information flows to and from consumers and devices on the network, and will be supported by enabling solutions.

The result will be a transformation from a process characterised by dominant large-scale generation, with little or no customer involvement or choice, and with limited information about and control over the devices by which the infrastructure delivering the energy is managed, to one which enables and facilitates higher levels of local, renewable energy generation, customer choice and participation, real-time management and operation of the network infrastructure.

4. Industry's vision for the future of the sector

In its efforts to ensure this transformation and the continued delivery of reliable, affordable and clean energy Industry has developed the following vision for the sector—the smart network.

An energy network that promotes diversity, efficiency and flexibility in the transportation of energy that underpins the secure, affordable, and environmentally friendly supply and use of energy in a carbon constrained world.

Industry will achieve this vision through cooperating in the development and implementation of energy and telecommunication technologies that will enhance energy efficiency by allowing customer choice in their energy consumption, facilitating the use of new and renewable energy generation technologies and working with government to ensure that the regulatory environment in which the sector operates supports these goals.

5. The key drivers for change

The key drivers for change are the need to respond to climate change through the reduction of carbon emissions, and the need to maintain and enhance energy security. Globally, the threat to the supply of reliable, affordable and clean energy from climate change combined with the desire of those economies that lack indigenous energy resources to secure energy supplies has driven the development and deployment of new and renewable technologies including advancing ways in which energy is delivered.

Australia, while energy resource rich, is not immune to the challenge to the supply of safe and secure energy posed from climate change. The implementation of a smart network can mitigate against that risk.

In the short term, a smart network will function more efficiently, enable the delivery of the level of service that consumers have come to expect more affordably in an era of rising costs, and offer considerable public benefits in the form of reducing green house gas emissions. In the long term, a smart network will facilitate a step change in the way energy is produced and consumed.

5.1 Network challenges

As we know, electricity must be consumed the moment it is generated. The main problem is supplying peak demand. The challenge for energy networks is that they must be designed to meet peak rather than average demand. There are three ways to mitigate the challenge of rapidly growing peak demand: managing supply; managing demand; and solutions to shift demand away from peaks. A smart network will support all three of these solutions:

- supply is supported via the network capability to allow the introduction of new generation options on to the network;
- demand is supported through demand management and the ability to send pricing signals to consumers; and
- smart supply is created through the availability of information that allows both supply and demand systems to shift demand into the right time of day and into the least stressed parts of the network.

In supporting these challenges, the smart network is reducing costs by reducing capital expenditure to meet peak demand.

5.2 Enabling climate change solutions

The Federal and State governments have introduced a range of policy initiatives to reduce emissions of carbon and other gases into the atmosphere and have moved to encourage greater uptake of renewable energy, promote energy efficiency and invest in technologies that reduce reliance on traditional CO_2 emitting energy sources.

As a result of these measures, there will be significant changes to the way Australians produce and consume energy. The energy network sector, through the development and implementation of the smart network, will play an important role in facilitating the shift to a low carbon economy.

The key means by which demand and emissions can be reduced is by:

- providing consumers with information about the amount and cost of the energy they are using and enabling them to make choices before they buy;
- facilitating local, renewable generation;
- providing better ability to deal with the intermittency of large-scale renewable generation such as wind, wave and solar; and
- facilitating the uptake of electric and hybrid vehicles. These vehicles will be a new demand on the system, but will also act as a source of energy storage. The balancing of the demand and supply features of these vehicles will be an additional challenge that the network sector will need to meet.

5.3 Local area issues

Transmission and distribution networks in Australia often face community opposition to the siting of new infrastructure, particularly substation sites and feeder corridors and routes. This often results from the 'Not In My Backyard' or 'NIMBY' situation.

At the Transmission level it is likely that significant additional infrastructure will be required to accommodate the changing stock of 'big-end' generation (for example wind farms, geo-thermal etcetera).

At the distribution level, the introduction of a smart network will, to some extent, alleviate some of these issues. Under the right model there should be a reduced need to build distribution infrastructure. This will result from the greater uptake of embedded generation, more localised renewable energy and greater energy efficiency as consumers make informed choices about the level of their consumption.

On the other hand, there is some belief within the community that distributed renewable energy sources will remove the need to install traditional network infrastructure. This is not correct, and in many instances the opposite is true—it is the energy networks of Australia that will allow the true value of interconnected renewable energy sources to be realised.

What is clear is that in order to maximise the benefits from the introduction of new technologies, industry and the community will need to become partners in this process.

5.4 Energy security

A smart network facilitates energy security by:

- reducing total demand as customers respond to price signals and implement energy saving strategies and responses in their homes and businesses;
- facilitating local, renewable generation, adding to the total generation capability;
- enhancing reliability by way of:
    - real-time monitoring and control of network performance at the global and local level;
    - rapid fault diagnosis and response;
    - 'self healing' or automated switching under fault conditions;
    - 'local Intelligence' automatically sectionalises to limit outage scope;
    - local generation providing alternatives to central generation in the event of major disruptions;
    - greater interconnection; and
    - reducing the total cost of energy production as demand is reduced and peak demand loads are reduced, thereby reducing the need for additional infrastructure.

As with all critical infrastructure, there has been heightened security awareness since 9/11, and specific consideration will need to be given to securing the new smart network. This will mean the implementation of security policies for the physical and cyber components of the network at the national level.

5.5 Costs

Elements of the strategies the network sector will need to adopt to implement smart networks include:

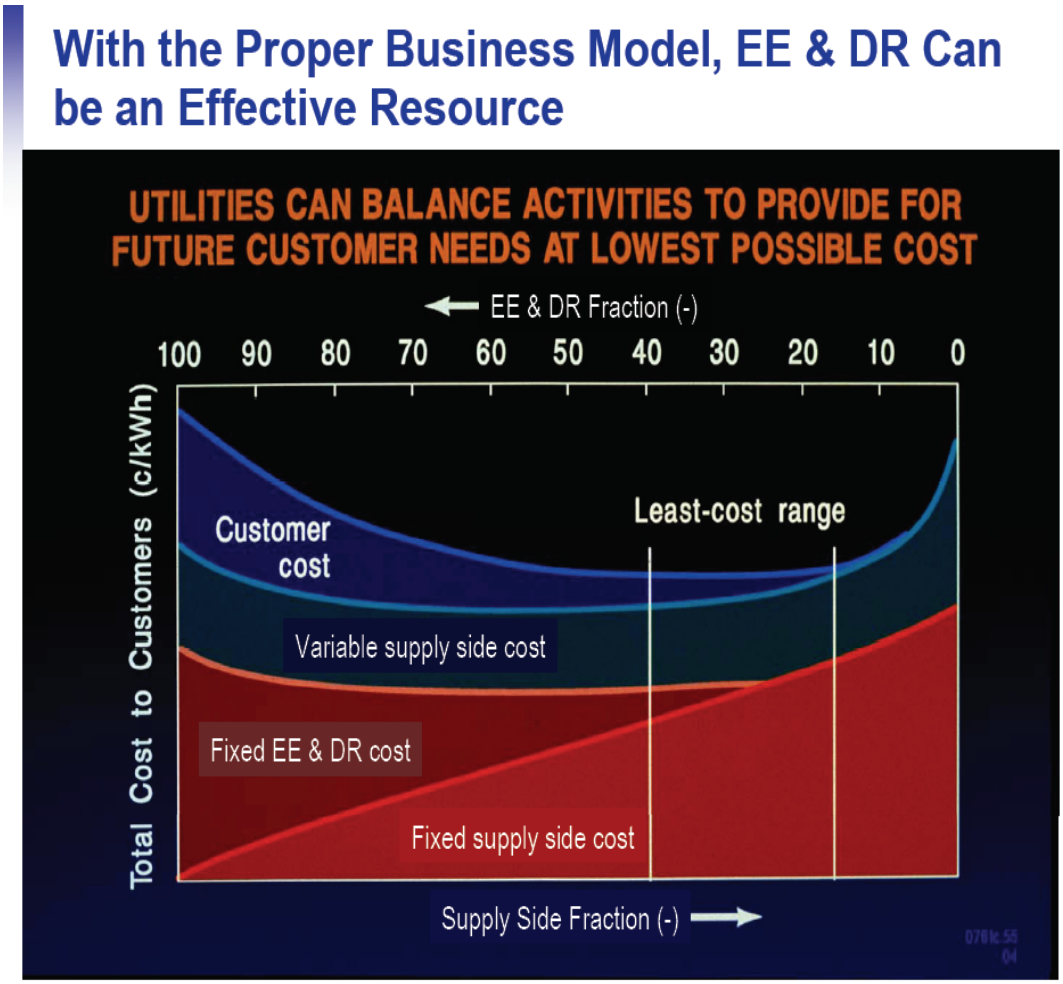
- Improved asset management and network intelligence (including real-time control, modelling and monitoring) that allows for greater utilisation, security, quality, reliability and availability. This will help with managing aged asset, growth issues and reliability issues.
- Improvements in customer interface management to allow for increased participation of customers in energy decisions. The deployment of Advanced Metering Infrastructure (AMI) which offers significant opportunities in the area of demand side management, energy efficiency, behind the meter services and improvements in customer service including automated meter reading and improvements in connection services and fault restoration.

- Improved asset management, works management, including outage management, enabled by best practice processes and IT to ensure that available scarce resources including financial, human, materials and logistics are deployed as effectively and efficiently as possible.
- Enablement of distributed energy supply and embedded generation to allow full integration of demand-side opportunities.

Overall the strategies are about finding a least cost sustainable model that balances the supply-side and demand-side opportunities as outlined in the following EPRI diagram.

The strategies outlined above are not only about utilising the existing infrastructure but managing the assets, energy flows and work processes with 21st century technology which provide, not only improved asset management and customer service, but a basis on which additional new and emerging technologies such as micro distributed energy resources can be implemented. Essentially these technologies provide a bridge to the implementation of future smart technologies where real-time data will be the key to best practice network and work management. These technologies will allow real-time asset management, peak load management, interactive distributed energy resources and cost management and give customers the ability to choose energy solutions that best match their requirements including real-time energy pricing. They will provide a basis for implementing behind the meter services to provide a range of security, quality, reliability and availability outcomes including digital quality services.

Developments at the small/micro distributed energy resources should be of particular interest to the distribution network sector. It is widely recognised in the industry that achieving better than 99.995% reliability (SAIDI of around 30 minutes) is not practically achievable from a conventional supply system. To achieve the quality and reliability of supply needed for 'smart chips', a local distributed energy resource in the form of battery, UPS, standby generator or plug-in electric vehicles is needed to support the conventional supply. As energy storage technology develops and the new power chips become available to allow the seamlessly switch between the distributed energy resources and the traditional power supply, the role of the local distributed energy resources could become more than just a backup option. It could become an integral part of the grid operating at times



of high energy cost. This development would fundamentally change the nature of the distribution system. Depending upon the pace of technology developments, small scale distributed energy resources is likely to become a significant opportunity over the next decade.

There are, however, significant risks that rapid changes through either disruptive technologies or political direction on climate change could change the supply paradigm more quickly than is currently predicted. Without some significant modernisation of the distribution system as outlined above, such changes could find distribution utilities ill-prepared.

6. Technology

As discussed, over the next two decades technologies will emerge on both the supply-side and demand-side that will challenge the conventional utility paradigm of large generation, long transmission lines and generally one-way distribution of energy.

On the supply-side:

– Environmentally friendly central generation options will continue to develop and become more cost effective. In addition, more cost-effective distributed energy resources will emerge which will increasingly challenge the current centralised generation model.

– The smart network will support step changes in reliability, capacity and customer services.

– Improved asset management and system control through real-time asset and load data will extend and improve the capacity, reliability and availability of existing assets.

On the demand-side:

– Distributed energy resources coupled with advanced metering infrastructure, customer portal technology, 'smart' appliances and a range of 'behind the meter' services, will almost certainly change the way customers interface and manage their energy requirements.

These technologies will be supported by an ever increasing capability of computer based systems that will afford new levels of data acquisition, analysis and real-time information that will open new opportunities on the supply and demand-sides that have previously not been possible. To support these 'smart' technologies, the availability of an adequate communications infrastructure is a key support element.

In addition, there will be a significant innovation in delivery of energy to customers which better aligns with their economic requirements and the community's needs for improved environment stewardship. What is also becoming clearer is that the supply network and customer interfaces will become more complex and dependent upon new technologies to effectively operate the systems. The implementation of the smart network is a key to this transition.

7. What is the smart network?

7.1 Definition

Numerous definitions exist as to what constitutes a smart network. However, at the highest level there is a stark comparison between:

- the electricity networks of today—transporting energy from major generation sources using mostly non renewable fuels, to consumers who have limited knowledge of their consumption, where outages affecting customers are largely unknown until the customer alerts the network operator; and
- a future smart network—serving as a dynamic network for two-way energy flows; linking widely dispersed micro-level renewable energy sources at the customer level and large-scale energy sources; providing more dynamic information to customers; facilitating greater customer choice about energy source and level of consumption; and providing real-time information on the performance of the network and optimising the network operations.

7.2 Characteristics of a smart network

The American Department of Energy developed a paper titled *The smart grid: an introduction*. The following table is an extract from that paper which perfectly describes the smart network of the future. In 10 or 20 years time we should expect the following transformation to have occurred:

Characteristic	Today's grid	A future smart grid
Enables active participation by consumers	Consumers are uninformed and non-participative with power system	Informed, involved, and active consumers—demand response and distributed energy resources
Accommodates all generation and storage options	Dominated by central generation—many obstacles exist for distributed energy resources interconnection	Many distributed energy resources with plug-and-play convenience focus on renewable energy
Enables new products, services and markets	Limited wholesale markets, not well integrated—limited opportunities for consumers	Mature, well-integrated wholesale markets, growth of new electricity markets for consumers
Provides power quality for the digital economy	Focus on outages—slow response to power quality issues	Power quality is a priority with a variety of quality/price options—rapid resolution of issues
Optimises assets and operates efficiently	Little integration of operational data with asset management—business process silos	Greatly expanded data acquisition of grid parameters—focus on prevention, minimising impact to consumers
Anticipates and responds to system disturbances (self-heals)	Responds to prevent further damage—focus is on protecting assets following fault	Automatically detects and responds to problems—focus on prevention, minimising impact to consumer
Operates resiliently against attack and natural disaster	Vulnerable to malicious acts of terror and natural disasters	Resilient to attack and natural disasters with rapid restoration capabilities

The following provides additional comment on the smart network characteristics described in the table above:

- active participation of consumers occurs through the provision of two-way communications and information that gives the consumer the ability to make informed decisions to both consume and provide energy;

- achieve 'self-healing', or automatic fault response, the integration of devices and sensors with a secure communications network will inform decision making engines that can apply business rules to automatically recover unaffected sections of the network and isolate those elements in need of repair. Resistance to security attack is enhanced as end-to-end cyber security is enforced across the network with smart network security protocols;
- enable generation and storage options at the macro and micro-level by way of participatory networks established at all levels of the network, allowing individual and industrial customers—as well as commercial small scale generators—the ability to contribute to the environmental agenda. Fully-enabled electricity markets allow consumers access to products and services that provide consumer choice based on price and environmental concerns; and
- optimise asset use and minimise operating costs through peak shaving (deferring capital expenditure) and reduced operating and maintenance costs, harnessing the information provided by sensing and monitoring devices and automatic switching capability.

8. International and Australian context

A key consideration for developing the characteristics of a smart network in the Australian context is the differences that exist across different geographies. In general, it could be viewed that there are major differences between the metropolitan networks of major capital cities such as Sydney and Melbourne where the networks are heavily meshed, to that of rural areas where the networks are characterised by long radial electricity lines.

The physical characteristics will therefore vary across different geographic regions resulting in different communications technologies and applications being used with varying smart network benefits. As such, a smart network can be considered as the application of a suite of technologies, tools and techniques to enhance consumer interaction and make the network work far more efficiently. The national smart meter program represents the most significant change to Australia's electricity industry in recent years. However, it is important to clarify that a smart network is not simply a smart meter. As previously discussed a smart meter is just one piece of technology that may be used and does not equate to a smart network (smart grid).

International developments

Different countries are at different stages in developing their smart grid/smart network infrastructure. For instance:

- In the UK, Ofgem recently announced a £500 million Low Carbon Networks Fund for large-scale advanced trials of advanced technology and commercial initiatives. The fund will enable distribution network operators to experience new technology and new commercial arrangements to see which arrangements will best enable them to provide the services that users will need in a low-carbon economy.
- In Germany, the Federal Ministry of Economics and Technology has contributed to the development of a project that is taking place in the region of Karlsruhe/Stuttgart.

  The Minimum Emission Region Project (MEREGIO) aims to develop a test region that reduces the carbon footprint as much as possible. To achieve this goal energy suppliers as well as energy consumers within this region will be equipped with intelligent information and communication technology (smart devices) that facilitate efficient energy generation and consumption. Furthermore, variable energy price tariffs will be introduced which should further incentivise a precautious and sustainable consumption of valuable energy resources. Besides the technical part of the project a 'minimum emission' certification program will be developed that ultimately helps regions display their energy saving efforts with a high public visibility.
- In Denmark, the government has joined with IBM, Denmark's largest energy company DONG Energy, the regional energy company of Oestkraft, Technical University of Denmark, Siemens, Eurisco and the Danish Energy Association in the Electric Vehicles in a Distributed and Integrated Market using Sustainable Energy and Open Networks (EDISON) project. The project aims to build a recharging infrastructure capable of supporting the 10 per cent of Danish cars that are expected to be electric in 10 years' time. The first step is to develop smart technologies to be implemented on the Danish island of Bornholm, which is to be used as a test bed. The island has 40 000 inhabitants and an energy infrastructure characterised by a large proportion of wind energy. Creating a test bed on the island will allow researchers to study how the energy system functions as the number of electric vehicles increases.
- In the US, the Department of Energy (DOE) is responsible for implementing over $40 billion (including loan authority) of the $787 billion Recovery and Reinvestment Act package. Of the DOE total, $4.5 billion is allocated to the Office of Electricity Delivery and Energy Reliability. As outlined in the legislation, these funds are an investment in a nationwide plan to modernise the electric grid, enhance security of US energy infrastructure and ensure reliable electricity delivery to meet growing demand. The funds will support implementation of the smart grid programs authorised by the *Energy Independence and Security Act of 2007*. These include the smart grid technology research, development and demonstration projects, a resource assessment and an analysis of future demand and transmission requirements, the development of interoperability standards that are critical to effective and consistent application of smart grid technologies.

9. Consumer perspectives

Consumers expect the delivery of safe, secure and affordable energy. Consumers want to increase their ability to reduce their costs and to contribute to the climate change solution through the ability to:

- make informed choices about the level of their consumption;
- understand what costs are involved before they buy their energy; and
- make choices about the source of energy they use and to be able to produce their own energy.

Simplicity will be essential. Consumers are unlikely to be prepared to spend much time optimising their energy use. Smarter solutions will be required to facilitate appropriate consumer outcomes. What they will want to do is spend a few hours per year to set their comfort, price and environmental preferences—enabling collaboration with the network to occur automatically on their behalf and saving money each time.

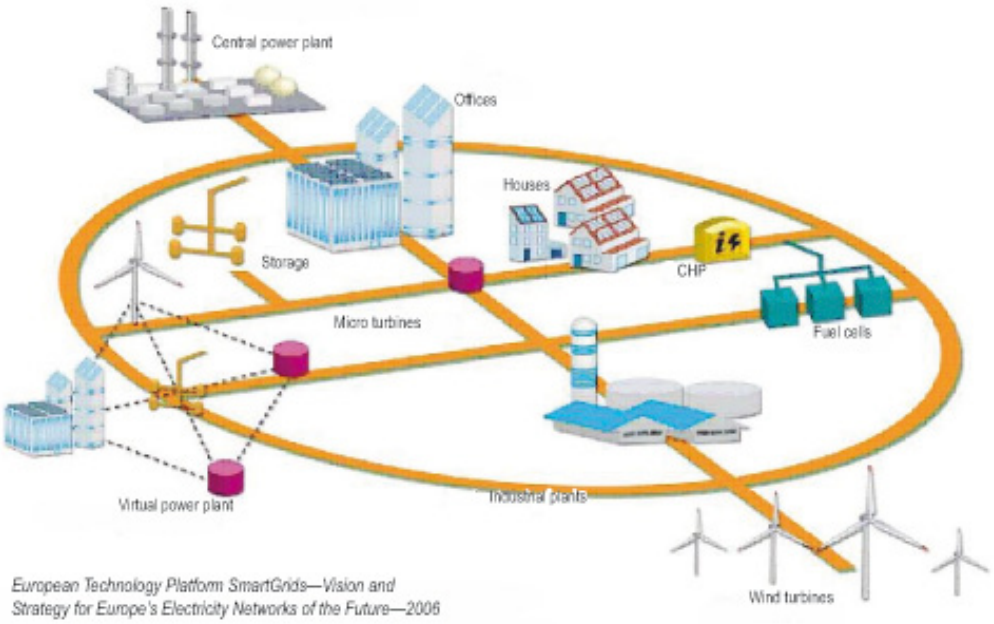
10. Implementing smart network

The first steps in the process of building a smart network are happening now through the replacement of foundation infrastructure supporting the current network.

Technology is available to replace current in-service instrumentation (widely used to manage and operate the electricity network across Australia) with smarter, integrated supervisory equipment at substations, on the power lines and at the customer premises with two-way communicating sensors and intelligent analytics. This replacement across transmission, distribution and the customer is the starting point for any smart network deployment.

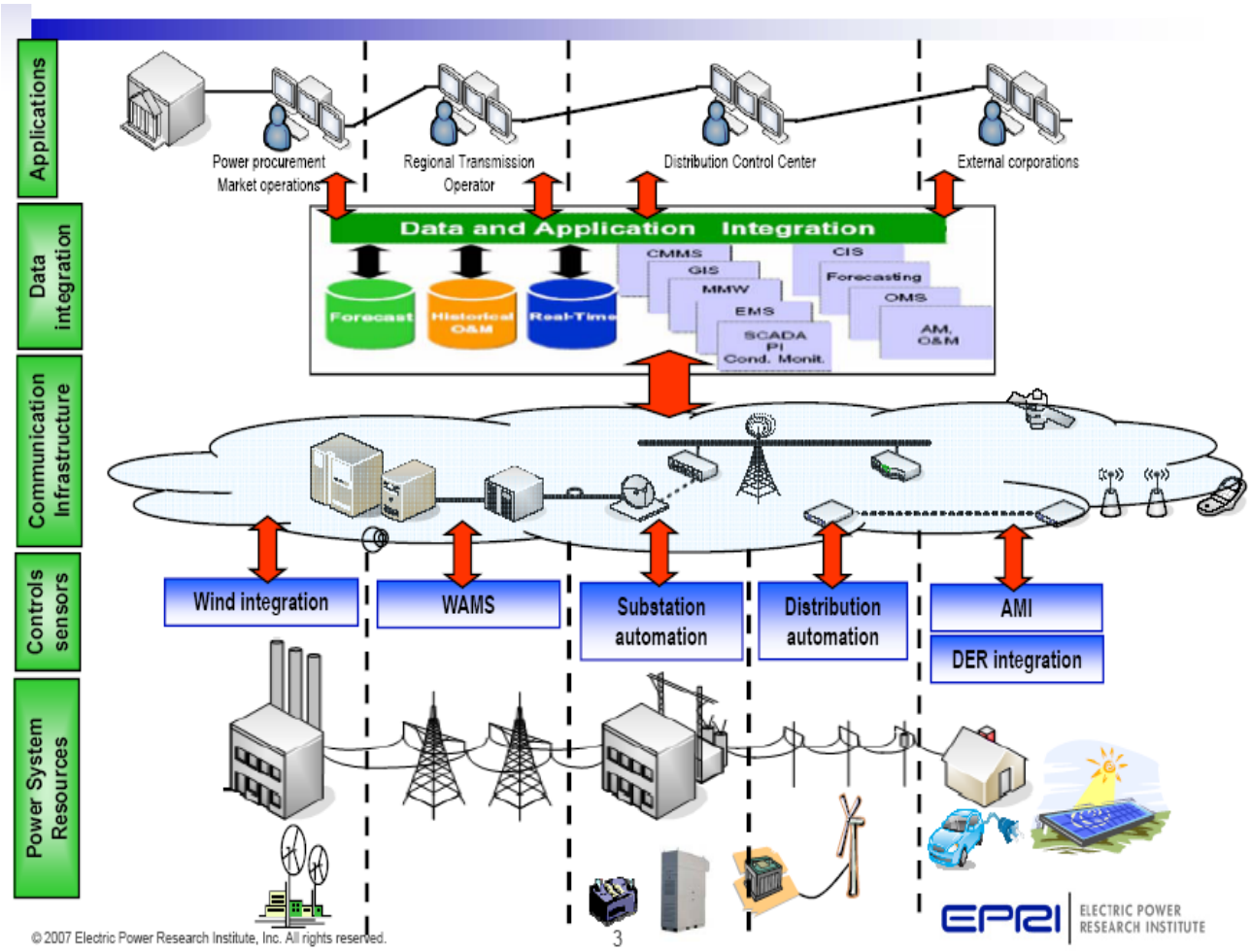
The key to the smart network is to leverage or overlay this updated network with a combination of communications technologies and interoperability standards to facilitate two-way information flows. The intelligent network that has been established will then 'enable' initiatives that will facilitate further uptake of greenhouse-friendly technology and enhance energy security. Such technologies will include micro-network solutions, two-way electric vehicles and consumer interaction including the choice and control of energy consumption.

The European Union's vision of what such a smart network will look like is depicted below:



European Technology Platform SmartGrids—Vision and Strategy for Europe's Electricity Networks of the Future—2006

This diagram produced by the Electric Power Research Institute is useful in demonstrating the 'layers' in the smart network.



11. Challenges and barriers

11.1 Telecommunications

A secure telecommunications network is the underpinning of the smart network. The telecommunications network must be secure, interoperable and conforming to international standards. The network must provide utilities with the confidence to invest in long-term, two-way communication assets without fear of stranding these assets as technology is superseded.

A range of communication technologies are available and currently being deployed as part of network operations and management. The introduction of smart network technologies will see a dramatic increase in the volume of data which is exchanged, together with an increase in the number of stakeholders requiring access to the data, including network operators, market operators (AEMO), customers, and other market participants (retailers, generators, meter providers, meter data agents etcetera).

The choice of communications platforms will be driven by the usual cost benefit analysis, however the concept of the National Broadband Network presents a unique, once-only opportunity to consider the benefits of building the infrastructure to support both NBN and smart network technologies, thereby reducing costs to both initiatives.

Adoption of open architectures and adherence to internationally adopted standards is essential, regardless of the selected communications platform.

11.1.1 Spectrum

One of the communication technologies currently being deployed as part of the smart network development is wireless. A number of energy utilities have encountered difficulties in acquiring access to appropriate spectrum for the wireless components of its smart network on a commercial basis. For the reasons detailed below, it is industry's view that:

- given impending requirements to roll out electricity smart networks, and the difficulties encountered in obtaining commercial access to appropriate spectrum, 10-15MHz of spectrum presently under 15 year spectrum licenses should be identified and reallocated for use in the rollout and operation of electricity smart networks;
- given the unique and substantial social and public policy benefits enabled by electricity smart networks, and the significantly different commercial values of spectrum to mobile broadband carriers as opposed to smart network operators, consideration should be given to setting any spectrum access charge applicable to the use of such spectrum in smart networks by reference to considerations other than purely commercial ones;
- any spectrum identified for smart network use should be allocated to users for a sufficient period to ensure that smart networks builds can be justified; and
- the Federal Government should establish a formal liaison process with the electricity industry to ensure that sufficient appropriate spectrum is identified and set aside.

In order to address these issues, the policy position that Industry is advocating is:

- The Federal Government appoint a joint working group, comprising energy industry and National Broadband Network representatives, to ensure the proposed investments in energy and communications infrastructure achieve the greatest possible synergies and therefore least cost outcomes; and
- The Federal Government consider making a dedicated portion of telecommunications spectrum available nationwide for the purposes of implementing smart networks. The regulation of this spectrum should be aligned to the requirements of smart network infrastructure.

11.2 Technology standards

The speed of development and widespread adoption of smart networks across Australia will depend heavily on national standards being applicable in a number of key areas.

11.2.1 End-to-end cyber-security for smart networks

As previously discussed, there has been a heightened awareness towards the security of critical infrastructure since the 9/11 attacks in the United States. The broad telecommunications infrastructure deployed for smart network applications will increase the potential number of attack points on the electricity network, increasing the risk posed from cyber-security on energy supply. These vulnerabilities were recently highlighted when security analysts showed, in April 2009, that they could gain unauthorised access to a utility's smart metering network infrastructure.

The importance of developing end-to-end cyber-security protection has been further highlighted by the United States government recently establishing a specific initiative to address the security concerns of smart networks. This process is being run through the National Institute of Standards and Technology (www.nist.gov/smartgrid), and this initiative encompasses the previous work undertaken in the United States on developing Critical Infrastructure Protection (CIP) standards.

The technology choices deployed for smart networks will heavily depend on the setting of cyber-security policies. Depending on the level of risks identified and preventive measures, these security decisions will then determine the types of communication infrastructure and devices that an operator will choose for an application. Given the potential risk and the key dependency, it is suggested that Australia follow the overseas approach and give this issue significant national level attention to set widespread smart network security policies.

Industry suggested that the matter be incorporated into national critical infrastructure protection measures and be reviewed by the appropriate national energy, Defense and the Attorney General's departments to develop an appropriate path forward for the industry.

11.2.2 Interconnection and interoperability standards for energy connection

The connection of widespread energy storage and micro-generation solutions is anticipated to increase significantly with the adoption of smart networks. These new energy sources are predominantly focused on renewable technologies and low carbon emitting alternative fuel sources. There is currently widespread research into possible hybrid and electric powered vehicles for the automotive sector.

While there are existing standards already available in the industry for connecting new loads, it is suggested that these standards need to be reviewed and modified to cater for interconnection of devices onto the network. In particular, the network will need to interact with these devices on a more sophisticated level, for example in the case of electric vehicles different batteries will tolerate different charging patterns to enable optimum life, or the type of plug connection for an electric vehicle.

11.2.3 Application-level data communications standards

In order to facilitate a national smart network, there is also a need to establish standards in areas that will enable interoperability and technology advancement. In the short term, standards development for data communications is required. These standards will be needed to enable a device in the field to converse with back-office systems using a common protocol that is interoperable. It is suggested that these standards are leveraged from existing local and international telecommunications and IT industry standards.

Other areas of standardisation may come through utilities developing consistent IT and operational telecommunications architectures. It is suggested that best practice be encouraged but not mandated, as these standards will emerge from other parts of the world and their adoption will be subject to individual 11.3

In order to address these issues, the policy position that Industry is advocating is:

Standards be developed by appropriate joint working groups, drawing on international experience, in the areas of:

- end-to-end cyber-security for smart networks;
- interconnection and interoperability standards for energy source and storage devices; and
- application-level data communication for enabling sensor-to-network consistent communications; home energy systems; home area networks; metering; exchange of meter data; and network to home energy management systems interactions.

11.3 Energy storage

Energy storage is often referred to as the holy grail of renewable energy. However, it is not energy storage that is needed to equip networks with the capacity to reliably incorporate renewable energy sources, it is *inexpensive* energy storage.

At present, most energy storage technology is expensive, so networks have difficulty justifying its value in the current one-way fossil fuel transmission and distribution network model that currently powers Australia.

Scale and location is another issue. In general, energy storage needs to be suitably sized to have an impact on the sub-transmission and transmission networks. This problem could be overcome if a significant number of suitably sized storage units installed in customer premises, or on the low voltage or distribution networks could aggregate to have significant network impact.

The scale of storage required is also another challenge for rapidly evolving new battery technologies. The intermittency of renewables like wind and solar need bulk storage to buffer their unpredictability.

Advanced energy storage technology is also a key tool for improving network security and reliability. Storage and information control will enable networks to better utilise network capacity to manage load profiles and the unpredictable surges of peak demand for energy which occur for a relatively few hours a year, by charging during off-peak periods and generating back into the network at peak periods.

'Next generation' technologies, such as electric vehicles, could be a key to energy storage. They could be used to charge up during periods of excess renewable power or to provide stored power when needed. As discussed, in aggregate, electric drive vehicles have the potential to significantly increase the load on electricity networks but they may also provide inexpensive energy storage and can therefore enable larger penetrations of renewables.

A low-cost and highly reliable electricity resource plan will necessarily include a mix of energy efficiency, distributed generation, renewable energy, demand response, and importantly electric storage—potentially largely from electric vehicles.

The appropriate integration of energy storage is key to the development of the optimum smart network, however this needs to be done carefully to achieve the least cost outcome. Open consultation on such matters as plug-in electric vehicles is essential to achieve this. ENA is best placed to undertake this role.

In order to address this issue, the policy position that Industry is advocating is:

- Industry work with the relevant bodies to develop inexpensive energy storage. This is particularly relevant with the emergence of plug-in electric vehicles.

11.4 Skilled Workforce

The ageing workforce and institutions do not necessarily have the structure, capabilities or competences to address the consumer and technology issues outlined above. A renewal in infrastructure and human capital will be a key input to the change processes. There has however, been little investment in human capital in the energy sector for over two decades.

There is little doubt that the required re-invention of the electricity industry to meet the challenges of the 21st century will require significant investments in new skills and capabilities. Urgent action is required in this area as the current workforce is ageing with many key technical staff reaching retirement age in the next 10 years.

In order to address this issue, the policy position that Industry is advocating is:

- Increased consideration be given to funding and course development for the next generation of power and telecommunications engineers across Australia's tertiary education facilities.

11.5 Existing regulatory framework

Regulators will need to understand the benefits of smart networks. Since the early 1990s, the institutional structure for the electricity sector has been fundamentally changed. In general, the industry has been pleased with the National Electricity Law and the National Electricity Rules, the National Gas Law and the National Gas Rules, the establishment of the Australian Energy Market Commission and Australian Energy Regulator which provides a much more cohesive set of rules and institutions than existed previously. However, in some areas, the sector is still labouring under inconsistent and conflicting sets of regulation. This environment of uncertainty is not conducive to the type of investment required to address the emerging supply issues.

To optimise investment in emerging smart network technologies, there are three areas in which the regulatory framework needs to be examined:

- facilitating research and development expenditure (discussed in 12.6 below);
- ensuring appropriate commercial returns for network investments recognising upstream benefits, for example reductions in carbon emissions, deferment of investment in generation plant and reduced energy production are captured; and
- in order to gain the maximum energy security and climate change benefit from the investment of smart network infrastructure and technologies, it is essential that over time pricing structures are developed that provide consumers with the right incentives to become producers of renewable energy and to become more efficient users of energy particularly in peak demand periods.

It is in the interests of the network industry—and ultimately the national interest—that if necessary policies should be amended to encourage businesses to optimise their investment in this area. Any investment to stimulate the initial development of smart networks should be directed towards funding the areas that to date are not enabled as part of the current regulatory framework. For example, areas that involve multiple industry participants such as electric vehicle development. It would be disappointing if this investment was directed solely at smart metering projects and not focused on developing smart networks across the entire transmission and distribution business supply chain. Similarly, it would be disappointing if funding was distributed to a range of projects, each of which does not have the level of scale to provide learnings that would be required to provide real input to formulating policy.

The industry will benefit from the recently announced National Energy Efficiency Initiative (NEEI) proposed by the Federal Government. The NEEI is an opportunity to consider issues that span the entire electricity industry and the $100 million investment has the potential to define a critical national competence..

In order to address these issues, the policy position that Industry is advocating is:

- Industry continues to work with governments, rule makers and regulators to ensure appropriate commercial returns for network investment recognising upstream benefits, for example reduction of carbon emissions, deferment of investment in generation plant and reduced energy production costs.
- Industry continues to work with governments, rule makers and regulators to develop pricing structures over time which reflect energy costs and network constraints, providing consumers with the right incentives to become producers of renewable energy and to become more efficient users of energy particularly in peak demand periods.

11.6 Research and development

The need for Research and Development (R&D) expenditure arises for a number of reasons, including—but not limited to—the currently unknown impacts of exponential increases in the volume of micro-generation connections; using renewable (and therefore intermittent) sources and the corresponding impact on the operation of the network; the quality of the energy delivered to customers; and the need to develop real-time pricing signals (tariffs) which interface with home energy management systems.

Consideration must be given to R&D funding for smart networks to ensure that sufficient investment is being made to maintain national skills and innovation in this area. This is extremely important to accelerate the changes required for smart networks; to support the timeframes for changes in the industry; and to build national competencies in this field.

The current regulatory environment in Australia may provide only weak incentives for a distribution business to engage in activities of a developmental nature that may have the potential of reducing longer term capital costs. This would be the case for example if the pay back period for the investment in innovation was longer than the regulatory period. Weak incentives for innovation are likely to result in under-investment in innovation

It is proposed that Australia consider adopting an incentives scheme that would direct investment towards broad-based smart network initiatives, related to demand management; asset management; communications improvement; and other more general areas of improved products and network management designed to deliver customer benefits.

It is important that sponsorship of R&D investment in smart network technologies allows enough opportunity for proper investigation and to demonstrate clearly the customer interaction models on a scale large enough to represent the national build-out.

Technological and process innovations has been a matter of recent debate in the United Kingdom. To address this concern and to provide the basis for future efficiencies, the UK energy regulator, Ofgem, has initiated a new scheme that provides significant allowances to network related innovations by use of an innovation funding incentive (an 'I factor'). Examples of the myriad of types of projects contemplated by this scheme were first outlined in a 2004 Ofgem report.

Since introducing the scheme, innovation investment by infrastructure businesses has increased rapidly, demonstrating the significant scope for researching better and more cost effective ways to delivering infrastructure services.

In order to address this issue, the policy position that Industry is advocating is:

- Industry continues to work with governments, rule makers and regulators to ensure appropriate allowances for Research and Development investment in smart network technology.

11.7 Education

Change management within the energy industry and education of regulators, all levels of governments and customers will be essential to deliver smart networks.

Regulators will need to fully understand the national benefits of smart networks and appropriate funding of investments.

Equally critical to the success of the implementation of smart networks is the education of customers as to the opportunities available to them. Customers must be able to see the full consequences (prices) of their energy choices and in particular, the time that they consume energy. This awareness will become a key driver for change. At present, for most jurisdictions the alignment between the signals that customers receive through their price/tariffs and the investment/cost drivers and carbon costs is poor.

In this context, the political and social issues associated with the transformation of the sector may emerge to be more problematic than the technology challenges. Therefore, the strategies for change must be focused on providing customer empowerment and choice around a range of energy solutions to match customers' economic and lifestyle aspirations. By matching the services to the customers' requirements and the ability to pay, the political and social risks and the risks of over-investment in the network will be significantly reduced. A key concept is that customers will not be required to pay for services that they do not value.

In order to address this issue, the policy position that Industry is advocating is:

- Education of all stakeholders to the benefits from and opportunities that will arise from the implementation smart networks

11.8 Leadership

A framework for a smart network requires national agreement across market participants. To date, without clear coordination and leadership, a number of overlapping smart network related initiatives have begun to emerge and will continue arise which have the potential to hinder national development on smart networks. It is important that there is a clear leadership role played across the industry with the clear support of all industry participants.

The industry is made up of a range of stakeholders, and the retail, distribution and transmission energy businesses are central to any coordination activities related to smart networks. As a result, the Energy Networks Association (ENA) as the peak national body for Australia's energy networks is best placed to represent the industry on the topic of smart networks.

In order to address this issue, the policy position that Industry is advocating is:

- Education of all stakeholders to the benefits from and opportunities that will arise from the implementation smart networks

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