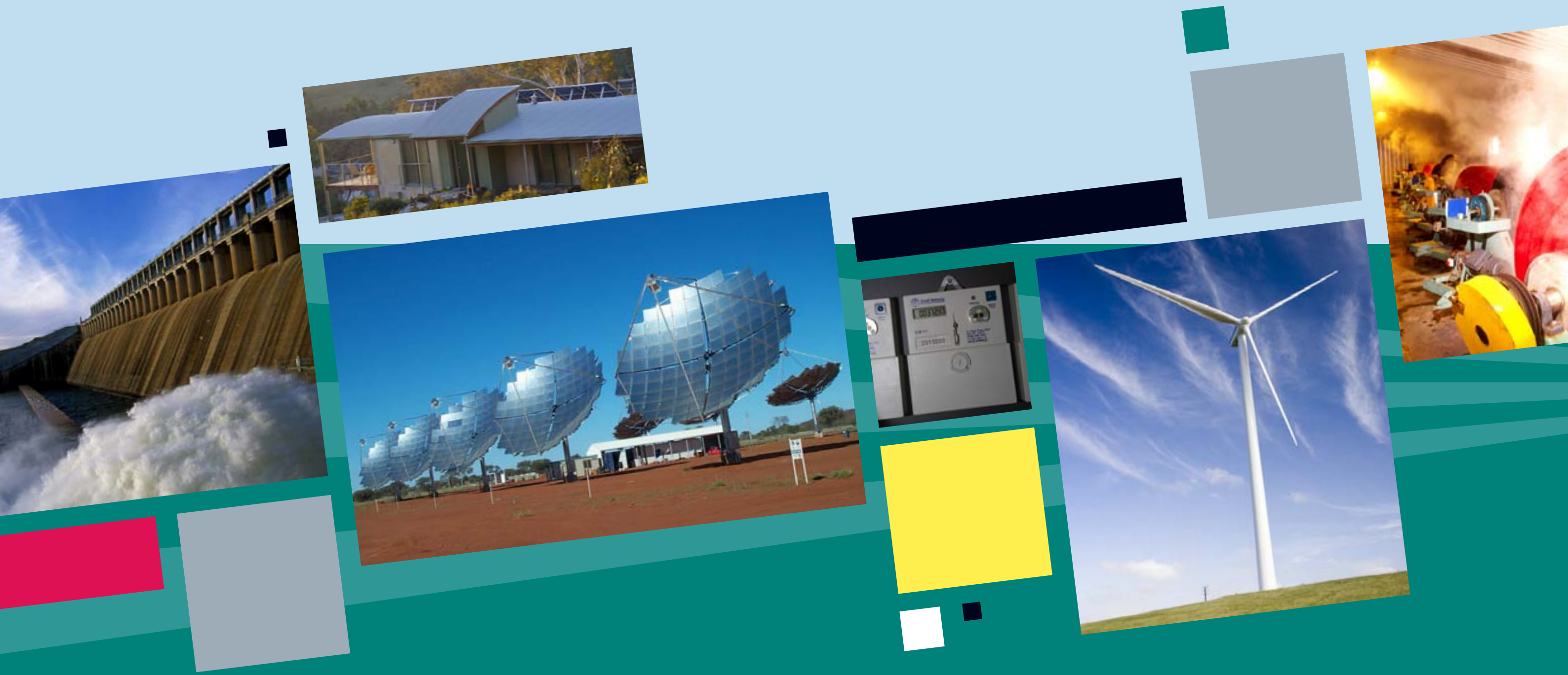
Australian Government
Department of the Environment,
Water, Heritage and the Arts



Smart Grid, Smart City
A new direction for a new energy era

The National Energy Efficiency Initiative

This report was prepared by the Department of the Environment, Water, Heritage and the Arts.

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MINISTER'S FOREWORD

The Australian Government has identified energy efficiency as a critical component in its approach to tackling dangerous climate change, with the potential to achieve significant, cost-effective and relatively rapid reductions in greenhouse gas emissions across key sectors of the economy.

Smart grids represent the cutting edge of energy efficient technologies, applied in energy production, distribution and householder use, a frontier the Australian Government is committed to exploring quickly and strategically as we move to a low-carbon future.

In the May 2009 Budget, the Australian Government announced that subject to a pre-deployment report, it would invest up to $100 million to develop a commercial-scale smart grid demonstration project in partnership with the energy sector. I am delighted to release this report, delivering the first vital step in that commitment.

Smart grids are modernised electricity grids that interact with information technology and communications infrastructure to provide greater transparency on energy use to consumers, and to improve the quality of energy supply. Smart grids more easily integrate renewable and distributed energy sources into the grid, like solar, wind and co-generation plants.

Smart grids are more reliable, with fewer and shorter blackouts. They allow electric vehicles to be charged when demand on the network is low, and their combined battery storage can be used to support the network when demand is high.

Consumers need no longer be passive receivers of power, but instead can take charge of their energy use and make meaningful decisions that will benefit both the environment and their hip pockets. Household appliances can be programmed or directly controlled by the network to run when it is most cost-effective.

Many of these changes will help lower peak electricity demand and reduce the need for electricity companies to build extra power plants simply to cope with daily peaks in consumer demand.

Both here and abroad, governments and power companies are focussing on the potential of smart electricity grids, and Australian businesses are among world leaders in this technology. We aim through smart grids to ensure the health of our growing green energy sector and to create clean energy jobs and reduce emissions.

Smart Grid, Smart City will test the business case for key smart grid applications and technologies, and gather information to inform future smart grid investment by Australia's electricity leaders.

The initiative will inform Australian governments, businesses and communities about how smart grids work and how power can be delivered in a mode that is more efficient and consumer-friendly. It will bring together representatives from both the public and private sector active in power generation, transmission, distribution, information technology, retail and community groups, and advance discussion about the future of electricity infrastructure in Australia.

The Hon Peter Garrett AM MP
Australian Government Minister for the Environment, Heritage and the Arts

EXECUTIVE SUMMARY

PURPOSE

The Australian Government announced in the 2009 Federal Budget the availability of up to $100 million for the implementation of a fully integrated smart grid at commercial scale, through the National Energy Efficiency Initiative (NEEI). The government's investment in *Smart Grid, Smart City* was subject to a pre-deployment study designed to provide further information to the government on the potential economic and environmental benefits of smart grid technologies and the best way to maximise the benefits of the government's investment including the best governance framework and business model for the initiative, and how best to bridge any gaps in knowledge about the benefits. The results of the pre-deployment study undertaken in July and August 2009 are presented in this report.

It is the intent that the program design of *Smart Grid, Smart City* builds off and leverages the programs and lessons from other government and industry initiatives, including but not limited to the Smart Meter program (led by the Ministerial Council on Energy), Solar Cities, Solar Flagships and the National Broadband Network (NBN).

SMART GRID OPPORTUNITIES IN AUSTRALIA

Near-universal access to cheap electric power has helped Australia achieve a high standard of living and a leading position in the global economy. Indeed, low-cost power has helped drive the country's economic growth for decades. Today, the national power industry is large and complex, with $11 billion[1] in revenue, over 45,000 kilometres of transmission lines and 700,000 kilometres of distribution network, and over nine million customers[2], including many in remote areas.

An abundance of coal has helped keep the cost of electricity relatively low. But coal imposes environmental costs in the form of greenhouse gases, including 200 million tons of carbon dioxide equivalent (CO2-e) released in 2008[3], more than a third of Australia's total CO2-e emissions.

1. All currency references throughout this document refer to Australian dollars unless explicitly stated otherwise
2. AER State of Energy Market, 2008
3. Department of Climate Change, 2009

Global and national trends are beginning to affect the entire value chain of the electric power sector:

- Expert scientific evidence confirms that human activities, power plant emissions in particular, alter the climate and affect the environment. The Australian Government is investing in measures to reduce reliance on fossil fuels
- Rising and more volatile fuel prices and globalisation of fuel markets
- Ageing electric infrastructure that will require costly upgrades to meet the demands of an expanding modern economy.

The nation will need to manage power more efficiently and effectively, lower the ratio of electricity consumption per economic output, reduce overall greenhouse gas emissions with demand management and encourage energy efficiency, improve reliability, and reduce recurring costs while making prudent investments.

The global call to action has initiated a wave of innovation in distributed power generation, electric transport, energy efficiency and smart grid capabilities. Power utilities and solution providers across Australia and around the world are starting to experiment and deploy a wide range of these innovations.

To bring this vision to reality, Australia will need to integrate information processing and communications into power systems to create a unified smart grid that includes generation, transmission, distribution, retail and end-use. This smart grid vision encompasses a suite of applications which are currently at different stages of technical and economic maturity. They can be categorised into *grid-side* applications, which reduce line loss and improve fault detection and restoration, for example, and *customer-side* applications, which help people understand and manage their power usage.

Preliminary analysis carried out in the course of this study indicates that implementing smart grid technologies across Australia could deliver at least $5 billion of gross annual benefit to Australian society. This includes improvements in the operation of the power industry and an estimate of the monetised benefits of reduced greenhouse gases and improved power grid reliability. The significance of the potential benefits and sizable range indicates that many applications are worthy of further investigation and refinement as part of the *Smart Grid, Smart City* demonstration.

These potential benefits have attracted enormous interest in smart grid technologies and their implementation and governments around the world are making power grid upgrades a priority. The United States (US), for example, has announced USD $4.5 billion in smart grid funding, while Europe has mandated smart meters as a critical component of a broader smart grid.

Although smart grids offer significant potential, the benefits are largely unproven at commercial-scale and like other countries, Australia faces barriers to a broader adoption, including:

- Australian and international authorities have yet to agree on standards for many applications
- Power industry leaders do not currently share a common understanding about the costs and benefits of different smart grid applications
- Regulatory frameworks that may not reflect the full potential benefits of smart grid applications or provide industry with critical guidance on cost recovery or risk
- Utilities have no comprehensive national or global reference cases to guide them toward best practices or help them avoid mistakes.

There are no regulatory barriers for the successful implementation of *Smart Grid, Smart City* but a regulatory reference group is recommended to identify potential barriers that could impact a broader smart grid adoption in Australia.

The absence of standards for smart grid technology and applications are a significant investment risk for the wider adoption of smart grids and, to a lesser extent, the *Smart Grid, Smart City* demonstration project. It is anticipated, however, that this risk will be mitigated by a flexible approach to the deployment of the smart grid communications platform. This approach will see a variety of communications solutions adapted to suit different and varying network requirements, which will help spread the risk. A standards working group is recommended to identify standards needed to minimise technology investment risk for a broader smart grid adoption in Australia.

RECOMMENDATIONS

This report contains the following recommendations:

- Smart grid implementation in Australia should aim to optimise the overall value for society, including financial and non-financial benefits (see sections 2.1 and 2.2).
- Since some underlying technologies are too immature and their business cases too unproven to allow for accurate up-front cost estimates, analysis suggests that gross annual benefits, rather than a net present value, will best prioritise the allocation of funds across potential applications. The *Smart Grid, Smart City* demonstration should gather data to allow more accurate calculations of the net present value of each major application (see sections 2.1 and 2.2).

- The available funding should be directed at reducing or eliminating as many of the barriers to widespread deployment as possible—including business case uncertainty, technological immaturity, standards development and regulatory uncertainty—enabling a rapid and prudent market-led adoption of smart grid technologies and capabilities that could build on other relevant government initiatives such as the National Broadband Network (NBN), subject to commercial decisions. Funding disbursements should be split between project milestone outcomes and a final performance payment upon completion of project requirements. Consortium applicants should provide significant co-investment for the program to align interests and generate 'ownership' and to drive lessons for *Smart Grid, Smart City.* Finally, the *Smart Grid, Smart City* program design can be adjusted or scaled in terms of the breadth of the applications deployed pending the total available funding (see section 3.6.4).

- To achieve this objective, *Smart Grid, Smart City* should provide a competitively solicited grant to a distributor-led consortium to fund a unified deployment of smart grid technologies within a single distributor's region that rigorously assesses and analyses applications at a relevant commercial scale. This is consistent with the government's recommendation for the initiative to be in one Australian town, city or region. Finally, distinct modules should address regulatory barriers and standards that could impact a broader smart grid adoption in Australia (see section 3.2).

- Consumer-side applications deployed at commercial scale should aim to understand what drives customer behaviour and therefore should test several different packages across different consumer demographics. The packages should include various tariff programs (e.g. Time of Use and Critical Peak Pricing), the provision of more detailed information for consumers (e.g. real-time energy usage and environmental information via in-home displays or portals) and controls that maximise potential behaviour change (e.g. programmable controllable thermostats and home energy controllers; see sections 3.1 and 3.2). Smart metering will be a critical enabler of customer-side applications.

- Grid-side applications to be deployed at commercial scale should include (see section 2.3):

  - Fault detection, isolation and restoration

  - Integrated Volt-VAR control, including conservation voltage reduction

  - Distributed storage.

- Secondary applications that should be piloted (although not necessarily at commercial scale) include: electric vehicles; substation and feeder monitoring and diagnostics; wide-area measurement; and distributed generation support.

- In order to effectively demonstrate a wide variety of customer-side applications, a minimum of 9,000 – 10,000 participating households is suggested (implying a total minimum population of some 200,000 people), depending upon the number and design of each trial, and the anticipated take-up rate of those trials within the population.
- To ensure a broader adoption of the applications shown to have a positive net benefit, the successful consortium should provide detailed commentary on how it will ensure:
  - Close ongoing engagement with the regulatory reference group established for *Smart Grid, Smart City* to identify most pressing regulatory challenges and help create recommendations to government and regulatory bodies (see section 3.3)
  - Active dialogue and engagement with the standards working group established for *Smart Grid, Smart City* to identify standards required to minimise investment in new technologies and ensure broader industry participation (see section 3.4)
  - Mechanisms to involve other industry players and disseminate lessons, e.g. peer evaluation panels and secondments from other distributors/industry players (see section 3.5).
- Government will require the consortium to ensure continuity of supply by using robust security procedures that include plans for handling breach or discovery of weakness (see section 2.3).

1 BACKGROUND, OBJECTIVES AND APPROACH

CONTENTS

SUMMARY

- The overriding objective of deploying smart grid technologies should be to maximise the societal benefits for Australia, which fall into four broad categories: direct financial savings, reliability, environment protection and customer empowerment. *Smart Grid, Smart City* should prioritise its grant based on these societal benefits.
- *Smart Grid, Smart City* should roll out a commercial-scale project that tests the business case for adoption across the country, investigate synergies with other infrastructure including water, gas and broadband networks, build awareness of the benefits and buy-in from industry and customers, and provide solutions to key barriers.
- Stakeholders and experts from over 50 organisations across Australia and around the world provided input and feedback for this report. They shared ideas on objectives and focus areas, program design, economic analysis and barriers to adoption.
- A smart grid uses information and communications to improve the efficiency and effectiveness of power generation, transmission, distribution and usage. Its applications can be categorised broadly as grid-side, customer-side and enabling applications.
- An integrated smart grid system is in its early stages in Australia. However, robust programs for both smart meters driven by the MCE (i.e. advanced metering infrastructure) and distributed generation (i.e. Solar Cities program) have already started in Australia. *Smart Grid, Smart City* should build upon the knowledge gained through these programs. Some distributors and retailers have also begun to test customer applications, including programs to reduce peak usage and improve energy conservation. The tests of customer-side applications so far have been relatively small in scale.
- *Smart Grid, Smart City* can also take lessons from other domestic and international smart grid related initiatives, such as Solar Cities in Australia; Smart Grid City in Boulder, Colorado, US; other US smart grid demonstration projects; and the PRIME project in Europe.

1.1 OBJECTIVES OF *SMART GRID, SMART CITY*

Since its inception, the electricity industry has focused on adjusting supply to meet the forecasted demand. This focus on supply has resulted in a significant portion of installed generation capacity and network infrastructure to cater for peak demand on a small number of occasions per year. Furthermore, the relatively large distances covered by transmission and distribution lines in Australia presents challenges of their own in terms of line loss and fault detection, isolation and restoration. Australia's abundance of coal has helped to keep energy prices low; today, more than three-quarters of the country's electricity is generated by coal-burning plants, about double the global average.[4] Australia's reliance on coal-fired power gives it one of the highest per-capita greenhouse gas emission rates.

A smart grid can address all of these issues, offering societal benefits for Australia in four broad categories:

- Direct financial impact, including operating and capital cost savings and potential to lower bills for consumers
- Reliability, including fewer outages and injuries and improved power quality
- Environmental, assisting customers to adapt to a carbon-constrained future through, for example, energy efficiency and supporting increased use of renewable energy
- Customer empowerment, including greater transparency and choice, and distributed generation.

While smart grid trials are underway around the world, they have yet to demonstrate the full benefits of the technologies or overcome all the barriers to wide adoption. As a result, many aspects of smart grid remain unproven at scale, including:

- Maturity of component technologies
- Clarity of benefits and costs for each player in value chain
- Business case details
- Supporting regulatory mechanisms
- Supporting standards frameworks.

4. IEA 2008, Energy efficiency Indicators for Public Electricity Production from Fossil Fuels

Given these uncertainties and the benefits to Australians if they can be overcome, the Australian Government is implementing the *Smart Grid, Smart City* initiative, deploying a complete system at scale to inform industry best practice for national adoption and government policy.

There are seven objectives suggested for the *Smart Grid, Smart City* deployment:

- Optimise societal benefits by prioritising applications
- Undertake a commercial-scale deployment that tests the business case and key technologies
- Investigate synergies with other Australian Government programs (e.g. NBN) and related infrastructure projects
- Build awareness of the benefits and obtain buy-in from industry and customers
- Overcome key barriers
- Inform adoption of smart grid technologies across Australia
- Develop an innovative solution that can serve as a global reference case.

Given the size of the government's investment —up to $100 million in total— the *Smart Grid, Smart City* program should be constructed carefully to meet all seven objectives. Experience in the US has shown, for example, that focusing too closely on technology can limit learning about what drives customer behaviour, producing fewer benefits.

The goal of this pre-deployment study is therefore to identify the characteristics of a *Smart Grid, Smart City* deployment that would meet all seven objectives and help catalyse industry to achieve these goals.

1.2 STAKEHOLDERS CONSULTED FOR PRE-DEPLOYMENT STUDY

A central objective of the *Smart Grid, Smart City* deployment is to enable and inform a broader adoption. As a base condition for this to occur, stakeholders should have a shared understanding of:

1. A definition of smart grid applications
2. The costs and benefits of each application
3. Agreed approaches on regulations and standards
4. A commitment to accelerate deployment of proven applications across Australia.

While some aspects of smart grid technology, such as transformer monitoring systems, are well understood and have readily quantifiable benefits, others depend heavily on expected customer behaviour or regulatory settings to facilitate deployment and therefore are still debated within the industry.

To ensure that *Smart Grid, Smart City* deployment will focus on what is essential for broader adoption, a wide range of stakeholders and experts across the industry in Australia and around the world were interviewed. The aim was to identify the most important issues and consider all relevant viewpoints. The following issues were discussed:

Objectives and focus areas for *Smart Grid, Smart City*

What applications will drive the most value to society in Australia? What should be prioritised and why?

- **Program design considerations**

  How should the program be run to understand what is possible with the smart grid? What is essential and what is desirable?

- **Economic analysis**

  What data will best inform the business case?

- **Barriers to *Smart Grid, Smart City* and broader adoption**

  What could prevent implementation of *Smart Grid, Smart City?* What could slow or block a broader adoption in Australia? What are the possible solutions?

- **Key lessons from previous rollouts**

  What can be learned from existing or planned programs to help minimise overlap and maximise the value of investments?

  This report encapsulates discussions and feedback from over 50 different organisations in eight stakeholder categories that were consulted, as laid out in Figure 1. Discussions focused on stakeholders in Australia, starting with three workshops for industry and consumer groups in Melbourne, Sydney and Brisbane. The purpose of the workshops were to raise key issues and start a dialogue with industry players on potential solutions. Discussions were then held with government, regulatory and standards bodies, professional organisations, academics and consultants.

Extensive discussions with international experts yielded global insights. Interviewees included the head of the US smart grid standards working group at NIST, utilities experts in the US who have developed smart grid programs, including Pacific Gas & Electric in California, Commonwealth Edison in Illinois, and Florida Power & Light, and the US Department of Energy on the possibility of connecting the *Smart Grid, Smart City* data to the US Clearinghouse database.

Figure 1

SELECTION OF CONSTITUENCIES CONSULTED THROUGHOUT PRE-DEPLOYMENT PROJECT

NOT COMPREHENSIVE INDICATIVE ONLY

Energy industry	▪ Transmission and distribution ▪ Generation, retailer, gentailers and distributed power companies including renewable power	**Academics**	▪ UTS ▪ CQ University ▪ UNSW (CEEM)
Government, regulatory and standards	▪ DRET, DCC and DBCDE ▪ AEMC, AER and State regulators ▪ Attorney General's office ▪ Standards Australia	**Consultancies**	▪ Aurecon ▪ Daly International ▪ MCBT Group ▪ NERA ▪ Paul Budde Group
Vendor community	▪ Integrated service providers ▪ Communications equipment ▪ Grid equipment ▪ Electric vehicle providers	**Consumer advocacy groups**	▪ Consumer Utilities Advocacy Assoc ▪ Energy Users Assoc ▪ Alternative Tech Assoc ▪ Brotherhood of St Laurence
Professional organisations	▪ CSIRO ▪ Energy Networks Association ▪ Smart Grid Australia	**International experts**	▪ NIST ▪ DOE ▪ Pacific Gas & Electric, other US utilities (confidential) ▪ Kleiner Perkins Caufield Byers

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1.3 SMART GRID DEFINITION

Broadly defined, a smart grid is the application of information and communications technology to improve the efficiency and effectiveness of the generation, transmission and distribution, and usage of power. In Australia, the smart grid system primarily includes distribution and retail value chain elements, although transmission and generation (both distributed and centralised) are also affected. In general, the primary smart grid technologies considered as part of this study reside on the distribution network, within/around the home, with the information being processed in a data centre. Smart grid is a vision that includes a suite of applications, each in varied stages of maturity.

The applications can broadly be categorised into customer-side applications, grid-side applications, and enabling applications. Please see Chapter 2 for a detailed definition of each application. Prime examples of these applications include (Figure 2):

1. **Customer-side applications**
   - Information (e.g. energy usage or CO2 information provided by website or in-home display)
   - Controls (e.g. in-home displays, automated controls for appliances, programmable thermostats with communications)
   - Tariffs that fluctuate with time of usage (e.g. Time of Use, Critical Peak Pricing, Real Time Pricing).
2. **Key enabling applications**
   - Smart metering infrastructure (SMI) - known as advanced metering infrastructure (AMI) in Victoria.
3. **Grid-side applications**
   - Integrated Volt-VAR control (including conservation voltage reduction)
   - Fault detection, isolation and restoration (FDIR)
   - Substation and feeder monitoring and diagnostics
   - Wide-area measurement.

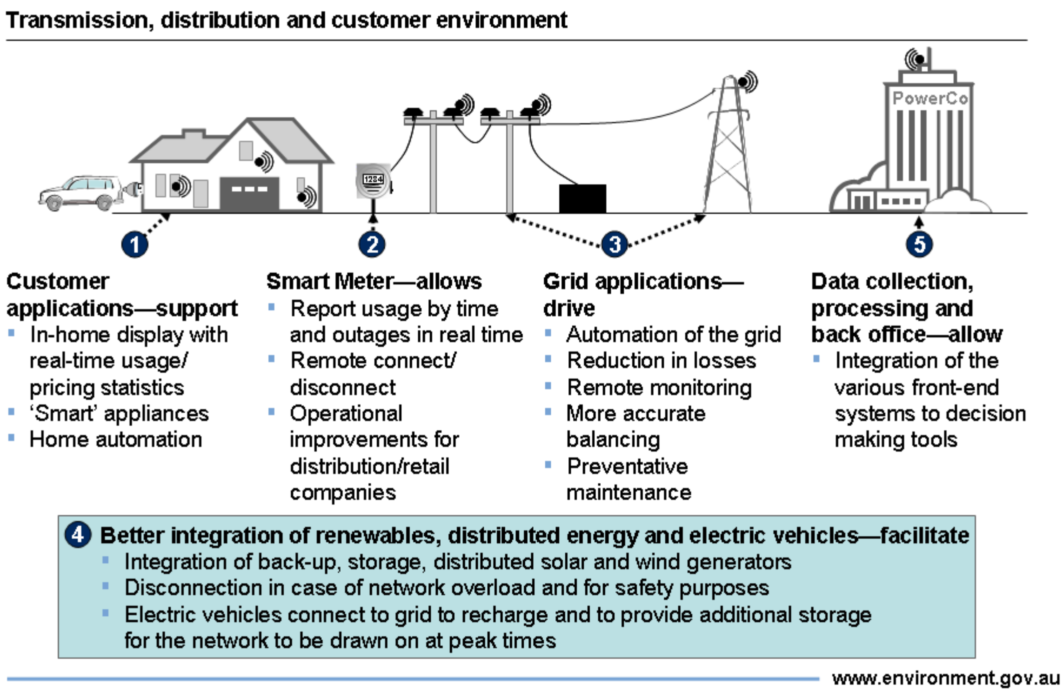
4. **Renewables, distributed energy and electric vehicles**

- Distributed storage (which may include electrical vehicle elements)
- Distributed generation enablement (e.g. solar photovoltaic on residential roof tops)
- Electric vehicle support.

5. **Data collection, processing and back-office**

Figure 2

TAXONOMY OF SMART GRID APPLICATIONS DESCRIBED IN THE REPORT



Each application, or suite of applications, can also be represented by the following logical layers: traditional power systems equipment, communications network, computing capability, and smart grid application layer (see Figure 2). The defining layers of smart grid are the communications and computing layers; these represent what is 'new' about smart grid and are an essential element. Primary elements of the layers include:

- **Traditional power systems equipment**

  Equipment that comprises the traditional architecture of transmission and distribution system, including meters, transformers, switches, capacitors, fuses, lines, re-closers and other power equipment.

- **Communications network**

  Equipment that provides a data network to transport data and information from/to/between the traditional power systems equipment and the data centre. For example, a smart meter transmits energy usage data from the meter to the data centre over the communications network. A partial list of potential technologies include: radio frequency mesh, power line carrier (PLC), broadband over powerline (BPL), WiMax, GPRS/GSM, LTE, fibre optic cable, DSL.

  The smart grid communications network comprises three key elements (see figure 3), these are:

- **Home Area Networks**

  Connections between the smart meter and intelligent devices and appliances within the consumer's premises. This communication layer enables greater control of electricity usage.

- **Wide Area Networks**

  The *last mile solution t*hat provides two-way communication between the consumer's premises and the distributor substation. This communications layer is one of the key enabling elements of the smart grid.

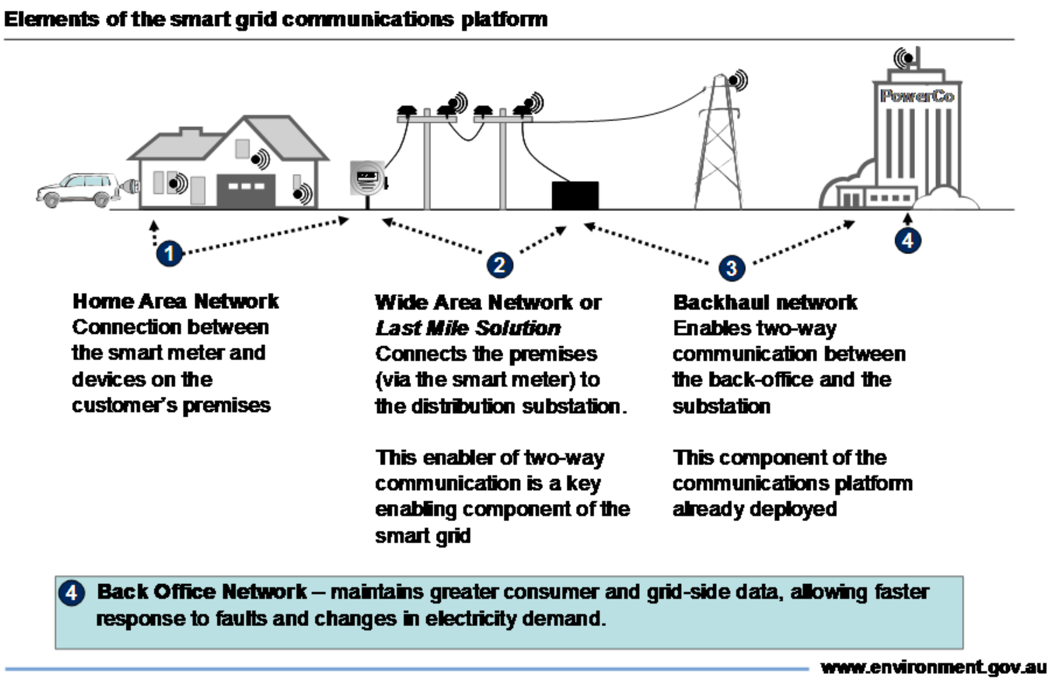
- **Backhaul Networks**

  Existing communication infrastructure that links the distributor substation to the utility enterprise (or back office).

  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.

Figure 3

ELEMENTS OF THE SMART GRID COMMUNICATIONS PLATFORM



- **Computing layer**

  Information processing capability provided by software, databases, servers, storage and other IT equipment. These systems are typically located in data centres but could also be 'distributed' (e.g. when information processing occurs at the endpoint or node such as the smart meter).

- **Smart grid application layer**

  Business logic and processes to enable the smart grid applications listed above (e.g. smart meters, integrated Volt-VAR control).

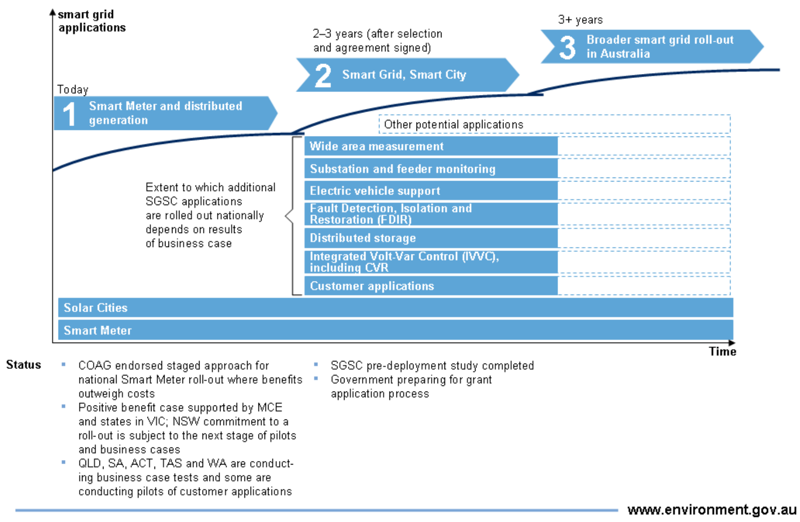
1.4 STATUS OF SMART GRID IN AUSTRALIA

The Australian smart grid deployment is in its early stages. Each state and player in the electric power value chain is at a different stage of learning, planning and implementation. Distributors have been the most active amongst industry players, focusing primarily on smart metering infrastructure (SMI), the underlying communication technology, and customer applications to enable peak load-shifting and conservation (Please see Appendix B for details on the breakdown of smart grid trials in Australia).[5]

Robust programs for many smart grid elements such as smart meters, Time of Use and other pricing trials and distributed generation have already started in Australia, notably in the Victorian advanced metering infrastructure rollout and the Solar Cities program. Smart meters are key enablers of many smart grid applications, which has led to the commitment of COAG and MCE to a staged approach for a national smart meter rollout where the benefits outweigh costs, and to develop a national framework to support the adoption, use and further trialling of smart metering infrastructure. Key elements of this work are being delivered by the industry-led National Stakeholder Steering Committee on smart metering. *Smart Grid, Smart City* should build upon these programs and leverage the infrastructure, governance arrangements and lessons where appropriate (see Figure 4).

Figure 4

SMART GRID, SMART CITY SHOULD BUILD ON AND LEVERAGE EXISTING SMART METER TRIALS AND SOLAR CITIES PROGRAMS



5. National Smart Meter Program: Pilots and Trials 2008 Status Report to the Ministerial Council on Energy

There have been a small number of elements of the smart grid set including some done under the Solar Cities program. However, some retailers are interested in participating in *Smart Grid, Smart City* to better understand the business model and how the smart grid will impact them. Retailers should engage in *Smart Grid, Smart City* because they are the gateways to customers, know how to engage customers, and are in the best position to create new products and services. Retailers will likely be interested in further managing their risk through more detailed customer interval data and additional ways to acquire and retain customers through data mining and customer analysis.

Western Power, for example, is working with its primary retailer, Synergy, on a smart meter demand-side management pilot through the Solar Cities program. Western Power's Solar Cities program includes a PV saturation trial (30 per cent saturation) to test the impact of distributed generation on the network and will be using the smart grid to manage voltage changes. Ergon Energy's Solar Cities project at Magnetic Island is also a location with high PV penetration and the impacts on the grid are currently being analysed.

Many of the trials conducted thus far have focused on smart metering systems and the associated communication technology. Industry in Australia is starting to find common ground as the business case for SMI becomes clearer. Many installation challenges will be identified and addressed during the MCE-supported rollout starting in Victoria in 2009.

In addition to smart meter technology, some pilots have included limited tests of the impact of consumer demand responses on peak and overall consumption, but the data so far has not been of sufficient scale or with robust enough design to inform a broader rollout. For this reason, MCE committed in June 2008 to pilots and trials to reduce the range of uncertainty and inform implementation plans to maximise benefits.

Furthermore, while these pilots typically focus on elements of the smart grid, such as the smart meter, direct load control or customer applications, they are yet to incorporate an integrated set of applications to understand their interactions at scale. Nor have these tests included many of the grid-side applications that can improve reliability and energy conservation. *Smart Grid, Smart City* should be able to combine all of this knowledge in a central clearinghouse, and should gather insights from around Australia to inform the program design and minimise redundancy.

Smart meter programs

Smart metering infrastructure (SMI) projects and smart meter tests, including critical trials of the underlying communications technology, are well underway. In 2008, NERA completed a cost benefit analysis of smart metering by state for the MCE. The expected rollout of smart meters in Victoria from 2009-2012, together with the completed and planned trials in other states, will provide a solid understanding of the state of the technology. Therefore, while the inclusion of smart metering infrastructure in *Smart Grid Smart City* will be required to enable the testing of customer applications, such as in-home displays (IHDs), programmable controllable thermostats (PCTs), critical peak pricing (CPP), and gas and water communications, operational testing of SMI is not a focus of the project. Meanwhile, several utilities have launched smart meter and communication technology trials, including Energy Australia, Integral Energy and Country Energy in NSW, and Ergon Energy and Energex in Queensland, and the Department of Primary Industries in Victoria. Western Power's Smart Grid will be deployed in both metro and edge of grid locations to fully test the capabilities of smart grid communications infrastructure in various field situations. The smart grid infrastructure will be used to support distributed generation and alleviate capacity and reliability issues in remote locations. Western Power's Smart Grid trial will be combined with an energy efficiency education program to enable customer behaviour change. Western Power is also proposing (partly through its Perth Solar Cities project) an SMI trial for 12,000 smart meters to test dynamic load management, remote meter-reading, remote disconnect, theft identification, TOU tariffs and meter data management systems.

Energy Australia, having completed a trial of SMI Project Phase 1 technology, reports large differences in communication technology performance in laboratory and field situations. Still, the Victorian advanced metering infrastructure technology trials, conducted in 2006-2008, indicated that communication technologies are suitable for a state-wide rollout, and that while the technology was not fully mature, the prescribed functionality, performance and service levels might be within reach. Energy Australia also indicated that more advanced communications technology, including 4G or WiMAX cellular radio networks may work in smart metering applications. Energy Australia experts said that standard telecommunications platforms (such as those used for mobile phones) can provide implementation, maintenance and security advantages over systems designed specifically for electricity grids.

In addition to smart meters, some pilots have included limited tests of the impact of consumer demand responses on peak and overall consumption, but the data so far has not been sufficient in terms of statistical significance or relevance to broader rollout. Furthermore, while these pilots typically focus on one piece of the smart grid, such as the smart meter or customer applications, they are yet to incorporate an integrated set of applications to understand their interactions at scale. Nor have these tests included many of the grid-side applications that can improve reliability and energy conservation. *Smart Grid, Smart City* should be able to combine all of this knowledge in a central clearinghouse, and should gather insights from around Australia to inform the program design and minimise redundancy.

SP AusNet has progressed further and chosen WiMAX as its preferred communications solution to meet the requirements of the Victorian State Government's advanced metering infrastructure rollout mandate. The selection of WiMAX follows a detailed solution assessment process including completion of field testing. Field testing has validated WiMAX solution's ability to achieve key service level requirements and has successfully demonstrated the ability of the solution to provide over the air firmware upgrades (both meter program and WiMAX modem). WiMAX was selected over traditional proprietary technologies due to its adoption of a defined communications standard, inherent levels of wireless security and the solutions capability to meet the Victorian SMI Service Level requirements.

- **Customer applications**

  Several distributors have also begun to test consumer attitudes to smart grid features, including in-home devices, different types of information messages (e.g. energy consumption, environmental implications, social and network effects) and pricing for smart grid services such as Time of Use (TOU) and Critical Peak Pricing (CPP). However, no one has yet commenced integrated, large-scale consumer testing of smart grid applications across customer segments, pricing levels, interaction formats and information messages. These interactions will be need to be understood to induce customer behaviour that limits peak energy use and conserves energy.

  Country Energy completed a home energy efficiency trial with 150 residential customers over 18 months, which was Australia's first trial of in-home displays and TOU tariffs with CPP. The tests yielded demand reduction of up to 30 per cent during the CPP and an average overall reduction of 8 per cent in usage over the life of the trial. Country Energy noted that customer education was critical to achieving these results. Energy Australia conducted a strategic pricing study of customer behaviour with 750 residential and 550 business customers with TOU and CPP pricing. Energy consumption during the CPP was reported as between 21 per cent and 25 per cent of the total average daily consumption on non-critical peak days, and the results were not significantly affected with or without an in-home display (IHD).

  Integral Energy also conducted an in-home test with 900 customers across CPP and TOU pricing programs. Demand reduction in response to CPP was 30-40 per cent, average consumption reduction was 3 per cent, and IHDs had small incremental impact to CPP (41 per cent with and 37 per cent without).

  Energy Australia is also planning a comprehensive test in Newington Village, NSW that will test multiple stimulus and information messages on the energy conservation and peak shifting metrics. It will also attempt to measure societal network effects (e.g. how one person's energy consumption compares to and is potentially influenced by his/her neighbours).

Ergon Energy as part of its Solar City project is testing the use of IHDs, smart meters and customer assessments. The Townsville Solar City project has conducted 742 residential and commercial assessments, installed 1,445 smart meters, 160kW of solar panels and eight advanced energy storage systems. Ergon Energy is also conducting a pilot with a group of large customers in Townsville that involves utilising customer embedded generation and remotely controlling this generation directly from its Network Operations Centre.

- **Fault Detection Isolation and Restoration (FDIR)**

  FDIR is a key smart grid innovation for transmission and distribution companies. FDIR improves system reliability and saves on repair costs by automatically detecting and locating faults, rerouting service and speeding repair. Victorian distribution companies (SP AusNet, Jemena and Citipower/Powercor), are targeting increased customer service levels and in response to regulatory incentives, have introduced measures that are currently delivering some of these benefits. (e.g. Distribution Feeder Automation schemes). However, not all FDIR applications have been tested in all the relevant grid configurations such as mesh vs. radial systems or in brownfield vs. greenfield comparisons. These applications provide an ideal environment for the *Smart Grid, Smart City* demonstration project to prove the benefits of integrated utility smart systems as they typically require the inter-operation of a number of interdependent components that form the foundation building blocks of smart grids. Accordingly, FDIR will be a critical application to test in *Smart Grid, Smart City*. Some distributors, including Country Energy, have included some pieces of FDIR in their rate cases to the AER and are building business plans that illustrate the benefits of grid reliability systems.

- **Substation and feeder monitoring**

  Various network service providers throughout Australia have been deploying several types of condition monitoring systems for feeders and substation equipment including power transformers. This is extremely beneficial in improving reliability as well as reducing operational costs for network service providers. Energy Australia in particular have tested and begun deployment of distribution monitoring systems. However, the net benefits associated with remote control and monitoring are still not completely proven. Consequently *Smart Grid, Smart City* can help address this uncertainty and increase broader deployment of these substation and feeder monitoring systems.

- **DG enablement**

  The Solar Cities program has helped many distributors begin to understand the impact of inverter connected renewable distributed generation (DG). These tests have often included smart meters that collect bi-directional data, to capture how much power the distributed generator is feeding back to the grid. However, no program has been of sufficient scale to test the potential destabilising impact of widespread DG. Both CSIRO and distributors that were consulted throughout the pre-deployment study concluded that a test must include at least 20 per cent penetration of these inverter-connected renewable distributed generators in any one area to test these limits. One potential control enabled by the smart grids in this instance would be to dynamically change the voltage and current characteristics of equipment to ensure consistent power factor quality. DG should be another application tested in *Smart Grid, Smart City* and consortium should consider involving forms of distributed generation other than those tested in Solar Cities, including cogeneration for small businesses and commercial buildings. It is recognised that achieving this level of DG in a concentrated area may not be possible; accordingly, simulation may be required to supplement real time data. Two current DG examples being tested are:

  - Western Power's Solar City program includes a PV saturation trial (30 per cent saturation) to test the impact of distributed generation on the network and will be using the smart grid to manage voltage changes.
  - Ergon Energy's Solar City project at Magnetic Island at Townsville is also a location with high PV penetration and the impacts on the grid are currently being analysed.

- **Other applications**

  No significant trials in Australia have addressed the other potential smart grid applications, including integrated Volt-VAR control including CVR, which can improve lines losses and reduce the power required to deliver final voltage (while still being compliant with the acceptable voltage range), distributed storage, electric vehicle enablement or wide area measurement (WAM). These applications can take advantage of the communication infrastructure and have incremental benefit in Australia. As a result, these applications should also be included in *Smart Grid, Smart City.*

  Ergon Energy's Ubiquitous Telecommunications Network (UbiNet) project is a $134 million high-speed microwave communications network for regional Queensland which would provide an opportunity to test this type of telecommunication infrastructure platform as an enabler for a smart grid. By enabling the remote control of devices on the electricity network, UbiNet will improve the service level experienced by rural customers and the safety of Ergon Energy staff. Further, by combining the information available from these remote devices, the duration of customer outages can be substantially reduced. UbiNet will allow for faults to be more easily identified and located, and as a result, enable services for residential customers and important commercial loads to be brought back online faster.

1.5 LESSONS LEARNED FROM OTHER DEPLOYMENTS

In addition to the trials that have taken place in Australia, *Smart Grid, Smart City* benefits from the knowledge gathered in trials around the world. Useful examples include the Smart Grid City in Boulder, Colorado, other smart grid demonstration projects across the US, and the PRIME project in Europe.

- **Smart Grid City in Boulder, Colorado**

  Boulder set up a USD $120 million project to understand the best underlying smart grid technologies and what factors will drive the business case. While Boulder is still in the middle of its trial, Smart Grid City has already generated important findings. First, the sponsoring consortia identified more than 70 hypothetical value drivers to help build the business case. This helped focus efforts, limit required technologies and build a compelling and logical governance structure. Second, Boulder showed what not to do: one of its primary selection criteria for companies to lead the trial was the amount of cash and in-kind resources that bidders were willing to put in. Five vendors delivered $20 million each to participate in the trial, but there was no guarantee that the best technology or operator was thus selected. Australia will adopt more robust and evenly weighted selection criteria to ensure *Smart Grid, Smart City* has the best partners to achieve the stated objectives. Finally, the selected technology had significant impact on the progress and budget of the Smart Grid City. Broadband over Power Line (BPL) was selected as the underlying communication technology in Boulder. BPL has the potential to deliver significant bandwidth and low latency capability, but requires a significant investment in fibre-optic lines. For backhauls, implementing the technology required tremendous effort to dig into the bedrock that surrounds Boulder, which resulted in unexpected costs and delays. *Smart Grid, Smart City* should include a technology assessment and a detailed implementation plan to ensure that the technology can be implemented on time and on budget. Furthermore, it is beneficial to include technologies that lower the overall risk of project execution to ensure that the critical applications are tested.

- **Other smart grid demonstration projects in the US**

  As part of the American Recovery and Reinvestment Act (ARRA), the US federal government has earmarked USD $3.4 billion for smart grid investment grants to utilities and USD $615 million for smart grid demonstration projects. There are four main lessons from the ARRA Request for Proposal that are relevant to *Smart Grid, Smart City.* First, the demonstration project proposal was open to which smart grid applications to test in the demonstration. The proposal gives guidance to the important requirements for smart grid testing, including full utility participation (all participants of value chain), and participation of other important consortia members, including product and service suppliers, customer engagement, state and local governments, and financial community, but it does not specify which applications could deliver the most value. The proposal lets the consortium decide which applications and resulting technologies can best meet the overall objectives. Second, the grants stress interoperability and security: bidding consortia must be able to demonstrate how they plan to deliver both of these benefits as part of their trial. Third, the request for proposal clearly lays out the objectives and the potential benefits that the smart grid can deliver. This helps to provide a consistent reference frame to evaluate the different consortia bids. Finally, it delivers clear selection criteria standards including guidance on “must have” versus “nice to have” criteria. The RFP lists four main factors with relative weighting for the selection criteria and an “other selection factor” section with five characteristics of a distinctive proposal, see Figure 5.[6]

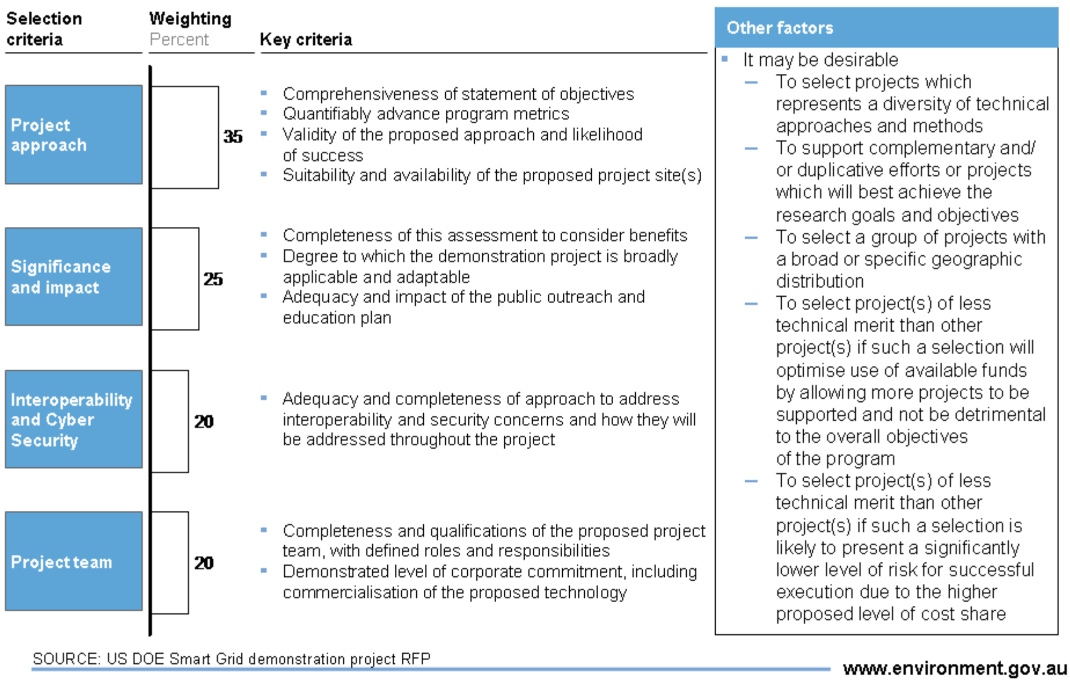
- **PRIME project in Europe**

  The PRIME project was launched by Iberdrola in Spain to assess the idea, define and test a new, future-proof, open standard that could meet the future requirements on customer real time interfacing and smart grid evolution. It is a based on powerline carrier (PLC) technology, which means the communication signal will be sent over the electrical wires from the central utility to the customer. PRIME project has highlighted the need for interoperability and open standards. Improved interoperability has benefits to the energy industry and to customers. For energy industry, interoperability will help individual utilities maximise their vendor options. For customers, standards and interoperability improve the ease with which developers can create new applications to run on top of the fundamental architecture. *Smart Grid, Smart City* should encourage the use of industry-defined standards and identify areas where standards are needed to reduce the risk of investment in particular technologies.

6. US Department of Environment Funding Opportunity Announcement DE-FOA-0000036; June 2009

Figure 5

U.S. DOE SMART GRID DEMONSTRATION SELECTION CRITERIA



2 SMART GRID BUSINESS CASE: EXPECTED BENEFITS IN AUSTRALIA

CONTENTS

SUMMARY

- This chapter sets out a business case by smart grid application. A clear understanding of the economics should form the basis of determining the priority of applications to be included in *Smart Grid, Smart City.* During the pre-deployment study a business case was built aimed at assessing the potential societal value that each application could create if rolled out nationwide.

- Altogether, gross benefits could reach, at a minimum, some $5 billion annually. To calculate these benefits, direct financial benefits were considered along with reliability and environmental benefits, and four applications were flagged as especially important: customer applications, integrated Volt-VAR control (IVVC) including conservation voltage reduction (CVR), fault detection isolation and restoration (FDIR), and distributed storage.

- Four further applications have potential value and should be implemented in *Smart Grid, Smart City*, though at a reduced scale. These are electric vehicle support, substation and feeder monitoring, wide area measurement, and distributed generation support. Many of the key questions that would inform a broad SMI deployment (e.g. 'real world' installation and administration costs, performance of communications systems at scale in 'real world' environments, etc.) are being addressed in the Victorian rollout and pilots and trials planned to inform the MCE commitment to review smart meter rollout timing in 2012. Hence, SMI should not be a direct focus of *Smart Grid, Smart City* but should instead be included only to the extent that it is needed to enable testing of the above applications and determination of synergies with non-electricity programs such as the NBN.

- All the estimates of gross annual benefit reflected a considerable level of uncertainty between minima and maxima. For consistency, the conservative approach taken throughout this report is to report the minimum level of benefit expected from each application. The key drivers of uncertainty include changes in customer behaviour during peak hours and the performance of specific technologies. It is therefore critical that *Smart Grid, Smart City* alleviates this uncertainty.

- The pre-deployment study calculated costs for nationwide deployment to confirm that the projects offer positive returns on investment. Costs are likely to fall as manufacturing scale expands, technological breakthroughs occur and utilities climb the installation learning curve.

2.1 OVERVIEW

The vision of a smart grid encompasses a wide range of applications and technologies with varying degrees of societal value, so the pre-deployment study built benefits estimates for each application, in order to prioritise them for inclusion in the *Smart Grid, Smart City*. Overall estimates of benefits are based on nationwide adoption, because while *Smart Grid, Smart City* is an ambitious project, its immediate benefits will be small compared to the value of the knowledge it will produce. This will help accelerate and expand the adoption of smart grid technologies nationally.

By its nature, *Smart Grid, Smart City* is an exploratory project, designed to test and study scale deployments of promising applications. The pre-deployment study has estimated the gross annual benefits of each application only to prioritise them, not to set industry standards or guide regulations. An assessment designed to set industry standards, guide regulations or inform decisions on commercial adoption would also need to consider the costs of each application.

The minimum estimated gross annual benefits are summarised below:

- Direct financial = $3.4 billion
- Reliability = 60 minutes of SAIDI
- Environmental = 3.5 Mt CO2-e
- **Total financial = $5 billion**

The following applications were reviewed in detail. They are listed here in order of importance for *Smart Grid, Smart City:*

A. **Customer applications** include power information and management technologies downstream of the meter, as well as the pricing and billing arrangements they support. Example components include in-home displays, home area networks (HAN) clients, smart appliances and thermostats, time-of-use pricing and prepaid billing. Benefits of these systems include reduced critical peak prices (reflecting lower generation costs) and overall energy conservation, worth at least $1.3- billion annually.

B. **Integrated Volt-VAR control (IVVC) and conservation voltage reduction (CVR)** systems precisely control grid voltage and power factors, and include components such as automated or remotely controlled capacitor banks, tap changers and central control systems. Benefits include customer savings and emissions abatement from avoided line losses and reduced consumption, and could be worth a minimum of $0.7 billion annually.

C. **Distributed storage** relies on centrally-dispatched on-site storage devices that can provide electricity for residential or small commercial uses during outages or reduce demand during critical peak times. Today, lithium-ion batteries like those used in EVs appear to be one of the most suitable technologies for distributed storage. Benefits include less outages and the ability to reduce distribution network capacity needs, which could be worth a minimum of $0.5 billion annually.

D. **Fault detection, isolation and restoration (FDIR)** comprises systems that reduce the duration or scale of outages[7] and includes components such as sectionalisers, mid-circuit re-closers, smart relays and ties, and fault sensors. Benefits include improved reliability from automated responses to some types of outages and faster scouting and repair for others, which could be worth $0.9 billion annually.

E. **Electric vehicle support** includes central dispatching systems to optimise the load created by charging electric vehicles. The key benefits of these systems are avoided transmission and distribution (T&D) investment and using the car's battery to increase the effect of distributed storage. In total, EV support could be worth $0.5 billion annually to Australia.

F. **Substation and feeder monitoring** provides information that can help manage outages and optimise maintenance. Components include transformer monitoring systems and other substation equipment sensors. The systems help avoid outages and lower maintenance and inspection costs, saving approximately $0.2 billion annually.

G. **Wide-area measurement (WAM)** provides real-time monitoring of high-voltage transmission and distribution lines, using technologies such as phasor measurement units (PMUs). Benefits of these systems, worth up to $0.4 billion annually, include increased transmission line capacity and avoided catastrophic (but infrequent) large-scale outages.

H. **Distributed generation support** comprises the protection, control and billing systems needed to support distributed (e.g. residential rooftop solar) generation, including the sale-back of excess power to the grid. Projections show that the installation of solar panels is unlikely to reach levels that would destabilise the grid in the near future.[8]

I. **Smart metering infrastructure (SMI)** includes remotely-controllable interval meters with bi-directional communication, including smart meters, communications network, 'back-office' systems integration and operational integration. Benefits include operational savings for distributors, such as automated, remote meter reading, that could be worth at least $0.5 billion annually.

7. Many systems—such as smart re-closers or sectionalisers—reduce certain types of faults to momentary outages and are therefore often said to 'prevent' faults or reduce fault frequency.

8. McLennan Magasanik Associates Report to Department of Climate Change - Jan 09

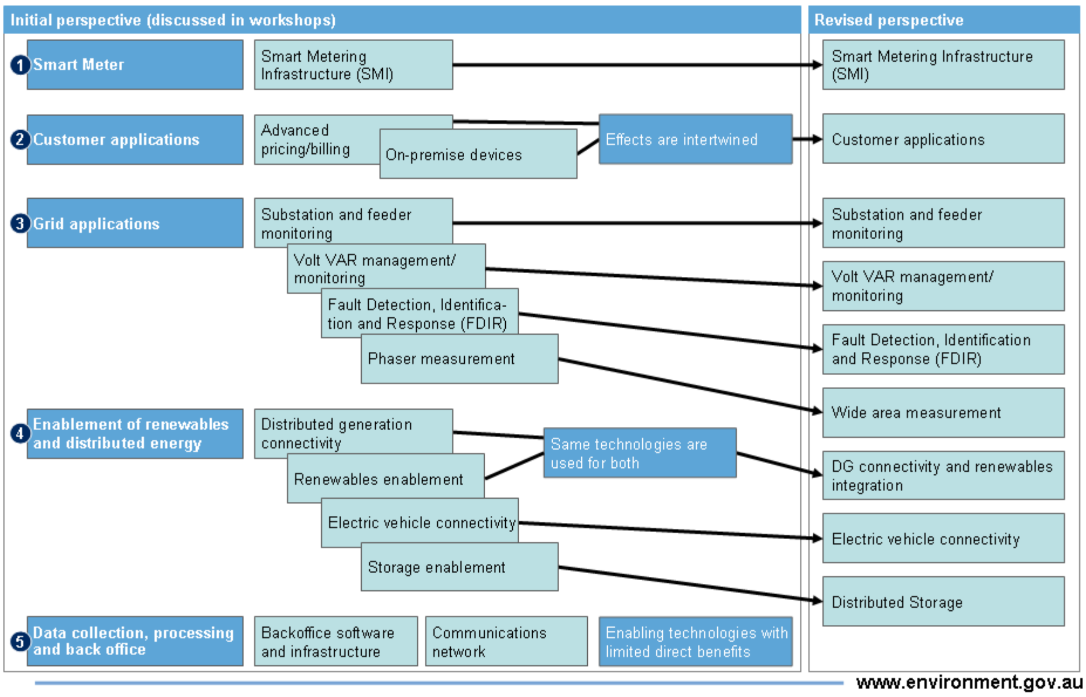
2.2 METHODOLOGY

Selection of applications

The pre-deployment study identified 13 smart grid components and grouped them into nine applications for evaluation. The selection was guided by international experience and workshop participants (Figure 5).

Figure 6

CONSOLIDATION OF APPLICATIONS FOR BENEFIT ESTIMATION



Benefits considered

Smart grid applications offer societal benefits on three dimensions:

- **Direct financial savings** from technologies that streamline distributor operations, allow capital investments to be avoided, lower energy prices (or at least slow their rise) or help customer reduce energy consumption
- **Improved reliability** from technologies that reduce outage frequency, scale or duration
- **Reduced greenhouse gas emissions** from technologies that help reduce line losses and energy consumption.

Societal benefits from increased safety, employment and customer empowerment were also considered, but their benefits were not quantified or included in the estimates below.

'Conversion factors' were used to calculate values in the two non-financial dimensions:

- **Reliability** estimates relied on the system average interruption duration index (SAIDI) minutes. To convert this to a dollar value, the latest value of customer reliability figures were used – calculated by CRA International and advocated by the AER ($47,850/MWh) – together with average NEM consumption of 208 TWh/yr to establish a conversion factor of $21m of societal value per minute of SAIDI reduction (Australia-wide).
- **Greenhouse gas abatement** estimates used metric tonnes of CO2-e. To find a financial value, a conversion value was used, from a lower limit of $10/tCO2-e as the initial CPRS price cap up to $40/tCO2-e based on a potential long-term CPRS price cap. Use of these approximate conversion factors was supported by the projections team at DCC. Abatement costs in this report are calculated at the lower limit.

Smart grid application costs

Using these conversion factors, total gross societal benefits for each application were calculated and served as the basis for the prioritisation. Analysis focused on gross rather than net benefits because costs for most applications are likely to change dramatically as technology improves and the scale increases. Unit costs for small-scale rollouts were developed and scaled nationally to confirm that most applications are already at or near break even levels over the life of the application.

2.3 ROLLOUT SYNERGIES WITH NON-ELECTRICITY PROGRAMS

While the above sections have discussed the direct benefits of smart grid technologies in detail, there are also a number of potential areas in which deployment synergies between smart grid technologies and non-electricity initiatives could result in potentially significant benefits and cost savings.

These synergies fall into two broad categories: synergies with other utilities' metering systems, and synergies with the NBN.

Synergies with other utilities

Among the greatest benefits of SMI and customer applications are the ability of utilities to avoid site visits when reading meters (enabled by the SMI communication systems) and the ability of customers to have greater transparency into their usage (enabled by in-home displays and portals). Both of these benefits apply, albeit to different degrees, for water and gas utilities as well, and the infrastructure that enables them can be largely shared. Several schemes have been proposed for doing so:

- A 'slave' gas (or water) meter could be installed that would transmit its readings to the smart electricity meter (e.g. via a HAN protocol such as Zigbee) for on-forwarding to the distributor and then to the gas/water utility, perhaps also echoing the reading to an in-home display and/or web portal
- A central multi-utility communication hub could be installed that would serve as a gateway for metering communications for all utility metering. (Note that these two schemes are functionally similar, except that the hub and the electric meter have been collapsed into a single device in the former).

While the cost synergies and behavioural benefits from such schemes remain unproven and the business models that would enable them remain unclear, it is technically feasible to integrate these systems with the electrical infrastructure. The first step to capturing the benefits is to confirm and quantify them.

Role that *Smart Grid, Smart City* could play

To this end, *Smart Grid, Smart City* could include a trial aimed at accurately measuring the benefits and cost synergies that could result from multi-utility smart metering and demonstrating at least one viable business model for utility coordination.

Rollout synergies with the NBN

Among the greatest costs of a smart grid deployment is the cost of the communication system to allow data and commands to be relayed to and from the smart meters and possibly clients on any smart-meter-created Home Area Network (HAN). Given that Australia has committed to a NBN that would create a robust, high-bandwidth communication network to the vast majority of residential and commercial premises, it would be wise to establish early on the nature and scale of any synergies that could be captured between smart grid and the NBN. The following are potential areas of synergy between the two projects.

Cost synergies from simultaneous installation of endpoint devices

Both NBN connection and SMI installation require a site visit by a trained electrician, and the use of NBN as the communication system for SMI will likely require a wired connection from the NBN entry point to the smart meter. If all three of these tasks can be completed at the same time, then significant time and labour savings might be achieved relative to separate, uncoordinated installations.

- Potential barriers to capture:

  These savings could only be captured if the rollout schedules of the two programs are compatible and if the actual time and labour required for the joint installation is significantly smaller than separate installations.

- Ways that *Smart Grid, Smart City* could address:

  Smart Grid, Smart City could incorporate a small but diverse trial of simultaneous Fibre to the Premises (FTTP) and SMI installation and compare the ease/time of installation with that of separate non-fibre-based SMI and Fibre to the Premises.

Cost synergies from last-mile communications network

SMI (and dependant applications) require communication systems that reach to the vast majority of electricity endpoints. Given that this ambitious and costly functionality will be delivered as part of NBN, it is natural to investigate the cost synergies that may be achieved by using the NBN for the communications between smart meters and distributors. From this a broader issue emerges about whether the last mile connectivity for connecting meters should be a new smart grid specific network or whether this connectivity could be provided using existing commercial networks of which the NBN is one example.

- Potential barriers to capture:

  Several potential concerns have been voiced about the benefits feasibility of capturing this synergy (though these concerns have not yet been confirmed or dismissed):

  - The cost of running cables from each premises' NBN termination point to its electricity meter, plus the cost of an Ethernet chipset in each meter could together exceed the cost of an entire wireless communication system; however, no cost analysis is available to confirm whether this is the case.
  - Deployment schedules could be incompatible
  - Utility concerns about the availability of an externally-controlled network during a power outage could limit willingness to 'outsource' this component of the grid to NBN (in the same way that it has limited willingness to outsource to traditional telecommunications providers).
  - Concerns (both founded and unfounded) about the security of using NBN for monitoring and control of the nation's power grids could complicate a joint rollout.

- Ways that *Smart Grid, Smart City* could address:

  Smart Grid, Smart City could investigate the feasibility and complexity of metering via a broadband network (e.g. a fibre-supported VLAN) by trialling a small deployment of meters communicating in this way, accurately reporting the costs required, and sharing a detailed assessment of the reliability and security concerns from this architecture.

Cost synergies from backbone communications

Many power utilities already have substantial high-bandwidth communications systems to selected sites within their service territories, and the wide deployment of smart grid technologies could require a significant expansion of this network (particularly if it were decided not to use NBN for the 'last mile' communications). Given that NBN will require network connections to similar regions, these 'backbone' network lines could be shared between the two systems, resulting in a cost synergy. This could be achieved through a variety of business models, ranging from utility sale or lease of bandwidth on existing lines to NBN to the coordinated installation of new NBN lines to lease by the utility for additional backbone capacity.

- Potential barriers to capture:

  The most-significant obstacles to capturing of this synergy are the details of required network topologies, the deployment timelines, and the ability of the involved parties to find a mutually-agreeable business model

- Ways that *Smart Grid, Smart City* could address:

  The solution to these problems may be beyond the scope of *Smart Grid, Smart City*. However care could be taken to clearly determine and articulate the precise network requirements (e.g. bandwidth, latency, uptime) necessary to support smart grid applications as well as the typical overlap of smart grid communications required with planned NBN endpoints

Summary

Areas of possible synergy include simultaneous installation of endpoint devices and rollout of last mile communications networks and the sharing of backbone communications lines. In addition to rollout synergies, broader conceptual synergies exist because smart grids involve the broader deployment of information and communications technology throughout our economy to drive productivity, efficiency and other benefits.

While the timing of the *Smart Grid, Smart City* demonstration project and the rollout of the NBN may not align, there are prospects for synergies with the NBN to be explored to the extent the *Smart Grid, Smart City* project is deployed in an area which already has FTTP rolled out. Positioning exploration of NBN rollout synergies as a mandatory requirement in the *Smart Grid, Smart City* project would significantly limit the likely bidders given the timing of the two initiatives. Instead, NBN synergies have been included as a guiding principle.

Ultimately, the chosen consortium will make a commercial decision as to what communications platform, or combination of platforms, will be used in the demonstration project, including whether or not existing commercial networks are used or new smart grid specific network are deployed.

3. PROGRAM DESIGN FOR *SMART GRID, SMART CITY*

CONTENTS

SUMMARY

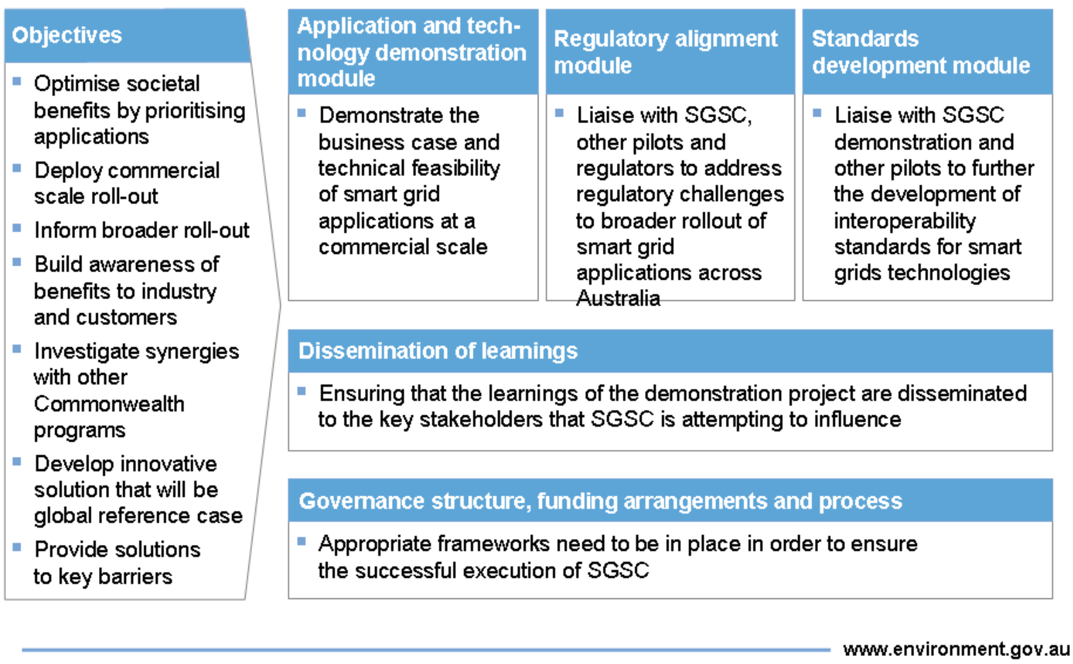
- The successful consortium chosen to deliver *Smart Grid, Smart City* should be chosen through an open, competitive process against transparent selection criteria.
- *Smart Grid, Smart City* should include three modules to address the challenges of broader adoption: (1) application and technology demonstration; (2) regulatory alignment; and (3) standards development.
- The application and technology test module should prioritise smart grid applications based on societal value and answer questions about business cases and technical feasibility.
- Experimental design and location selection should aim to produce credible results that can inform the broader adoption. Location need not be a perfect microcosm of Australia but should provide a reasonable representation of the grid, customers, geography and climate.
- *Smart Grid, Smart City* should be in a single distributor's network that could include urban, suburban, and rural areas and include some 9,500 customers across multiple distribution feeders.
- *Smart Grid, Smart City* is likely to require three years after commencement to produce full findings, although most findings will be generated within two years.
- The project should include mechanisms to capture, analyse and disseminate findings to a range of audiences, the most important of whom are industry players who will effect the broader adoption of smart grid applications.
- The program also requires an appropriate governance structure and oversight process.
- The consortium should be led by a distributor, acting as lead contractor and underwriting the consortium's commitment to funding the program.

3.1 OVERVIEW OF *SMART GRID, SMART CITY* PROGRAM DESIGN

The critical program design elements for *Smart Grid, Smart City* are laid out in Figure 7.

Figure 7

PROGRAM DESIGN FOR *SMART GRID, SMART CITY*



It is recommended that *Smart Grid, Smart City* include three modules to address the challenges of a broader adoption of smart grids:

- Application and technology demonstration to resolve questions about business cases, technology maturity and the disaggregated value chain (discussed in Section 3.2)
- Regulatory alignment to help define what changes will be necessary (discussed in Section 3.3)

- Standards development to settle industry-wide questions about interoperability (discussed in Section 3.4).

This chapter includes recommendations on how each module should be structured, with an emphasis on the application and technology demonstration module, as it will require most of the funding and commensurately generate most of the benefits. The findings from this module will also inform the regulatory alignment and standards development modules.

Supporting the core modules are two design elements critical to the success of *Smart Grid, Smart City:*

- **Dissemination of findings**

  Since the value of any demonstration project lies in its ability to inform a broad community, *Smart Grid, Smart City* must include mechanisms to capture, analyse and disseminate the findings from each of the three core modules (discussed in Section 3.5).

- **Governance structure, funding arrangements and process**

  The *Smart Grid, Smart City* must have a framework for execution and government oversight (discussed in Section 3.6).

3.2 APPLICATION AND TECHNOLOGY DEMONSTRATION MODULE

The central focus of *Smart Grid, Smart City* is the application and technology demonstration module. Its major design elements include:

- The prioritisation of applications and the variables that should be tested
- The experimental design principles required to adequately inform broader industry adoption
- The location characteristics, scale and number of sites required for a valid test
- An estimate of the time required.

3.2.1 APPLICATIONS AND KEY VARIABLES TO TEST

To prioritise the various smart grid applications for inclusion in the *Smart Grid, Smart City* project, the total societal benefits each could offer Australia if deployed nationally were compared. The process of estimating these benefits is discussed in Chapter 2.

Due to rapidly changing technology costs – which would be further affected by broader adoption – focus has been on gross annual benefits in the prioritisation. The gross annual benefits best reflect the potential for Australia, as market forces and scale will drive prices down over time.

Based on this, *Smart Grid, Smart City* should prioritise applications in the following order, deploying the first four at commercial scale, and the remainder at demonstration scale (or as needed to enable deployments of the priority applications):

A. Customer applications

B. IVVC (including CVR)

C. Distributed storage

D. FDIR

E. Electric vehicle support

F. Substation and feeder monitoring

G. WAM

H. Distributed generation support

I. SMI

When considering how to include these applications in the *Smart Grid, Smart City* project design, the focus should be placed on addressing the obstacles that are preventing or delaying a broader adoption of these applications, and, in particular, answering key questions that require a large-scale deployment, such as those in Figure 8.

Particular attention must be given to the experimental design used to produce answers to these questions: answers are only valuable if they are robust, commercially relevant and extrapolate reliably to the rest of Australia.

Figure 8

QUANTITATIVE AND QUALITATIVE METRICS TO BE TRACKED BY APPLICATION

Application	Quantitative measurements	Qualitative results	Technical accomplishments
A. Customer applications	• Percent overall consumption reduction among participants for key customer segments and select number of programs • Percentage peak-reduction among participants for key customer segments and select number of programs • Proof of statistical significance and extrapolation to state-by-state impact as well as for Australia overall (taking into account the differences of customer circumstances and demographics between the SGSC site and other regions) • Costs of deployment and system administration • Variation in customer energy spend	• Key lessons about the implementation details that drive highest response among different customer segments • Potential business models that could drive market players to optimise customer application benefits • Business processes needed to support enhanced billing and communications (e.g. via in-home-display) • Perceived benefits or disadvantage by customers. Degree to which customers churn during trials	• Installed and operational system comprising statistically significant number of households, billing based on and delivering information to in-home systems
B. IVVC and CVR	• Reduced energy consumption at different levels of voltage reduction • Improvement in power factor achieved on different types of feeders	• Customer reaction to voltage decrease (incl. appliance/ device problems and the installation of additional devices, such as extra lights)	• Integration of voltage control system with end-point voltage monitoring system to ensure power quality (e.g. SMI) • Broad power factor monitoring system installed and producing grid data (which should be shared after any necessary sanitisation)

Application	Quantitative measurements	Qualitative results	Technical accomplishments
C. Distributed storage	• Percentage reduction in critical peak demand due to storage systems • 'Real world' operational metrics of storage systems (including number of charging cycles achieved before deterioration—if reached during SGSC duration—and maintenance & customer service costs)	• Customer satisfaction with storage systems • Algorithms developed for triggering charge/ discharge	• Installation of a sufficient number of distributed storage systems to confirm technical reliability of installed systems • Creation of a centrally-administered system to dispatch battery discharging
D. FDIR	• Reduced SAIDI/ CAIDI/SAIFI as a result of smart reclosers/relays/ ties/ sectionalisers • Change in operational costs associated with FDIR system	• Key lessons of implementing changes to business processes related to outage management (e.g. repair crew dispatch)	• Installation of communication-enabled distribution-automation systems at a wide scale, including algorithm-controlled grid reconfiguration (either distributed intelligence or centrally determined) • Real-time overlay of FDIR/SCADA data with outage data reported by SMI system

Application	Quantitative measurements	Qualitative results	Technical accomplishments
E. EV support	• Actual charging behaviour (load as a function of time) of EV users under both the status quo pricing scheme(s) and an un-dispatched time-of-use pricing scheme • Energy cost to consumer to charge	• Customer receptiveness to centrally-dispatched charging • Customer receptiveness to vehicle-to-grid (V2G) discharging during critical events • Benefits/ disadvantages to network and to consumers of various business models for cost recovery (i.e. compensation to consumers for access to battery storage, energy costs)	• Installation of a number of electric vehicles whose charging load can be read at near-real-time and whose charging behaviour can be centrally dispatched in response to grid conditions and current wholesale power price • Development of dispatching algorithms and implementation of a dispatching system that can demonstrate the peak-shaving potential of dispatched charging—in response to both predictable load characteristics (e.g. daily peaks) and critical events • Optionally: installation of centrally-dispatched systems to facilitate vehicle-to-grid discharging during critical events—and testing of these systems during multiple instances (natural or artificial)

Application	Quantitative measurements	Qualitative results	Technical accomplishments
F. Substation and feeder monitoring	• Calculated number and severity (SAIDI, capital losses, and collateral damage) of outages prevented by monitoring systems on multiple sizes of distribution transformers. during a representative period of time comprising a full range of operating conditions and baseline transformer health and loading levels • Actual change in maintenance opex due to monitoring systems • Actual costs of system installation and connection (both new transformers and retro-fits each on multiple transformer sizes)	• Reliability of monitoring systems • Procedures for condition-based inspection and repair • Operational experience (e.g. how to overcome procedural challenges) with monitoring systems	• Installation of a significant number of transformer monitoring systems on multiple-sized distribution transformers • Real-time overlay of data feeds from monitoring systems into SCADA systems (including triggering of exception-based responses to concerning conditions)

Application	Quantitative measurements	Qualitative results	Technical accomplishments
G. Wide area measurement	• Level of increased HV line capacity as a result of real-time condition monitoring	• Algorithms for responding to changing characteristics of high-voltage lines (incl. response to cascading outages and maximisation of capital utilisation)	• Installation of phasor measurement units (PMUs) along a small number of high-voltage corridors including both transmission and distribution lines • Consolidation of data feeds and automated response to early warning of failure conditions • Automated dissemination of relevant condition data to operators of interconnecting transmission and distribution grids
H. DG support	DG impact on reliability (SAIDI/CAIDI/SAIFI) and power quality in highly-penetrated local areas	• On multiple feeders with different characteristics (size/topology/ age/ loading): level of performance reduction (reliability and power quality) associated with a range of levels of local solar and/ or wind DG, and description of protection systems needed to restore performance	• Installation of high levels of DG in concentrated areas and detailed monitoring of effect on grid

Application	Quantitative measurements	Qualitative results	Technical accomplishments
I. SMI	• Actual operational cost savings due to SMI • Actual SAIDI impact of SMI • Actual installation cost of SMI • Actual communication system performance levels	• Operational complexity of handling Smart Meters, including: • Example of a successful model for distributor-retailer coordination (including delivery of pricing cues for on-forwarding to HAN)	• Wide-scale deployment of smart meters, including: • Functioning communication system • Integrated billing • Delivery of power quality information to SCADA (automatically or by exception) • Integration of outage notification into SCADA systems

3.2.2 EXPERIMENTAL DESIGN

Experimental design is critical to ensuring that *Smart Grid, Smart City* informs a broader adoption of smart grid across Australia. A broad array of stakeholders will need buy-in to the key lessons and find them applicable to their service territory in order for *Smart Grid, Smart City* to lead to wide-scale deployment. To achieve these outcomes, the following six design requirements should be requested by the government in the approach section of the grant applications:

1. **Objectives linked to metrics**
    - Consortium goals should align with the *Smart Grid, Smart City* objectives defined in section 1.1.
    - Metrics recorded (such as those listed in Figure 8 as well as any additional metrics proposed by the consortium) should be directly linked to these objectives.
2. **Representativeness**
    - The region within a distributor's service territory proposed by the consortium to host *Smart Grid, Smart City* should be able to produce lessons that are relevant to the rest of Australia, in terms of the key characteristics of the grid, customers and geography/ climate (outlined in section 3.2.3).

- The consortium should detail how its chosen sample size is statistically significant/ commercially relevant.
- Customer recruitment, education, engagement and retention processes should be defined in order to meet representative characteristics.

3. **Measurement of effects**
   - A robust approach for measuring the effects of smart grid applications should be defined. Where appropriate, global best practices for evaluation and measurement should be applied by an independent third party.
   - Details of a control group, a baseline and supporting rationale should be provided.
4. **Dissemination of lessons**
   - The method of sharing project results with key stakeholders not involved in the consortium should be outlined.
   - Data evaluation methods should be outlined including the key variables detailed in section 3.2.1.
   - IP ownership should adhere to the guidelines outlined in section 3.5.4.
   - The method in which the project findings educate the public should be described.
5. **Innovation**
   - The use of innovative tools, techniques, technologies and processes in achieving the overall goals should be outlined.
   - The maturity levels of technologies being tested should be appropriate given the portfolio of smart grid applications being tested. A range of technologies for a given application may be appropriate to test current innovations.
6. **Objectivity**
   - Independent experts should be selected by the consortium for objective oversight.
   - Use of objective third parties to analyse data for assessment and verification should be considered.
   - Use of a peer review panel to assess approach prior to commencement of the project should be considered.

3.2.3 SCALE, NUMBER OF SITES AND LOCATION

Selecting the right location for *Smart Grid, Smart City* will help produce findings that can inform a broader adoption. As pointed out in section 3.2.2, the location proposed by the consortium to host *Smart Grid, Smart City* should be a reasonable representation of the key characteristics of the national grid, customers, geography and climate.

While the *Smart Grid, Smart City* location need not, indeed arguably cannot, match national characteristics perfectly, it should be 'relevant' in the sense that lessons obtained there can be extrapolated to the rest of Australia .When assessing a location, two questions should be asked:

- What are the major variations among regions in Australia that impact electricity load profiles and network performance?
- Does the location represent these variations well enough to make the test results relevant at the national level?

Figure 9 lists the major variations across electricity networks in Australia which are likely to influence the outcomes of the application and technology demonstration module. It also shows elements that will provide a reasonable representation of variation across Australia.

Figure 9

LOCATION NEEDS TO BE ASSESSED FOR ITS RELEVANCE TO THE REST OF AUSTRALIA

Categories	Dimensions of variation	Why important	What is element required for representative test	High importance
Network factors	Network architecture—radial or mesh	Network stress differs	Section of both radial and mesh included	
	Customer density	Local load curve	Varied line densities	✓
	Line utilisation	Higher utilisation have higher asset management opportunity	Mix of high and low utilisation lines	
	Overhead/underground mix	Rollout costs and tech vary dramatically	A section of each included	✓
	Age of infrastructure	Reliability differences Deferred capital investment Cost of retrofit	Old and new infrastructure included	✓
	Penetration of DG	Need more than representative to test future penetration levels	High penetration in several local areas	
	Greenfield or brownfield	Rollout costs vary dramatically	A section of each included	
Geography and climate	Climate	Peak demand Main drivers of energy consumption and customer behaviour Grid pressures (e.g. corrosion)	Representation of both a winter and a summer peak	✓
	Topography	Effectiveness of communications technologies Cost of rollout	Some varied topographies (e.g. hills and flat) included	
Customer segments	Customer type—I&C, SME, Residential	Understanding customer behaviour by segment Statistical significance requires sufficient sample size	Sufficient variation to provide sample representative of Australian customer base	✓
	Building stock and energy mix	Changes energy efficiency and consumption		
	Demographic factors (residential only)	Potential influences on behaviour		

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Not all dimensions listed in Figure 9 are equally influential. Five are especially important: climate, customer density, overhead/underground mix, age of infrastructure and customer type. These generally drive load profile and network performance.

Findings may be relevant even if a location as a whole is not proportionally representative of Australia. For example, one state might have a higher penetration of gas heating, which would have a significant impact on the pattern of electricity use. During winter, a customer who heats with gas will consume less electricity than a customer who heats with electricity. All other things being equal, this will result in a lower winter peak demand. But this difference in load profile would not prevent the distributor in that state from demonstrating applicability to states where electric heating dominates. All the distributor needs is a statistically significant sample of customers who use electric heating to understand how they behave.

The consortium should consider (1) how each location differs from others in Australia, and (2) how the experimental design can inform the broader adoption. The consortium may have to include test elements of little use in a specific service territory but of significant value to other areas of Australia.

Achieving reasonable representation has implications for the scale of *Smart Grid, Smart City.* Figure 10 lists the scale recommended to test each smart grid application. These estimates were derived from answering the following questions:

- What is the uncertainty that each application is addressing?
- What scale would provide a statistically significant or commercially relevant result?
- What scale would other industry players require to believe the findings?

The analysis indicates that scale requirements for *Smart Grid, Smart City* differ by application, but generally require either a representative group of customers (and devices in the case of conservation voltage reduction) or a representative set of grid components, such as feeders across both radial and mesh networks for FDIR or transmission corridors for WAM.

The factor with the greatest impact on overall scale is the number of customers required to test in-home applications.

Figure 10

INDICATIVE SCALE REQUIRED TO VALIDATE IMPACT DEPENDS ON THE APPLICATION

Application	Driver	Scale required	Rationale for scale
A Customer applications	'Representative' customer sample + testing different packages	Approx 9500 customers	▪ Number of minitrials required for statistical significance
B Integrated Volt Var Control (IVVC), including CVR	Representative sample of customer devices on grid (both) in single location (IVVC)[1]	Mix of devices covered by scale of customer applications	▪ Test impact of lower voltage on broad sample of devices ▪ Test ability to correct power factor
C Distributed storage	Representative sample of household usage patterns and appliances	100 customers	▪ Understand interaction between batteries and different devices and confirm business case
D Fault Detection, Identification and Response (FDIR)	Representative sample of feeder topology and fault sources	Multiple feeders across both radial and mesh networks	▪ Statistical significance to narrow confidence interval in business case
E Electric vehicle support	'Representative' customer sample	<100 customers	▪ Unrestrained customer charging behaviour and receptiveness to control
F Substation and feeder monitoring	Representative sample of transformers	Dozens of transformers at major voltage levels	▪ Statistical significance to narrow confidence interval in business case
G Wide area measurement	Number of transmission corridors	3–5 transmission corridors	▪ Sufficient data sources to develop algorithms
H Distributed generation support	Penetration (percentage of local load)	20% of demand on several low voltage transformers	▪ Test the effect of high local density of DG
I SMI	Number of meters in a contiguous area	N/A[1]	▪ Model of smart trial opex ▪ Test communications system

1 Already being tested in Victorian Smart Meter rollout; required in SGSC as enabling technology for customer applications

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Estimating how many customers should be included in customer application trials

Figure 11 outlines the three dimensions that *Smart Grid, Smart City* should test in the customer applications trials and the implications of each on their design and scale.

Figure 11

THREE DIMENSIONS THAT *SMART GRID, SMART CITY* SHOULD TEST IN CUSTOMER APPLICATONS

	Description	Implications for SGSC
1 Testing the benefit across different customers	▪ Different customer segments will react differently—consortia must demonstrate how the sampling approach will demonstrate the different reactions of different segments	▪ Need sample of customers which is representative of broader population and includes major segments (defined by dimensions that drive customer energy consumption and behaviour)
2 Test theoretical potential	▪ Need to trial a range of different combinations of program elements	▪ Must run multiple mini trials to trial a range of approaches (e.g. multiple home displays)
3 Make learnings scalable across Australia	▪ Consortia must demonstrate how their segmentation approach has addressed the differences between their customer population and broader Australia population	▪ Oversampling of under represented segments ▪ Granularity of raw data to allow other distributors to apply own segmentation approach

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To fully test the benefits of an application, the trial must identify customer segments likely to have different patterns of electricity use and likely to respond differently to the customer applications components being tested and ensure that each are sufficiently represented in the trial.

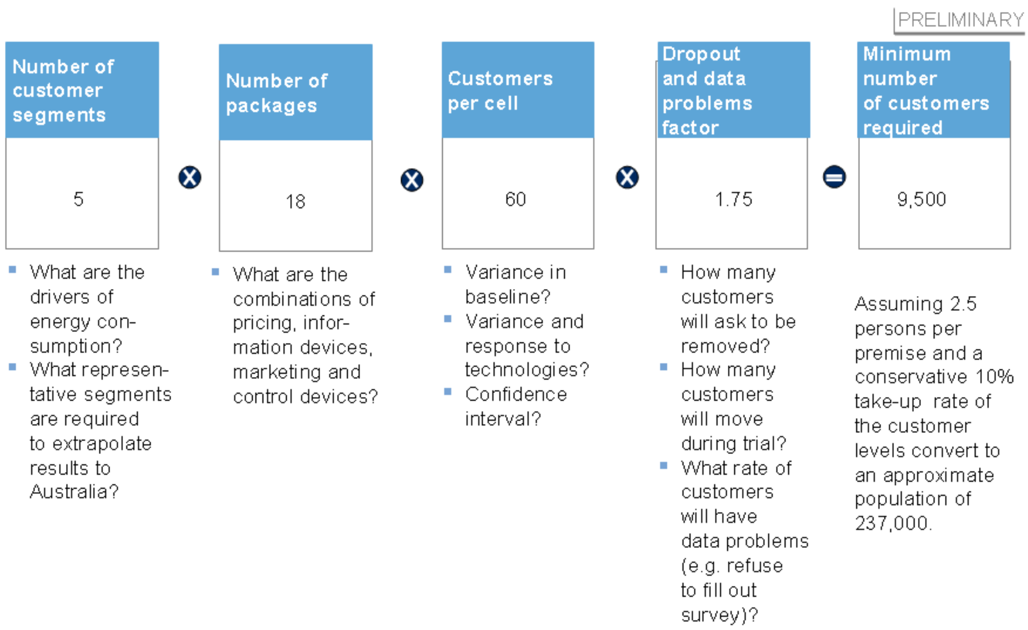
To test the potential of an application, the trials must involve different packages to gain insight into the features that drive greatest benefit. For example, one pricing scheme may result in more customers shifting electricity use from peak periods. The inclusion of multiple pricing packages will help to identify those that have more impact.

Finally, the trials should maximise the ability of stakeholders across Australia to apply the findings to their own customer bases. This will require the consortium to think about how customers differ around the country. If a prominent customer segment is under-represented in the site of the *Smart Grid, Smart City* demonstration, the consortium will have to over-sample this group to produce enough data to inform the broader adoption.

Figure 12 illustrates how the indicative scale required for customer application trials was determined.

Figure 12

IN ORDER TO PRODUCE ROBUST DATA, *SMART GRID, SMART CITY* MAY REQUIRE A MINIMUM OF 9,500 CUSTOMERS (OR APPROXIMATELY 200,000+ POPULATION)



The major drivers of the overall population size required for *Smart Grid, Smart City* are the number of customer segments tested, the number of trials (18 in the previous Figure) and the number of customers in each trial (assumed as an average of 60 in the previous Figure). Change to these parameters, for example by using a less granular segmentation of customers, sensible aggregation of some trials, and/or by testing across a statistically valid, but perhaps smaller numbers of participants in the trials, could reduce the overall population size. Consortia bidding will need to present clear information on the experimental design they have selected to deliver the customer-side applications, as the emphasis of the *Smart Grid, Smart City* is to produce data that are transferable to a national context.

Estimating the number of customers required in the application trials has two purposes:

- To identify the kinds of factors bidders should consider in designing trials
- To estimate the size of trial that would have to be conducted to answer the major questions surrounding customer applications.

Consultation with industry players, academics, representatives from government and CSIRO helped inform this analysis.

After estimating the number of customers required, researchers must calculate how many customers need to be approached to recruit a sufficient number.

The most important consideration in scale is the lower end of the range so that a statistically valid sample can be extrapolated beyond *Smart Grid, Smart City*. There is no upper limit to the size of customer application trials—higher numbers allow more customer segments and more packages to be tested. That said, a balance must be struck between more customer tests/ packages and focus to provide enough rigour around each customer segment and package to derive insights. Grant applications should provide rationales for the size of the proposed trial.

Number of sites

Figure 13 illustrates considerations in determining whether *Smart Grid, Smart City* should be located at one or many sites. Here, a 'site' is defined as a distributor's network. Within a single network, a consortium may disperse trials across its geography, but all trials must be integrated at a central point of control. Importantly, *Smart Grid, Smart City* should have a defined and central geographic locus and identity, where most customer-side applications are tested.

The analysis in Figure 13 suggests that the cost, visibility, control, and scale outweigh the representative value of multiple sites. Analysis therefore suggests that *Smart Grid, Smart City* be located in a single distributor's network that includes urban, suburban, and rural areas.

Figure 13

THERE ARE TECHNICAL, COST AND VISIBILITY BENEFITS OF A SINGLE SITE, WHICH OUTWEIGH THE REPRESENTATIVE BENEFITS OF MULTIPLE SITES

Criteria	Single distributor region	Multiple distributor regions	Comments
Testing grid and back office system capabilities	✓	✗	Integrated platform best tested by having more applications in one site—the larger the test, more convincing the scalability of system
Investment cost	✓	✗	Multiple sites requires duplication of back office and communications infrastructure
Visibility and focal point	✓	✗	Identifying a single site provides focal point for marketing of initiative
Single point of control	✓	✗	Single point of control (i.e. entire trial under 1 distributor) maximises speed of trial and consistency of results
Customer segmentation	✓	✓	Multiple sites more likely to give customer segmentation but arguable single site could be sufficient (with appropriate sampling)
Representative network characteristics	✓	✓	Some sites may offer sufficient mix of network architectures
Representative climate	✗	✓	Single site will not be able to provide representation of all climate zones in Australia[1]
Buy-in of more areas and players	✗	✓	Multiple sites likely to involve more consortia members

1 Referring to the seven climate zones defined under the Building Code of Australia

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Climate considerations

Testing customer applications will reveal what will move customers to reduce peak usage. Within Australia, peak conditions occur in summer and winter, so applications should cover both. A location with extreme weather in only one season will not likely be able to reveal as much as a location with multiple seasonal peaks.

Australia has seven different climate zones, but 60-65 per cent of the population lives in two – mild temperate and warm temperate. Tests need not represent every climate zone; a location that can approximate these conditions and test both winter and summer peaks is sufficient.

Climate is one of many variables that impact the peak shaving opportunity. Other characteristics, including housing stock, appliances, gas or electric heating, and generation supply base are important when considering representative locations.

Capacity constraint considerations

There are credibility and experimental design benefits from choosing a location that has network capacity constraints. The arguments in favour of selecting a location that has capacity constraints and is likely to experience further pressure on capacity due to growth are that it:

- Gives additional credibility to the test —"performed in battle conditions"
- Is likely to be more similar in some ways (e.g. age, brownfield vs. greenfield) to regions in which capital investment deferral benefits will be greatest
- May generate additional innovative outcomes under pressure of real constraints.

However, it is possible to achieve useful results in low growth area and model or extrapolate the impacts that it would have on a constrained network. This gives a wider range of locations to choose from. All other factors being equal, slight preference should be given to locating *Smart Grid, Smart City* in a high growth area with network constraints.

3.2.4 PROJECT DURATION

Figure 14 provides an estimated timeline for the *Smart Grid, Smart City* program, excluding the time required for selection and negotiation of the final agreement.

Figure 14

SMART GRID, SMART CITY WILL LIKELY REQUIRE TWO TO THREE YEARS TO GENERATE RESULTS ONCE ALL SELECTION ARRANGEMENTS HAVE BEEN COMPLETED

Process	Estimated time	Steps required
Program setup and design	3–6 months	▪ Clear plan for testing experiment ▪ Plan for reports and outputs ▪ Signing customers up for trials
Rollout of equipment	5–7 months	▪ Procurement of 'smart' equipment (possible delays) ▪ Rollout of grid-side and communications infrastructure ▪ Installation of customer equipment and training
Run test	1–2 years	▪ 1 year if CPP achieved in first year, 2 years if not ▪ Receiving data into consortium database ▪ Sanitising data for shared database ▪ Customer surveys
Analysis of data	Concurrent with running test	▪ Analysis of data and preparation of output reports ▪ Steering Committee review of analysis
Dissem-ination of learnings	Concurrent with running test **Total: 2–3 years**	▪ Publication of sanitised database ▪ Publication of academic articles ▪ Media releases ▪ Involvement of other distributors

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The time estimates were developed through interviews with academics, distributors and stakeholders involved in the conduct of smart grid pilots and schemes in Australia and overseas.

As the aim of *Smart Grid, Smart City* is to help inform the broader adoption of smart grid technologies, there is value in the program generating findings in a timely manner. There are some important lessons taken from other pilots on how to minimise delays:

- **Investing in program setup and design will save time in the long run**

  The consortium can use time efficiently by investing at the start of the program in clarifying questions, defining outputs to be produced and creating a detailed plan for conducting the experiment. Clear program setup aligns parties on their roles and responsibilities and facilitates timely analysis and dissemination of data. Upfront program design also increases likelihood that outputs produced by the demonstration project are acted on by other industry players. A large part of the program setup and design should be completed as part of the selection process. Some elements of program setup cannot be completed until the funding agreement is in place but are necessary prerequisites before equipment rollout. For example, customers will need to be recruited across the demographics being tested and agree to participate before the consortium rolls out the equipment required to run customer applications.

- **Data should be analysed and findings shared while the test is underway**

  Valuable information generated during the program should be shared immediately, encouraging players to take action. It will take time for all the data to be packaged, analysed and reported but some of this work can be done before the study ends.

- **Some elements of the tests are independent—delays in one test need not delay others**

  While having multiple applications running at the same time may offer insights into interaction effects and back-office data integration capabilities, for example, the findings of a single test can be useful on their own. For example, delays in recruiting customers for trials need not hold up the rollout, tests or analysis of FDIR. A notable exception is that some rollouts, including CVR and customer applications, require that smart meters be installed.

Figure 15 estimates the minimum time required to test each application's variables outlined in section 3.2.1. It shows that most applications will yield sufficient data in the first year of the test.

Customer applications and WAM may take longer for two reasons:

- **Impacts on customer behaviour evolve**

  A major question about customer applications is degradation of behavioural impact. By assessing behaviour over two years, *Smart Grid, Smart City* can understand more about how it will change in the longer term.

- **Reducing 'atypical year' data collection**

  A single year test is vulnerable to criticism that the data was skewed by atypical weather. Customer applications trials are particularly vulnerable because of the complex relationship between behaviour and weather.

Given the above (and the need to allow as much time as possible to develop and test algorithms that make use of WAM data), *Smart Grid, Smart City* should test these applications for least two years.

Figure 15

THE MAJORITY OF *SMART GRID, SMART CITY* FINDINGS WILL BE PRODUCED AFTER THE FIRST YEAR OF TESTING

Application	Driver	Time required Years	Rationale
A Customer applications	Behavioural change, need peak	2	Number of mini trials required for statistical significance
B Integrated Volt Var Control (IVVC), including CVR	Reaction to voltage levels	1	Device response will be stable after 1 year
C Distributed storage	Ability to shift peak demand	1	Each year, peaks typically occur over the same months
D Fault Detection, Identification and Response (FDIR)	Fault occurrence	1	Fault occurrence similar across years
E Electric vehicle support	Network capacity	1	Ability to support high penetration during seasonal peaks
F Substation and feeder monitoring	Equipment failure	1	Chance of equipment failures are similar each year
G Wide area measurement	Power system data	2	Data processing algorithms must be developed
H Distributed generation support	Capacity factor and contribution to peak	1	Require an annual weather cycle to measure performance
I SMI	Operational benefits	1	Maintenance and meter-reading consistent across years

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Figure 15 shows estimates of the *minimum time* each application test should run to produce reliable results. A longer test would provide additional valuable insight.

3.3 REGULATORY ALIGNMENT MODULE

Industry stakeholders agree on the need for regulatory alignment with smart grid objectives. In assessing regulatory barriers to adoption and how they might be overcome, first potential barriers to the broader adoption and *Smart Grid, Smart City* deployment were considered. Discussions with regulatory bodies were also held to understand the challenges that might need to be overcome at the state and national levels to enable a broader market-led adoption of smart grid technologies across Australia.

Regulatory issues facing *Smart Grid, Smart City*

Based on discussions with national and state-level regulators, including the AEMC and AER, it is evident that regulatory frameworks require no major changes for a successful implementation of *Smart Grid, Smart City.* In summary, the resources to deliver the project are likely to come from a combination of the government grant and in-kind and cash investments from the selected consortium, and hence would not require a specific regulatory rate.

Discussions at the regulator roundtable raised three regulatory issues that could affect successful execution of *Smart Grid, Smart City,* but further investigation and conversations with national and state regulators indicated that these would not prevent successful applications. The three issues and the rationale for why each should not be a problem are explained below.

Retail pricing flexibility

- **Potential issue**

  Smart Grid, Smart City will require tests of different packages of customer applications, including critical peak pricing and time of use tariffs. Retailers therefore need to be able to alter pricing structures without regulatory constraints.

- **Why this is not an issue for *Smart Grid, Smart City***

  With the introduction of full retail contestability, retail pricing in most states is flexible, and customers can choose to opt out if they are not satisfied. Coordination with state regulators for complete flexibility may be necessary in Western Australia, Tasmania and the Northern Territory.

Cost recovery

- **Potential issue**

  Funding from regulated members of the consortium may come from reallocating funds from other projects, shareholders or from a pass-through mechanism. The AER would have to approve a pass-through, and a regulatory change event would have to be triggered by the state government.

- **Why this is not an issue for *Smart Grid, Smart City***

  The government funding for *Smart Grid, Smart City* is intended to minimise the technology maturity and implementation risk of smart grid applications and therefore a pass through mechanism should not be required.

Voltage levels

- **Potential issue**

  CVR should be tested as part of *Smart Grid, Smart City*, requiring distributors to alter voltage at the customer level, violating their standards.

- **Why this is not an issue for *Smart Grid, Smart City***

  According to the voltage standards of Standards Australia and state governments, present voltage ranges are broad enough to allow the modifications required to test CVR.

The role of *Smart Grid, Smart City* in informing regulatory issues facing broader adoption

While *Smart Grid, Smart City* deployment is not suitable for evaluating specific regulatory rate case alternatives, it can help inform the regulatory issues associated with a broader adoption.

It would be difficult for *Smart Grid, Smart City* to directly evaluate new regulatory policy mechanisms or trial amendments, given how long it would take to develop appropriate policy mechanisms and amendments and implement them in the context of a scale deployment. For example, the AER would need to be consulted on the acceptable weighted average cost of capital for smart grid technologies, a process that takes up to a year. Furthermore, once such regulatory elements are agreed upon, it takes time for a distributor to incorporate new metrics into business processes.

That said, the *Smart Grid, Smart City* deployment can still provide invaluable information to inform broader regulatory decision making. Hence *Smart Grid, Smart City* should involve a regulatory module to identify regulatory barriers that would affect an Australia-wide adoption and make recommendations concerning current regulation to the MCE. The structure of such a regulatory arrangement has been discussed and a preliminary structure has been developed with the AEMC and the AER. This workstream would be chaired by DEWHA in close collaboration with DRET and involve a working team with representatives from the AEMC, AER and state regulators. Each regulatory body would concentrate on issues consistent with their current responsibilities.

During *Smart Grid, Smart City* deployment, the regulatory reference group will interact regularly with the consortium to evaluate the challenges facing a market-led adoption of smart grid applications and assess the status of these challenges in Australia. Consequently, they will coordinate with the existing regulatory working groups from the AEMC and other regulators already engaged on related topics. The regulatory working team will feed into the external working groups relevant lessons from *Smart Grid, Smart City*. Every six months there should also be a high-level regulatory and policy panel which will report the latest findings and the current status of their work to AER, AEMO and AEMC. The AEMC would then coordinate the work and collate all the findings to inform future policy.

Once the *Smart Grid, Smart City* initiative is completed, the regulatory module should provide recommendations to the MCE on the implications for broader policy and regulation, including any suggested amendments to existing policy or new mechanisms. In addition, the regulatory module should outline implications for a broader adoption and therefore society if policies are not modified.

Potential regulatory barriers impeding the broader adoption of smart grid technologies

Discussions with industry and regulators and analysis have revealed economic and technical regulatory challenges that might impede a market-led adoption of smart grid, presented here in order of importance:

High priority

- **Mechanisms to encourage energy efficiency and demand management**

  Many smart grid systems require investments and risk-taking by one party—often the distributor—and benefit another—often the customer. Where total benefits exceed total costs, it is efficient for society to make the investment. Relevant applications include CVR, line loss reduction and most notably customer applications. The National Electricity Rules (NER) allows the AER to develop and publish a Demand Side Management Incentive Scheme to provide incentives for distributors to implement efficient non-network alternatives and manage expected demand. The NER also permits the AER to consider network losses when developing an Efficiency Benefit Sharing Scheme. It is essential regulatory instruments are appropriately applied to capture the benefits of smart grid technologies.

- **Standards not in place to guide adoption**

  Many distributors would like to begin deployments but want to avoid investing in technology based on standards that have been marginalised by industry movement in another direction.

Medium priority

- **Timing—Rates are determined every five years but procedures take longer to change**

  While the timing of regulatory reviews is important and the long lead will delay technology rollout—or result in last-generation technology being installed in accordance with an older capital plan—it will not prevent a rollout from occurring.

- **R&D—Not in line with current risk profile for T&D**

  R&D is essential for the development of smart grid technologies, but distributors are not the only parties capable of verifying and developing technologies and systems. Vendors, research organisations, and even programs like *Smart Grid, Smart City* can test and refine systems in ways that inform distributor investment decisions.

- **Uncertainty—Returns may be affected by policy changes**

  Uncertainty is likely to constrain investment, as emerging technologies may become subject to new regulatory regimes. Many overseas distributors have found themselves holding significant amounts of 'smart' capital whose regulatory treatment has changed as technology capabilities and public demand have evolved. This has driven much of the industry to shy away from investments that present regulatory risks.

- **Return on capital not aligned with technology risk**

  Energy network operators are naturally conservative in making investments, which may result in a generally more robust and less-costly grid. Hence unproven technologies, such as many smart grid components, are unlikely to be deployed if their rewards are not in line with the perceived risks.

- **Spectrum availability is restricted**

  While this is a quite significant obstacle to the deployment of specific technologies, its specificity makes it less critical than some other obstacles.

Low priority

- **Jurisdictional differences**

  While jurisdictional differences add complexity to the broader adoption, they do not prevent it, and a successful regulatory approach in one state can inform that of another.

- **Regulated voltage range standards**

  This concern is unlikely to significantly delay or deter smart grid investment, as the current regulatory regime appears compatible with the proposed technology.

While directly solving these barriers is well beyond the scope of *Smart Grid, Smart City* it is expected that the regulatory module will identify the most-pressing issues and provide recommendations to government and regulators.

3.4 STANDARDS DEVELOPMENT MODULE

A potential barrier to a broader adoption of smart grid in Australia is the risk associated with installing technologies with a limited set of agreed standards. Lack of standards increases the risk of a stranded asset (i.e. utility deploys a technology that is no longer supported by the industry requiring de-installation of some applications prior to their expected lifetime). Standards can also help to reduce installation complexity, facilitate interoperability, and address security. Interoperability can provide third-parties, such as appliance manufacturers, the confidence and motivation to install smart grid equipment in their products. Finally, proven and accepted industry standards also reduce the utilities' risk of being locked into one vendor solution.

Australian and international standards have yet to be fully developed for a broad smart grid adoption. In the US, the National Institute for Standards and Technology (NIST) has received USD $10 million to define critical standards, and the agency has identified 16 so far for FERC to accept (Figure 16). Furthermore, Standards Australia has recently been commissioned to investigate the issues affecting the Electric Vehicle market in Australia, the findings for which will be released in September 2009.

These standards relate to multiple components of the smart grid, including communications security, metering data interface, home area network communications, and grid-side application communications. NIST has named two additional standards as priorities: those to signal demand response and communication standards for dynamic pricing. Both would impact customer applications and home area networks. NIST is likely to recommend several additional standards, such as including Internet Protocol (IP) / TCP as the transport layer in the communications platform.

Figure 16

16 STANDARDS IDENTIFIED BY NIST TO FACILITATE ADOPTION OF SMART GRIDS

Standards	Application
AMI-SEC System Security Requirements	Smart Metering Infrastructure (SMI) and Smart Grid end-to-end security
ANSI C12.19/MC1219	Revenue metering information model
BACnet ANSI ASHRAE 135-2008/ISO 16484-5	Building automation
DNP3	Substation and feeder device automation
IEC 60870-6 / TASE.2	Inter-control centre communications
IEC 61850	Substation automation and protection
IEC 61968/61970	Application level energy management system interfaces
IEC 62351 Parts 1-8	Information security for power system control operations
IEEE C37.118	Phasor Measurement Unit (PMU) communications
IEEE 1547	Physical and electrical interconnections between utility and distributed generation (DG)
IEEE 1686-2007	Security for Intelligent Electronic Devices (IEDs)
NERC CIP 002-009	Cyber security standards for the bulk power system
NIST Special Publication (SP) 800-53, NIST SP 800-82	Cyber security standards and guidelines for federal information systems, including those for the bulk power system
Open Automated Demand Response (Open ADR)	Price responsive and direct load control
OpenHAN	Home Area Network device communication, measurement and control
ZigBee/HomePlug Smart Energy Profile	Home Area Network (HAN) Device Communications and Information Model

The 2 standards that NIST is prioritising includes—(1) Standards to signal demand response (2) Communication standards for dynamic pricing

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These standards are a useful starting point, and similarly to the US program, a working group should convene as a module of *Smart Grid, Smart City* to help identify appropriate standards. These recommendations may be complementary to the work, which the DEWHA has commenced on smart appliances and will progress with advice from appropriate bodies, including Standards Australia and the National Measurement Institute.

The standards group would be one of three modules of *Smart Grid, Smart City* including the applications group and the regulatory group. The standards working group's mission would be to identify acceptable standards and gaps in the framework and propose solutions. If standards are being developed for the smart grid, this working group could help facilitate their acceptance. The working group could coordinate with other smart grid standards making bodies internationally, including NIST in the US and Comité Européen de Normalisation

Electrotechnique (CENELEC, responsible for European Standardisation in electrical engineering), Comité Européen de Normalisation (CEN, the officially recognised group for European Union), and European Telecommunications Standards Institute (ETSI, which sets standards for information and communication technologies). Many of the standards that come from these groups will be applicable in Australia, but Australia should take the lead in coordinating standards to facilitate a broader adoption.

The working group should include the consortium members and Standards Australia, the National Measurement Institute or other appropriate standard-making bodies, and be chaired by DEWHA and supported by DRET. The team should meet every four to six months and meet with the steering committee every six months to review progress. The issues they should review as part of the steering committee include:

- What is the best smart grid standards framework?
- What smart grid standards are in place today?
- Where are the critical gaps?
- Are these challenges being addressed by another body?
- How should the gaps be closed?

3.5 DISSEMINATION OF LESSONS

Disseminating the findings of each *Smart Grid, Smart City* module is essential. This section:

- Outlines the deliverables of each module
- Describes additional benefits that cut across the modules
- Identifies target audiences and how they can be influenced
- Outlines the ownership, methodology and process for *Smart Grid, Smart City*.

3.5.1 DELIVERABLES OF *SMART GRID, SMART CITY* MODULES

Figure 17 describes the major deliverables of each module. Responsibilities should be clearly assigned to the consortium or the regulatory or standards working groups to create accountability and allow monitoring. The proposed framework in Figure 17 specifies what each module should deliver.

While high-level deliverables are listed in Figure 17, government must understand the details of each of the consortium's deliverables as part of the funding agreement. The requirements will depend on the applications the consortium proposes to test. Section 3.2.1 describes what obstacles *Smart Grid, Smart City* would need to overcome preventing the broader adoption of smart grid applications.

Figure 17

THE DELIVERABLES OF THE THREE MODULES OF *SMART GRID, SMART CITY* ARE TARGETED AT ADDRESSING THE FIVE CHALLENGES TO A BROADER SMART GRID ADOPTION

Challenges	Modules	Ownership	Deliverables
Business case un-certainties	1 Application business case testing	Consortium	▪ Business case that delivers benefits and costs by application and reports on the key data needed to accelerate investment ▪ Database with key application outputs including quantitative and qualitative learnings ▪ Assessment of the potential synergies with NBN and multi-utility operations ▪ Evaluation of customer engagement techniques
Technology maturity		Consortium	▪ Assessment of the technical barriers that prevented successful execution of applications and a roadmap to address these issues ▪ Detail on the maturity level of key technologies before, during and after the trial based on critical metrics
Disaggre-gated value chain		Consortium	▪ Breakdown of the business case for retailers and distributors and the key drivers for each
Regulatory mechanisms	2 Regulatory alignment	Regulatory working group	▪ Recommendation to Commonwealth Government on policy and MCE on regulatory solutions to incent a market led roll-out of positive business case applications ▪ Report of issues identified throughout the SGSC
Standards development	3 Standards development	Standards development working group	▪ Recommendation of the critical standards needed for broader adoption of Smart Grid by application, including a roadmap of how to close the gaps ▪ Liaise with Standards Australia

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3.5.2 KEY OUTCOMES THAT CUT ACROSS MODULES

Figure 18 lists outcomes and benefits that cut across all three modules. Tangible examples can help build public awareness about what a smart grid can offer to customers, the environment and the economy. They can also help market Australia as a leader in researching, developing and implementing smart grid applications.

It is clear from the outcomes in Figure 18 that *Smart Grid, Smart City* could play an important role in coordinating initiatives in smart grid space across Australia.

Figure 18

THERE ARE A NUMBER OF IMPORTANT OUTCOMES THAT CUT ACROSS THE THREE MODULES OF *SMART GRID, SMART CITY*

Outcomes	Benefit
Complete live grid site that allows key stakeholders to visit	▪ Help inform other smart grid rollouts across Australia by allowing stakeholders to see an example of an integrated smart grid operating in real world conditions
Live site that is a potential test bed for future technologies	▪ Provide ongoing lab for testing smart grid advances ▪ Minimise need to duplicate investment in experimental infrastructure
Regular engagement with industry and government stakeholders to inform broader rollout	▪ Encourage collaboration throughout SGSC ▪ Coordinate smart grid investment and research and reduce duplication
Build visibility and capabilities of Australia's smart grid industry	▪ Increase potential for export industry ▪ Promote Australia as R&D hub
Reference set of analytic tools for industry	▪ Move towards common understanding throughout industry of best ways to assess new data sets generated by smart technology
Common approach for accepted regulatory cases	▪ Facilitate the preparation of rate cases for regulators if business case proven out
Increased public awareness about benefits of smart grid technologies	▪ Increase the customer uptake rates for broader rollout ▪ Generate pull-through demand for smart grid applications ▪ Pursue broad community engagement

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3.5.3 KEY INFORMATION AND MESSAGES TO DELIVER FOR EACH TARGET AUDIENCE

The program must engage many audiences to achieve its objectives. Figure 19 lists eight of them, why they are important and the topics to cover with them.

The consortium should develop a strategy to engage each of these audiences and assign funding to ensure that the strategy is executed. As will be discussed in section 3.5.4, this engagement should include on-going dialogue, since the project will deliver more if it solicits input from target audiences throughout the program and does not merely disseminate findings at the end.

Figure 19

SMART GRID, SMART CITY CONSORTIUM SHOULD DEVELOP AN ENGAGEMENT STRATEGY FOR KEY STAKEHOLDERS TO ENSURE BROAD ALIGNMENT ON SMART GRID OPPORTUNITY

Target audience	Rationale for target audience	Topic of dialogue
A Non-consortium distributors B Non-consortium retailers C Other industry players	▪ Stimulate market-led rollout of smart grid applications of greatest value to Australia	▪ Evidence of business case for smart grid applications ▪ Technical and operational knowledge ▪ Customer data
D Government and regulators	▪ Inform changes to regulatory regime	▪ Evidence of business case for smart grid applications ▪ Implications for regulatory regime
E Participants in customer application trial	▪ Ensure quality of data and customers stay engaged ▪ Act as reference point for customer benefits of applications	▪ What a smart grid is and how it can bring benefits to customers, the environment and the Australian economy ▪ Use of smart grid applications ▪ Impacts/achievements of SGSC and how they contributed
F Public and customers	▪ Generate pull-through demand for smart grid applications on energy industry	▪ What a smart grid is and how it can bring benefits to customers, the environment and the Australian economy
G International community	▪ Support export of smart grid knowledge and services	▪ Australia is a leader in the implementation of smart grids ▪ Australia has the characteristics of an premier location to test and develop smart grid applications (R&D hub) ▪ Australian companies can help other countries implement smart grids in other countries
H Academics	▪ Support continuing training and research in smart grids space	▪ All aspects of trial but focus on business case, technical information and customer behaviour

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3.5.4 OWNERSHIP, METHODOLOGY AND PROCESS

There are a variety of engagement models that could be pursued when disseminating *Smart Grid, Smart City* lessons. First, there are communications channels. Then pre-deployment study identified 12 potential channels for the dissemination of *Smart Grid, Smart City* findings, of which six should be mandatory. Figure 20 lists these channels and indicates which is likely to be most effective with which stakeholders (from among A-H of Figure 20). Beyond this, there are other ways to involve industry players (e.g. secondments of technical staff). The following sections give an overview of these additional engagement models.

Figure 20 outlines communications and engagement models channels *Smart Grid, Smart City* might use, and when/with whom each would be most effective (A through H from Figure 20).

Figure 20

POTENTIAL CHANNELS FOR DISSEMINATION OF LESSONS

Priority	Channels for disseminating learnings	Description	Timing	A	B	C	D	E	F	G	H
Must have	**Database of information**	▪ Granular data to allow independent verification and the application of own methodologies ▪ Differentiated access	Updated throughout SGSC	✓	✓	✓	✓			✓	✓
Must have	**Analysis of databases**	▪ Analysis of benefits achieved by smart grid applications	Interim report after first year of test and refined report after second year	✓	✓	✓	✓			✓	✓
Must have	**Involvement of non-consortium distributors during SGSC**	▪ Not constrained by concerns over competition ▪ Facilitate 'buy-in', reduce duplication	Quarterly	✓							
Must have	**Website**	▪ Constant point of contact with stakeholders and community	Updated monthly	✓	✓	✓	✓	✓	✓	✓	✓
Must have	**Site visits**	▪ Guided tours of SGSC provided for interested industry and education groups	By arrangement	✓	✓	✓	✓				
Must have	**Targeted advertising and media campaign**	▪ Traditional mainstream campaign across a range of media to raise profile of SGSC, highlight achievements and show potential benefits for customers, the environment and the economy	At start, mid-point and end of SGSC					✓	✓		
Nice to have	**Connection to international databases**	▪ Agree to two-way data sharing with international smart grid databases to increase SGSC profile and engage in international smart grids community	Discussions upfront to ensure compatibility							✓	
Nice to have	**On-site education and research centre**	▪ Focal point for studies ▪ Broader dissemination of message about smart grids to public and customers	Ongoing						✓		✓
Nice to have	**Ongoing R&D lab**	▪ Provide an advanced infrastructure base where emerging smart grid technologies and applications can be trailed	Ongoing							✓	✓
Nice to have	**Inform education and training**	▪ Ensure fast development of smart grid capabilities in Australia's engineers ▪ Support education export industry and direct export of smart grid services	Throughout SGSC								✓
Nice to have	**Mainstream advertising and media campaign**	▪ Traditional mainstream campaign across a range of media to raise profile of SGSC, highlight achievements and show potential benefits for customers, the environment and the economy	At start, mid-point and end of SGSC					✓	✓		
Nice to have	**Peer-reviewed academic articles**	▪ Encourage rigorous analysis of data ▪ Increase profile of SGSC as reference case	Throughout SGSC							✓	✓

Target audiences: A–H

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Engaging with other industry players

The consortium will need to engage with energy industry players, especially those who will be involved in broader adoption. Non-consortium retailers and distributors are most important, since they will need to buy-in to *Smart Grid, Smart City's* findings if the program is to stimulate a broader adoption.

The program's end products should include credible information that non-consortium distributors and retailers need to build business cases for smart grid applications.

To make sure other retailers and distributors trust and can use the *Smart Grid, Smart City's* output, the consortium should establish a peer engagement panel to seek input from them on design methodology.

In addition to the communications channels listed in Figure 20, the consortium can proactively engage with other energy industry players in other ways, including:

- Presentations at industry forums
- Externship programs whereby players second staff to the consortium to work on the *Smart Grid, Smart City* demonstration
- Direct involvement in the consortium.

The consortium may be reluctant to include competitors in the market place within the consortium structure, but distributors, as regulated monopolies, have incentives to share the cost of developing smart grid technologies.

The importance of granular data

In discussing the pre-deployment study, stakeholders highlighted the value of raw or 'granular' data. The consortium should be required to perform and publish benefit analyses—and share the underlying data. The benefits include:

- **Confidence in the findings**

  Audiences are more likely to trust and act on *Smart Grid, Smart City's* findings if they can analyse the underlying data themselves.

- **Adaptation to areas with different characteristics**

  Granular data will help other distributors apply different segmentation approaches and make statistical adjustments to account for differences in the characteristics of the *Smart Grid, Smart City* locations.

Databases should provide granularity without revealing private information from customer trials or commercially sensitive information.

Intellectual property

Since *Smart Grid, Smart City's* main output is information, it is critical that intellectual property that is required to inform a broader adoption be shared broadly with the relevant stakeholders. In conjunction with this, it will be important for government to include appropriate safeguards to ensure the consortium is comfortable with providing its own intellectual property.

3.6 GOVERNANCE STRUCTURE, FUNDING ARRANGEMENTS AND PROCESS

This section outlines requirements that will ensure that the program achieves it objectives in schedule, including:

- An overview of the recommended governance and oversight structure for *Smart Grid, Smart City*
- Recommendations on the consortium structure, roles and responsibilities
- Guiding principles for the funding arrangements, including co-funding and timeline for staged release of grant monies
- Lifecycle management issues.

3.6.1 OVERVIEW OF GOVERNANCE AND OVERSIGHT STRUCTURE

Figure 21 provides an overview of the recommended governance and oversight structure for the *Smart Grid, Smart City* program.

Six bodies would be involved in delivering the program:

- **Steering committee**

  With members from each government department in the *Smart Grid, Smart City* initiative, the steering committee will have oversight of project completion, quality, and timeliness of deliverables. DEWHA will be the contract manager and will make the funding agreement with the consortium.

- **Independent experts**

  Given the complexity and technical nature of the *Smart Grid, Smart City*, a temporary expert assessment panel should help the steering committee in the selection process (for details, see section 4.3).

- **Consortium**

  This group of involved stakeholders will be led by a single distributor responsible for executing the application and technology demonstration module and disseminating program findings (for details, see section 3.6.2).

- **Peer engagement panel**

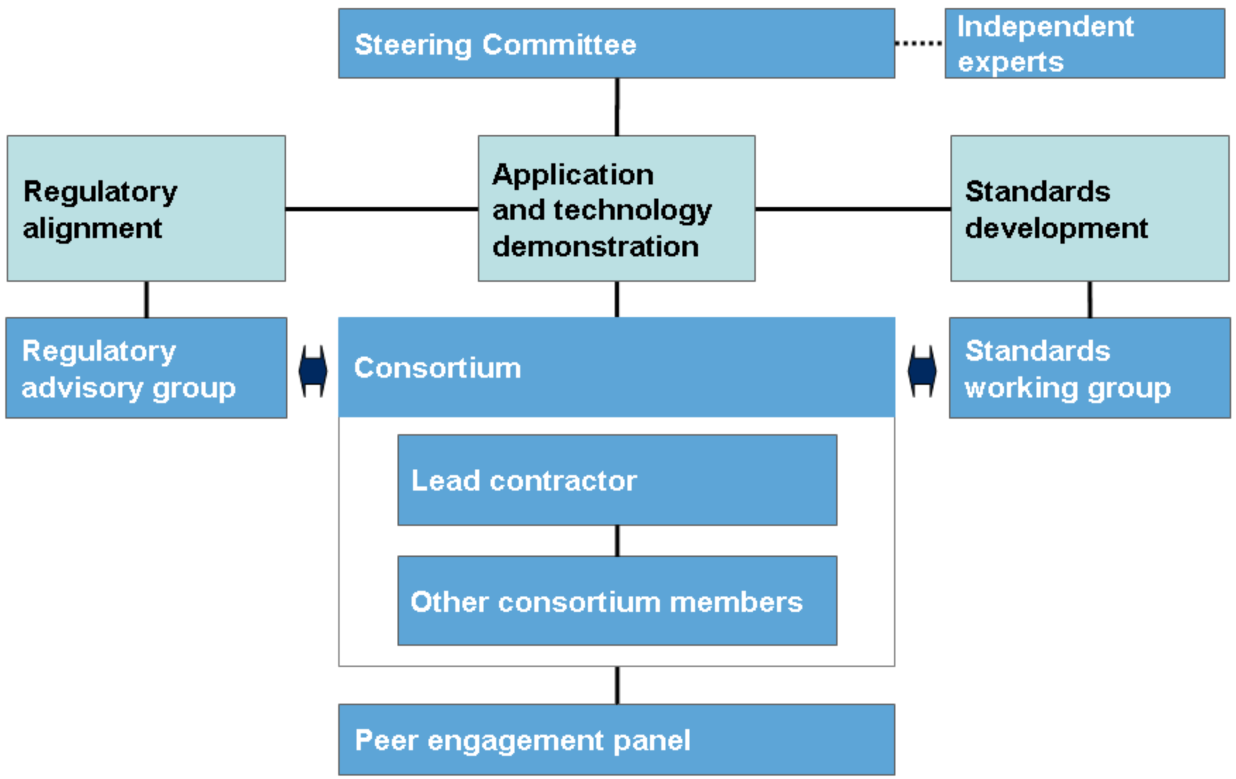
  Recommended for engaging other energy industry players in *Smart Grid, Smart City* (for details, see section 3.6.3).

- **Regulatory reference group and standards working group**

  The proposed regulatory alignment and standards modules will be executed by dedicated bodies in cooperation with the consortium. (for detail on these bodies, see sections 3.3 and 3.4).

Figure 21

GOVERNANCE AND OVERSIGHT STRUCTURE FOR *SMART GRID, SMART CITY*



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3.6.2 CONSORTIUM STRUCTURE, ROLES, AND RESPONSIBILITIES

Government will follow three basic principles when developing the grant application guidelines and reviewing submissions:

A. Distributor should be lead contractor and underwrite project risk

The consortium should be led by a distributor who acts as a lead contractor and underwrites the funding. This assigns project risk to one party, including risk associated with consortium breakdown or individual members not honouring their commitments. In addition, giving one party ownership and control over data will facilitate the dissemination of findings.

There are three reasons why a distributor should be the lead contractor:

- **Central point of control for smart grid applications**

  The distributor's position in the electricity network—managing distribution network and metering— makes it a natural point of control for smart grid infrastructure rollout and data collection

- **Positioned to manage investment and execution risk**

  Distributors are likely to be responsible for the majority of infrastructure investments, including all grid components and smart meters, and are likely to receive the majority of the benefits from the investment. As such they are best able to manage the risk of *Smart Grid, Smart City* and are the most appropriate party to underwrite the consortium's co-funding commitment

- **Competition not a barrier to dissemination of findings**

  As regulated monopolies, distributors are not in competition and are thus more likely to share data generated by *Smart Grid, Smart City.* Indeed, distributors have an incentive to cooperate and share the costs of smart grid research and development. This makes them natural owners of a demonstration project where effective dissemination of findings throughout the industry is critical.

B. A number of other potential consortium members could be included

A range of other stakeholders would be valuable additions to a consortium, as outlined in Figure 22. Figure 23 outlines how a broad consortium including some of these additional members might be structured. A consortium structure needs to balance depth and breadth of membership against the expectation that the consortium will be 'nimble' in its operations and able to respond quickly and appropriately to changing circumstances.

C. Retailer(s) should be included in the arrangements

One or more retailers should be included in the delivery of customer-side applications. Since they own the customer relationships, they are critical to the success of the customer application trials. However, it should be noted that distributors cannot form exclusive relationships with retailers, accordingly any offerings within *Smart Grid, Smart City* that can be delivered by retailers must be offered to all of them.

Figure 22

CONSORTIUM WILL REQUIRE INVOLVEMENT OF DISTRIBUTOR AND RETAILER(S); A RANGE OF OTHER POTENTIAL MEMBERS COULD BE INCLUDED

	Consortium members	Role	Rationale
Must have	Distributor	▪ Lead contractor ▪ Grid-side application rollout	▪ Majority of grid investment lies with distributor
Must have	*Retailer(s)	▪ Customer-side application rollout ▪ Customer engagement	▪ Retailers own the customer relationship ▪ Champion for generating detailed customer behaviour data ▪ Could have multiple retailers (and may be required to avoid competition law issues)
Nice to have	Integration service providers	▪ Integration of different elements of rollout	▪ Have detailed knowledge and expertise on integration of applications
Nice to have	SG equipment vendors (INCL IT/COMMS)	▪ Provision of smart grid equipment to each module ▪ Integration of back office systems	▪ Can bring significant co-funding of in-kind technology ▪ Knowledge of technology requirements
Nice to have	Local and state government	▪ Planning approvals ▪ Building local support for SGSC	▪ Local government support critical for success of project, but may not require local government to be member of consortium
Nice to have	Smart appliance manufacturers	▪ Provision of in-home smart appliances	▪ Knowledge of customer behaviour and in-home technology requirements ▪ Optional premium add-on for customer apps
Nice to have	Academics/ universities	▪ Design and execution of experiment ▪ Evaluation of trials ▪ Publication of results	▪ Possible to undertake these tasks without academics but would add credibility and skills
Nice to have	Other distributors	▪ Involvement of seconded staff on project teams	▪ Increase buy-in and transferability of SGSC learnings
Nice to have	Transmission operators	▪ Involvement on certain grid-side applications (e.g. WAM)	▪ Required if transmission related applications are proposed to be tested
Nice to have	Consumer interest groups	▪ Observation and commentary on impacts of customer applications on consumers	▪ Provide strong voice for consumers (particularly those that are disempowered) throughout SGSC
Nice to have	NBN Co	▪ Support testing of NBN synergies	▪ Opportunity to demonstrate synergies and influence shape of eventual smart grid deployment

* **Retailer involvement should be non-exclusive**

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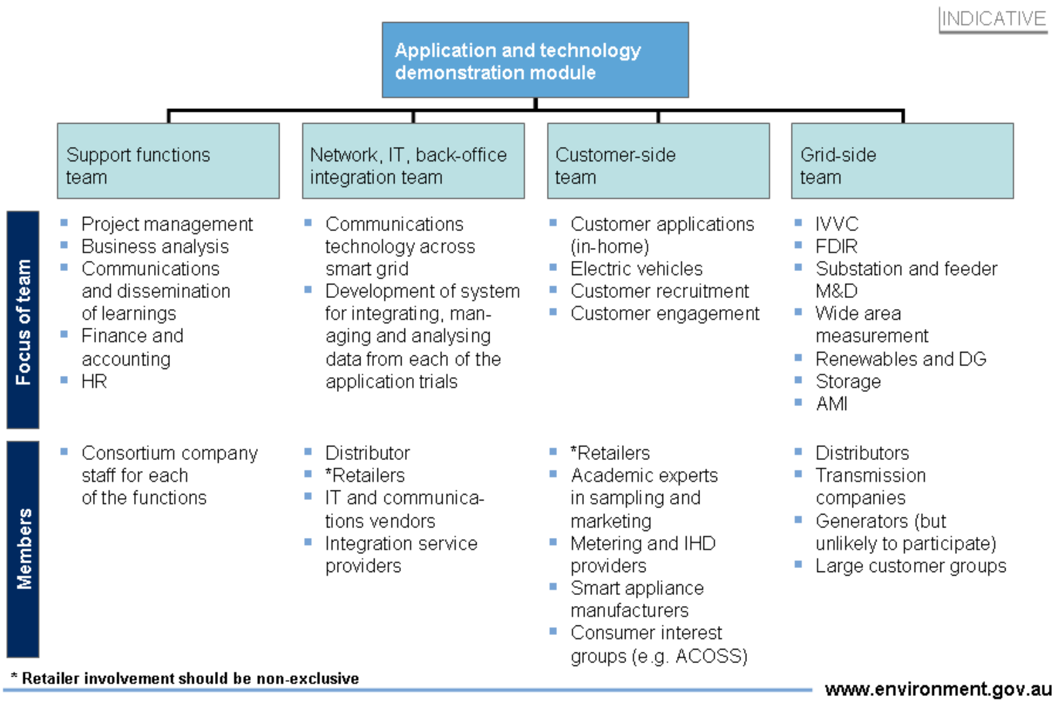
While many of these 'nice to have' consortium members could be brought into the program as subcontractors or through other structures, including them as members of the consortium may bring additional benefits:

- Direct financial contributions or in-kind support increasing the scope of the project beyond what can be achieved with the government's investment alone
- Greater commitment to the program
- Advance the dissemination of findings.

The last point has particular relevance to the involvement of other distributors. While the inclusion of a peer engagement panel is recommended (outlined in section 3.6.3), having other distributors join the consortium would facilitate broader buy-in and capability building across Australia, even though the project is hosted in the service territory of the distributor acting as lead contractor. The use of the existing NSCC process to meet all or part of peer engagement obligations should be investigated.

Figure 23

POSSIBLE INTERNAL STRUCTURE FOR CONSORTIUM



3.6.3 PEER ENGAGEMENT PANEL

As outlined in section 3.6, a peer engagement panel would help to ensure that the results of *Smart Grid, Smart City* are trusted and acted on by non-consortium industry players. The consortium might arrange for the creation of a peer engagement panel or a structure serving a similar function. Figure 24 describes characteristics of such a panel.

Figure 24

Characteristics of peer engagement panel	Description
Purpose	• To allow non-consortium industry players to provide input into the design of the SGSC trials and the outputs it should provide • To ensure outputs are trusted by non-consortium players • Encourage ongoing industry dialogue during the SGSC • Move towards uniform database categories and metrics across industry
Composition	• Non-consortium distributors • Non-consortium retailers • Other non-consortium industry players considered important recipients for data and results generated by SGSC
Process	• Consortium provides framework for outputs it will provide (e.g. data categories for databases, level of granularity, qualitative information on customer engagement and operating model) and access regime for full database for review of peer engagement panel • Peer engagement panel provides comments on the content and format of the outputs which the consortium proposes to produce • Steering committee can require the consortium to seek input from peer engagement panel on other issues during the course of the SGSC
Dispute resolution	• If a disagreement arises between the consortium and the peer engagement panel members, the steering committee will decide the outcome
Key risks	• Delays due to overly complex process • Competitive concerns of retailers reducing effectiveness of engagement

Additional mechanisms that may engage other distributors include:

- Involvement in consortium
- Externships or other staff interchanges
- Site visits and dedicated distributor education events.

3.6.4 FUNDING ARRANGEMENTS

Smart Grid, Smart City will be a major project and grant funding should be spent wisely. To this end, the consortium should provide funding needs for each proposed application and activity and highlight any additional funding required as a grant. The consortium should also propose a performance payment element for energy conservation impact.

Government funding for *Smart Grid, Smart City* should help overcome the five main challenges facing a market-led smart grid deployment:

- **Business case uncertainties**

  The costs and benefits of various applications are still uncertain. For example, the complete demand response effect of in-home displays is unknown. Government funding will reduce the consortium's risks in proving the benefits and costs associated with the smart grid applications.

- **Technology maturity**

  Many smart grid technologies still in the research and development stage could provide significant benefits. Government funds could be spent implementing these technologies, which are typically not sufficiently proven for utility investment.

- **Standards development**

  Lack of standards limit the ability to make prudent smart grid investments. Government funding should help overcome this uncertainty.

- **Disaggregated value chain**

  Potential benefits and penalties are misaligned throughout the value chain. Government funding should encourage the consortium to engage in activities for which they are not rewarded for but provide societal benefits.

- **Regulatory mechanisms**

  Current regulation may impede market-led adoption of smart grid applications. Technologies that cut consumption may run counter to the interests of distributors and retailers. Government funding should help bridge this gap.

Maximising the impact of government funding

The government should fund applications that benefit society and overcome barriers to market-led adoption. The consortium should provide co-investment for the program to align interests, provide an incentive for complete ownership and drive lessons for *Smart Grid, Smart City*.

Milestone performance

Milestone payments will be made against achievement of objectives and should encourage more deployment of technologies which are directly beneficial for both society and consortium members. To maximise the benefit of government funds, they should be directed towards major investment that do not generate a regulated return for the consortium.

Energy conservation

It is recognised that some applications, notably energy conservation from customer applications and CVR provide societal benefit rather than any direct, immediate benefit to players in the energy value chain. Measures to provide energy conservation remain of keen interest and would be welcomed in a consortium response.

As some demand management incentive schemes are already in place and managed by the AER, the AER may be involved in assessing the quantum of any energy conservation activities undertaken by the consortium to ensure verification of methodologies and outcomes.

The treatment of *Smart Grid, Smart City* investment in the network for the next rate determination

Network investments will come from two main sources: the network service provider and the Australian Government or other external parties. Funds provided through these two different methods will be dealt with separately in the next rate determination for the network service provider.

- **External funds** may come from the Australian Government or from external parties, including other vendors. This type of investment in the grid would not penalise the network service provider during the next rate determination. The AER has indicated that this funding should be treated as a customer contribution and not classified as a cost, so there would be no pass-through to customers. Consequently these assets would not be a part of the regulated asset base.

- **Consortium funds** may be provided through two options:
  - **Option 1**

    Funds dedicated to another project are diverted to *Smart Grid, Smart City.* As a result, capital investment would likely be rolled forward into their regulated asset base for the next regulatory period. This implies that the network service provider would possibly receive a regulated return on these assets
  - **Option 2**

    Compensation may be requested upfront in the form of a pass-through. If approved by the AER and a regulatory change event is triggered, this could be possible.

The preferred method is option one which would involve some *Smart Grid, Smart City* assets being rolled forward into the network service provider's regulated asset base for the next rate determination. But the consortium should also be encouraged to provide some funding beyond merely capital, and the government should reserve the right to choose how its funding should be allocated. The AER should also be included in this discussion to ensure compliance with the rules regarding rate determinations.

3.6.5 PROCESS AND KEY MILESTONES

The government funding for *Smart Grid, Smart City* should be granted to the consortium in stages to maintain an ongoing incentive for delivering the project throughout its life and to give DEWHA and the *Smart Grid, Smart City* steering committee a lever to support its decisions.

Figure 25 provides a proposed scheme for how the funding stages could be structured over the life of the *Smart Grid, Smart City* program. Under this model, some 90 per cent of the funds would be delivered to the consortium in staged payments:

- An upfront payment upon,
  - signing of the funding agreement, and
  - delivery by the consortia of the project plan and design.
- DEWHA may choose to link payment to completion of certain aspects of program setup and design outstanding after the selection and funding agreement negotiation and signing

- A payment at the commencement of test stage of *Smart Grid, Smart City* once the steering committee is satisfied that the rollout of infrastructure is progressing according to plan and the consortium is ready to begin the test phase

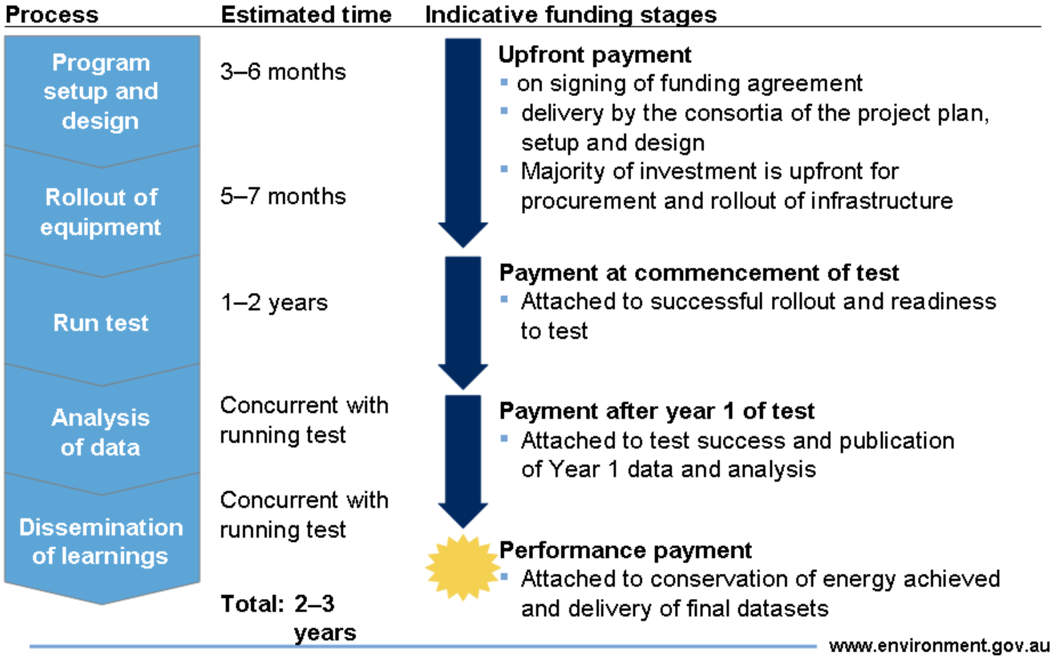
- Payments after completion of significant milestones as negotiated in the contract and the steering committee is satisfied with progress of the demonstration project and the associated data and analyses are published.

The remaining government funding would represent a performance and finalisation bonus payment linked to energy savings. This final performance payment could also be linked to the completion of the commitments on dissemination of findings.

The model in Figure 25 provides a greater share of the funds granted to the consortium in the early stages of the program, reflecting the expectation that most of the investment in capital and installation will take place early on.

Figure 25

***SMART GRID, SMART CITY* WILL REQUIRE TWO TO THREE YEARS TO GENERATE RESULTS**



The model outlined in Figure 25 is for illustrative purposes; adjustments are likely in the course of the selection process and negotiation. The following principles should guide the development of the funding stages:

- They should balance the need to provide funding when required and incentives to complete each stage of the program
- They should balance the need for regular check-ins with requiring onerous reporting. Each payment approval process will take time, so the scheme should be cautious about including additional funding stages.

3.6.6 LIFECYCLE MANAGEMENT

Three critical lifecycle management issues must be addressed prior to the completion of the *Smart Grid, Smart City*, and the recommended approach to each is included in Figure 26.

Figure 26

CRITICAL LIFECYCLE MANAGEMENT ISSUES

LIFECYCLE MANAGEMENT ISSUE	QUESTION	RECOMMENDED APPROACH
Defining the end of the project	• When is the SGSC project completed?	• Project ends when the consortium completes the commitments under funding agreement • Last commitment likely to be packaging of datasets, analysis and dissemination of findings • Funding agreement will probably cover at least three years • Must have mechanism for flexibility
Ownership of installed assets	• Who owns the assets installed during SGSC? • Who decides whether they remain in place at end of project?	• As funding is a grant, the consortium owns installed assets • Consortium chooses whether the assets are removed at end of trial • Ownership within consortium left to internal arrangements

LIFECYCLE MANAGEMENT ISSUE	QUESTION	RECOMMENDED APPROACH
Management of SGSC databases	• Who manages SGSC databases at end of project?	• Database should be created on an easily transferable platform • Require consortium to detail how they will append data and maintain the database • Consortium must also demonstrate how they will let academic institutions or other research institutions such as CSIRO take on the data if desirable and government backs the request • Require consortium to host SGSC databases for five years after project commencement • At end of five years, DEWHA arranges for ongoing hosting and management of datasets.

4 RECOMMENDED APPROACH TO INDUSTRY AND NEXT STEPS

CONTENTS

SUMMARY

- This chapter outlines next steps for *Smart Grid, Smart City,* focusing on the process for soliciting and evaluating grant applications and managing the major *Smart Grid, Smart City* project risks.
- The proposed selection process will include a formal statement of grant guidelines, evaluation by DEWHA and a number of experts, application feedback and possible revision, and final selection by government. The announcement of the selected consortium will occur in mid-2010.
- During this process, applications will be evaluated based on five criteria aimed at determining value for money:

  1. Applications, approach, and benefits (40 per cent)
  2. Operational plan and risk management (25 per cent)
  3. Dissemination of findings (10 per cent)
  4. Interaction with Regulatory and Standards modules (10 per cent)
  5. Consortium structure and governance model (15 per cent)

  Overall: Value for money

- Throughout the next steps of the *Smart Grid, Smart City* project, it will be critical to manage a number of risks. These risks, and potential mitigation strategies, are discussed in section 4.4. The most important risk management initiative is the careful design of grant guidelines.

4.1 SELECTION PROCESS

The proposed process for selecting a winner for the *Smart Grid, Smart City* grant consists of five phases:

- **Grant guideline preparation** (October 2009)

  During this time the grant guidelines will be prepared by DEWHA and 'without prejudice' versions will be shared with industry for comment

- **Grant application submission** (Late 2009)

  During this phase, interested parties will prepare grant applications, and DEWHA will engage with industry in workshops to answer questions, clarify objectives, and provide guidance on applications. Applications will be due in early January 2010, and will be quickly reviewed for compliance

- **Short list and expert review** (Early 2010)

  DEWHA conducts a preliminary review where applications will be disseminated to a panel of retained experts who will prepare a formal evaluation of each application (focused on their respective areas of expertise, and based on the applications as well as optional interviews with consortium member staff). DEWHA will then synthesise their review with the experts' review. DEWHA will use this phase to create, if necessary, a short list of the three to five most promising applications for assessment by an independent panel. Advice on regulatory matters is likely to be sought from the AER at this point

- **Assessment by independent panel** (First half of 2010)

  An independent panel of experts will assess and rank applications for technical and business merit. DEWHA will provide secretariat support throughout this process. The recommendations of the independent panel will be provided to the steering committee for endorsement

- **Final selection** (Mid 2010)

  Recommendations of the independent panel, with accompanying advice from the steering committee will be provided to government for decision on the winning consortium. Funding negotiations will proceed with the selected consortium, to be completed by mid-2010.

4.2 SELECTION CRITERIA (INCLUDING FIRM VS. FLEXIBLE REQUIREMENTS)

The greatest lever to overall risk mitigation is the careful choice of selection criteria. The grant guidelines will include a clear indication of which criteria are mandatory (i.e. 'firm requirements') and which are flexible. This will allow for a maximum number of competitive bids, set the stage for a smooth negotiation process, and reduce any confusion about the government's priorities. The initial proposed selection criteria, are outlined below and will continue to be refined during the preparation of grant guidelines outlined above.

As noted above, grant applications should be assessed against five different criteria that measure overall value for money:

1. Applications, approach and benefits (40 per cent)
2. Operational plan and risk management (25 per cent)
3. Dissemination of findings (10 per cent)
4. Interaction with the regulatory and standards modules (10 per cent)
5. Consortium structure and governance model (15 per cent)

Overall: Value for money

For each of these dimensions, there are 'firm requirements' with which proposals must comply in order to be considered at all, and 'flexible criteria' which will form the basis for selection from among those proposals that are considered.

Each of the five dimensions is explained below, using the following framework:

- The guiding principle of the dimension
- Materials that applicants should submit to document their approach to this dimension
- The firm requirements that must be met in order to be considered
- The 'flexible criteria' that will inform final selection from among applications that meet all firm requirements.

1. Applications, approach and benefits (40 per cent)

Guiding principle

Applicants must demonstrate how they will structure *Smart Grid, Smart City* to maximise the benefits of a broader smart grid adoption.

Materials in support

Applicants should be required to outline the specific applications and technologies they propose to deploy at scale, including the following data for each:

- Identify which characteristics are applicable to a national adoption and why, as well as which would require significant changes to inform estimation of national benefit
- Description of obstacles to a national deployment that will be addressed by the proposed *Smart Grid, Smart City* design
- The scale (e.g. the number of units, endpoints, feeders) and locations
- The experimental methodology for each application, including strategies for customer engagement/retention and approaches to establishing a baseline, control and sampling, trial segmentation, metrics for each application, statistical analysis of data, and extrapolation to the rest of Australia.

Firm requirements

At minimum, all proposed *Smart Grid, Smart City* plans must include demonstration-level deployment of all smart grid applications reviewed in Chapter 2. Additionally, *Smart Grid, Smart City* plans must include commercial-scale deployment of several smart grid applications including both customer-side and grid-side systems. Thirdly, applicants must outline the process that they will use for third-party verification of the achieved levels of kWh consumption reduction (This will serve as the basis for the calculation of the performance completion payment outlined in section 3.6.4.) Finally, applicants must describe how they propose to investigate potential synergies with NBN.

Flexible criteria

Preference will be given to grant applications that propose a *Smart Grid, Smart City* that better addresses the total societal benefits of smart grid technologies, through steps such as the following:

- Deploying a broader range of smart grid applications at commercial-scale
- Deploying at greater scale and to a broader cross-section of Australian customers and network typologies
- Employing a robust experimental design methodology that will yield more-credible extrapolation to rest of Australia

- Using technologies that are consistent with available standards (e.g. interoperable/ non-proprietary)
- Including trials to determine synergies with other utilities (i.e. water and gas metering) and the NBN
- Including trials of electric vehicles, customer-side and grid-side storage and integration of concentrated distributed energy.

2. Operational plan and risk management (25 per cent)

Guiding principle

Applications must demonstrate that their *Smart Grid, Smart City* proposal is built on a robust operational plan that prepares *Smart Grid, Smart City* to manage risks to project execution.

Materials in support

Applicants should be required to submit a detailed operational plan including deployment steps, costs, major milestones, key dependencies and overall timelines. Applicants must also submit detailed risk management plans.

Firm requirements

Applicants must provide a credible operational plan and cost breakdown, plans to manage each of the risks outlined in Section 4.4, and a plan to ensure continuity of supply by using robust security procedures including plans for handling a breach or discovery of weakness.

Flexible criteria

Preference should be given to grant applications that provide a compelling plan to manage project execution and risk by including elements such as the following:

- Robust operational plans with realistic and substantiated cost estimates and timelines
- Adequate buffer/contingency (time, money, resources) to manage unforeseen obstacles
- Contingency plans to manage risks, both those outlined in this report and others.

3. **Dissemination of Lessons (10 per cent)**

Guiding principle

Applicants must demonstrate how they will ensure that *Smart Grid, Smart City* lessons will be shared with industry stakeholders in an actionable way (including providing relevant information to inform industry business cases and increasing public awareness).

Materials in support

Applicants should be required to submit a detailed plan for dissemination of lessons including the specific information they intend to disseminate (e.g. gathered data, qualitative assessments, analytical results, processes/algorithms developed, etc.), how they will disseminate it (e.g. academic publications, interaction with industry peers, etc.), and the timing of the dissemination.

Firm requirements

Applicants must commit to make core lessons (i.e. lessons to inform a broader adoption) and the accompanying sanitised data freely available to the government as well as to all interested parties in Australia, fully licensing resulting intellectual property to the government (with limited exceptions) and hosting a database of the findings for a minimum of five years after the commencement of *Smart Grid, Smart City.*

Flexible criteria

Preference should be given to grant applications that offer a distinctive plan to ensure that lessons are made available to and are credible to relevant stakeholders, by including elements such as the following:

- Proactive engagement with key stakeholders including other distributors (e.g. through advisory panels or secondment of technical staff)
- Detailed specifications of the key lessons to be shared
- Plans for incorporating supplementary data from other trials or from the *Smart Grid, Smart City* site beyond the *Smart Grid, Smart City* lifetime.

4. Interaction with regulatory and standards modules (10%)

Guiding principle

Applicants should demonstrate that they will support, inform and ensure success of the regulatory and standards modules.

Materials in support

Applicants should be required to provide a statement outlining the resources committed to supporting these modules as well as their plans for interaction.

Firm requirements

Applications must include provisions for regular meetings with the teams leading the Regulatory and Standards modules and for making available to these teams all information and data that are necessary for their success. External advice (e.g. from the AER) may be sought by DEWHA in assessing this criterion.

Flexible requirements

Preference should be given to grant applications that demonstrate proactive support of these modules including dedicated resources, active sharing of data, active inclusion of peers, and pledges to adapt the *Smart Grid, Smart City* plan to ensure that the teams' questions are answered (e.g. testing of multiple standards).

5. Consortium structure and governance model (15 per cent)

Guiding principle

Applicants must prove that they have the capability and capacity to deliver on their proposed *Smart Grid, Smart City* plan as reliably and efficiently as possible.

Materials in support

Applicants should be required to provide detailed descriptions and supporting documentation outlining their proposed legal structure, sources and levels of funding for each application and major activity, consortium membership, and business cases for participation of major consortium members.

Firm requirements

The consortium structure should including the following:

- The lead contractor must be the licensed electricity distributor operating in the proposed deployment site(s)
- The consortium must also include at least one retailer operating within the proposed site(s), with the lead contractor ensuring equivalent offers are made to all retailers in the catchment.
- Applicants must articulate a clear and credible plan to provide the necessary funding (financial and in-kind), and the lead contractor must underwrite all execution, construction, and liability risks associated with delivery of the *Smart Grid, Smart City* project.

Flexible criteria

Preference should be given to grant applications that provide distinctive attributes of consortium structure and governance including:

- Experienced companies and corporate leadership with a proven history of strong R&D and deep familiarity with relevant technologies
- Highly-structured consortium that has a history of working together, has established clear decision rights, and includes plans to handle changes to consortium structure (e.g. insolvency of a member)
- Broad value-chain coverage within the consortium
- Strong interaction with peers from other geographies.

4.3 REVIEW OF GRANT APPLICATIONS BY EXPERTS

A number of experts should be consulted during the selection process by reviewing the relevant aspects of grant applications. Figure 27 lists parties with relevant expertise as well as the specific areas each would address.

Figure 27

EXPERTS WHO COULD PROVIDE INPUT DURING GRANT EVALUATION PROCESS

Proposal attributes	Potential experts	Areas of input
Applications, approach and benefits	CSIRO	Robustness of experimental design Implementation of selected technologies
	Academic community	Experimental design Approach to more-nascent technologies
	MCE AEMC AER	Compliance of proposed plan with existing regulation
	DRET	Proposed approach Impact on NEM
	AEMO	Impact on NEM
	Market research firms	Rigour proposed approach to customer segmentation/ selection and data interpretation
Regulatory and standards workstreams	AEMC	Robustness/sufficiency of plan to interact with regulatory workstream
	Standards Australia	Robustness/sufficiency of plan to interact with standards workstream
Consortium structure and governance model	Treasury/finance	Feasibility of business case and sufficiency of funding
	AER	Robustness of funding model (for regulated players)
	AGS	Robustness of consortium legal structure
	Investment bankers/ consultants	Robustness of business case
Dissemination of learnings	CSIRO Academic community	Efficacy of proposed dissemination plan
Operational plan and risk management	AG/DSD	Security of proposed Smart Grid systems
	AGS	Management liability risks
	Banking expert	Robustness of financial and operational plan
	Peers from domestic or overseas electric utilities	Robustness of operational plan

4.4 KEY RISKS AND MITIGATION STRATEGIES

Risk identification and mitigation will be a critical success factor for *Smart Grid, Smart City*. The table in Figure 28 describes a number of identified risks and outlines recommended strategies to mitigate them for the entire life of *Smart Grid, Smart City*. This reflects the belief that the most important risk mitigation strategy is robust program design and a well-designed and executed selection process. Nonetheless, ongoing risk management will also be critical to program success.

Figure 28 -

IDENTIFIED RISKS AND MITIGATION STRATEGIES

Risk	Description	Mitigation strategies
PROGRAM DURATION		
Customer engagement	• Customer uptake insufficient to conduct customer applications trials at scale	• Selection criteria include assessment of customer engagement strategy for consortia including privacy protections • Proactive public engagement strategy (advertising and education) to make case for nation-building program—benefits to customers, environment and Australian economy
Supply chain bottlenecks for *Smart Grid, Smart City*	• Energy industry players seeking to invest in smart grid applications after SGSC results but stalled by equipment supply shortages	• Increasing growth in demand likely to stimulate expansion in supply over course of SGSC • Early dissemination of lessons and involvement of non-consortium players in SGSC will stimulate discussions with suppliers to head-off bottlenecks

Risk	Description	Mitigation strategies
PROGRAM DURATION		
Some applications get sidelined	• Certain applications end up poorly resourced in execution given underlying concerns of benefits that conflict with current business models (e.g. energy conservation)	• Performance payment linked to applications that drive energy conservation. • Selection criteria to consider consortia that have champions for listed applications and benefits
Cost overruns, funding shortfall, or behind schedule	• Cost of SGSC balloons above initial budget threatening delivery on objectives • Consortium members do not honour financial commitments • Program runs behind schedule causing delay in delivery of findings and results	• Include in selection criteria assessment of feasibility of proposed budget for bid • Clear assignment of risk of cost overruns to lead contractor in funding agreement • Underwriting of co-funding by lead contractor covers problem consortium members pulling out before providing promised funds • Include in selection criteria assessment of feasibility of proposed timeline for project • Staged release of grant funds linked to project delivery milestones

Risk	Description	Mitigation strategies
PROGRAM DURATION		
Liability risk	• Rollout exposed to additional legal liabilities because of new activities being offered as part of electricity provision	• Clear assignment of legal liabilities related to the SGSC to the consortium under the funding agreement
Security risk	• Potential security threats (e.g. cyber security) related to communications system and information technology being linked to energy grid	• Requirement that bids outline how they intend to ensure security of SGSC

5 ROLE OF GOVERNMENT AND REGULATORY BODIES FOR BROADER SMART GRID ADOPTION IN AUSTRALIA

CONTENTS

SUMMARY

- The *Smart Grid, Smart City* regulatory module should feed its key learnings to the government through the MCE/AEMC. This should include clear recommendations on the future of Australian electricity market regulation and policy. A formal AEMC review of market frameworks should also be triggered at the designated review points if necessary. Consequently, *Smart Grid, Smart City* should signal regulatory changes required for a broader smart grid adoption in Australia.
- National and state regulatory bodies should be responsible for identifying the primary regulatory issues which could impede an Australia-wide smart grid adoption. The AER and AEMC should also develop amendments and new mechanisms to overcome any identified regulatory barriers on a national level. However, the national regulatory bodies should focus on regulatory issues within their current scope. State regulatory bodies should focus on amending technical regulation and retail pricing policy, if necessary.
- The Australian and state governments should interact with the regulatory bodies to help ensure the regulatory barriers are successfully overcome. Governments should provide guidance to these bodies. Furthermore, focus should be on encouraging the deployment of applications which provide the greatest net societal benefit. Finally, complete support for these changes must be provided by Australian and state governments to ensure successful response from industry.

5.1 IMPLICATIONS OF THE *SMART GRID, SMART CITY* REGULATORY MODULE

Regulatory issues may impede an Australia-wide smart grid deployment. Therefore, the findings of the regulatory module in *Smart Grid, Smart City* should guide future policy and regulation to ensure the maximum societal benefits are achieved. Any critical regulatory barriers to wide scale, industry-led deployment will be identified during *Smart Grid, Smart City*. Recommendations will then be made to the MCE outlining possible methods to overcome these issues.

If necessary, a formal AEMC review of market policy should further investigate the main barriers identified and propose solutions. This review should be within the current scope of the AEMC and be coordinated with the current regulatory working groups. The AEMC should consult the key stakeholders from industry and other regulatory bodies to develop solutions.

It is possible that smart grids will include wireless communications and consequently advice may be required from the Australian Communications and Media Authority (ACMA) concerning spectrum issues.

Therefore the *Smart Grid, Smart City* regulatory module may provide recommendations on new policy mechanisms or amendments being developed.

STATE REGULATORS

The national and state electricity regulatory bodies should have a leading role in both the investigation of regulatory barriers and development of solutions. A partial list of relevant activities is as follows:

- **Primary regulatory issues should be investigated** further by each of the respective regulatory bodies. The AER, AEMC, AEMO, ACMA and state regulators should mainly focus on investigating issues within their current scope.
- **Solutions should be developed** by the respective bodies in accordance with their present responsibilities. Multiple possible solutions should be outlined including amendments to existing policy and development of new policy.
- **Industry consultation** should be completed by the regulatory bodies. The purpose of consultation should be to assess their reaction to changes. Industry should also be consulted so they support the amendments.
- **Deployment of new policy mechanisms or amendments to existing** regulatory frameworks should then be executed by the regulatory bodies. This should be gradual to enable stakeholders to respond and adapt.

- **Constant monitoring** of the changes should be conducted to ensure maximum effectiveness. Further amendments should then be made if deemed necessary.

5.3 ROLE OF THE AUSTRALIAN AND STATE GOVERNMENTS

The Commonwealth and state governments should oversee the regulatory changes and guide the regulatory bodies to overcome the identified barriers. Emphasis should be placed on solving any regulatory barriers hampering the most societal value for Australia.

- **Guidance** should be provided by the government to focus the regulatory bodies on the issues which are most critical to societal value.

- **Working groups and reviews** should be initiated by the MCE to investigate these key barriers.

- **Sufficient resources** should also be allocated by the government. The personnel and funding needed to execute the changes which maximise societal benefit should be made available by governments.

- **Strong support** for the new or amended regulation should be provided by the government to signal industry to act on the changes.

APPENDIX A: GLOSSARY OF SMART GRID TERMINOLOGY

ABBREVIATIONS

ABARE	Australian Bureau of Agriculture, Resource and Economics
ABS	Australian Bureau of Statistics
AC	alternating current
ACCC	Australian Competition and Consumer Commission
ACT	Australian Capital Territory
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AMI	advanced metering infrastructure
ANTS	Annual National Transmission Statement
BPL	broadband over powerline
CAIDI	customer average interruption duration index
CBD	central business district
CCGT	combined cycle gas turbine
CO2	carbon dioxide
COAG	Council of Australian Governments
CPI	consumer price index
CPP	critical peak pricing
CPRS	carbon pollution reduction scheme
CPT	cumulative price threshold
CRA	Charles River Associates
CVR	conservation voltage reduction
DBCDE	The Department of Broadband, Communications and the Digital Economy
DC	direct current
DEWHA	The Department of the Environment, Water, Heritage and the Arts
DG	distributed generation
DRET	The Department of Resources, Energy and Tourism
ESC	Essential Services Commission (VIC)
ETS	emissions trading scheme
EV	electric vehicle
FERC	Federal Regulatory Energy Commission (USA)
FRG	full retail contestability
FDIR	fault detection, isolation and restoration

GHG	greenhouse gases
GJ	gigajoule
GSL	guaranteed service levels
GWh	gigawatt hour
HAN	home area network
IHD	in home display
IMO	Independent Market Operator (WA)
IVVC	integrated Volt VAR control
IPART	Independent Pricing and Regulatory Tribunal
kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
MCE	Ministerial Council on Energy
MW	megawatt
MWh	megawatt hour
NBN	National Broadband Network
NEL	National Electricity Law
NEM	National Electricity Market
NEMMCO	National Electricity Market Management Company
NER	National Electricity Rules
OCGT	open cycle gas turbine
PMU	phasor measurement unit
PV	photovoltaic
RET	renewable energy target
SAIDI	system average interruption duration index
SAIFI	system average interruption frequency index
SGSC	Smart Grid, Smart City
SMI	Smart Metering Infrastructure
SOO	Statement of Opportunities
TOU	time of use
TW	terawatt
TWh	terawatt hour
VENCorp	Victorian Energy Networks Corporation
VAR	volt ampere reactive
VoLL	value of lost load
WAM	wide area measurement

GLOSSARY

Term	Definition
AMI/SMI	Advanced metering infrastructure, includes the communications infrastructure and smart metering network
BPL	Broadband over powerlines which is an emerging technology that enables high bandwidth communications over the electricity grid
Critical peak pricing (CPP)	Market driven electricity pricing determined by the 10-15 hours of critical peak demand per year when the wholesale electricity price spikes
Customer applications	Packages of technologies or services for customers that enable demand side interaction
Customer empowerment	Empowering customers to be able to make active decisions about their energy consumption
CVR	Conservation voltage reduction lowers the power consumed by devices when voltage is reduced
DG	Distributed generation, usually smaller scale solar, co-generation etc embedded in the network close to end users
DG support	Automated protection and control systems to manage a high level of DG penetration
Direct financial benefits	Benefits which can be directly converted into financial savings
Distributed storage	Electricity storage technologies including lithium ion batteries which can be installed, for example, in households or small businesses
Environmental benefits	Benefits which contribute to carbon abatement and can be measured in kgCO2-e
EV support	Communications and control devices which support the charging/discharging of electric vehicles
FDIR	Technologies which automate and improve fault detection and response to network faults
Gentailer	A vertically integrated electricity company which owns both retail and generation businesses (e.g. AGL Energy, Origin Energy, TRUenergy, International Power)
Home area network (HAN)	A network which connects the electric devices in the household for automation or control purposes

Term	Definition
In-home-display (IHD)	A display in households which communicates some information regarding energy consumption
IVVC	Integrated Volt VAR control provides automated reactive support to correct power factor
NERA	National Economic Research Associates, Inc. - Consultancy firm who undertook cost-benefit analysis for national smart meter rollout
Pass through	A regulatory mechanism which “passes through” the entire cost of a device installed on the grid to the customer
Reliability benefits	Benefits which are attributed directly to reliability levels of electricity supply, i.e. SAIDI minutes
Safety benefits	Benefits from improving the safety of the electricity network
Smart appliances	Household appliances which can be controlled automatically and could respond to electricity prices
Smart grid	An electricity grid with instantaneous automation, control and bi-directional communications
Smart grid applications	Combinations of technologies which produce the benefits of a smart grid
Smart grid benefits	Societal benefits which occur from installing and operating smart grid applications
Smart meter	An interval electricity meter with remote control capabilities and bidirectional communications
Substation and feeder monitoring	Systems which automatically monitor the conditions of substation equipment and react accordingly
Tap changer	A component of most modern power transformers which allows the output voltage to be adjusted
Time-of-use (TOU) pricing	Pricing electricity differently depending on the time of day it is being consumed
VLAN	Virtual Local Area Network - is a group of hosts with a common set of requirements that communicate as if they were attached to a broadcast domain, regardless of their physical location
WAM	Wide Area Measurement - Phasor Measurement Units which provide a information on the power phase at different locations on the network

APPENDIX B:
SMART GRID TRIALS IN AUSTRALIA

Bold = completed/started trial
No bold = proposed trial

Smart Grid applications	NSW	QLD	SA	TAS	VIC	WA	ACT
AMI/Smart Meter	▪ Country Energy—communication tech trial ▪ **Energy Aus—AMI and tech trials**	▪ Energex—AMI business case ▪ **Integral Energy—tech trial**			▪ **Dept of Primary Industry—Technology trials** ▪ **Deployments 2009–12**	▪ Western Power—AMI feasibility	▪ **ActewAGL—multi-utility intelligent metering; Smart Meter**
Customer applications	▪ Energy Aus—in-home multi-utility ▪ **Integral Energy—Customer pricing** ▪ **Country Energy—Customer changes** ▪ **Solar Cities—IHD and Smart Meter**	▪ **Solar Cities—IHD and smart meter**	▪ Builder's Association—in-home automation ▪ **Solar Cities—IHD and smart meter**			▪ Western Power—cus. engagement and demand management	▪ **ActewAGL—IHD testing**
IVVC							
Distributed storage							
FDIR	▪ Country Energy—rate case automated						
Substation and feeder M&D							▪ **ActewAGL—substation and feeder monitoring**
EV enablement							
DG Enablement	▪ **Solar Cities**	▪ **Solar Cities**	▪ **Solar Cities**		▪ **Solar Cities**	▪ **Solar Cities**	
Wide area measurement							

SOURCE: National stakeholder steering committee: Pilots and Trials 2008 Status Report to the Ministerial Council on Energy

www.environment.gov.au

APPENDIX C: PILOT SUMMARY

Pilot	What is included?	Year	Duration Months	Size Customers	Critical peak % reduction	Daily peak % reduction	Overall load % reduction
MAISY study—analysis of 200 US utilities	Various communication and control technologies	2009	-	800,000	16–31	N/A	N/A
FERC—demand response potential	15 demand response programs	2009	-	375	5–26	N/A	N/A
Energy Australia—strategic pricing study	Critical peak pricing, smart meters, IHD, time of use tariffs	2008	30	750 res., 550 bus.	21–25	N/A	N/A
Integral Energy	Dynamic peak pricing, IHD, time of use tariffs	2008	24	900	30–40	N/A	3
Hydro Ottawa—Ontario smart pricing pilot	Critical peak pricing, time of use tariffs, smart meters	2007	12	375	6–25	2–12	5–7
Hydro One—time of use pilot	In home display, time varying rates	2007	12	234	2–6	N/A	7–8
Pacific Northwest—GridWise demonstration	Automated controls, smart appliances, real time pricing, distributed generation	2007	12	112	50	15	10
BC Hydro/ Newfoundland Power pilot	In home display	2007	24	200	N/A	N/A	3–18

Pilot	What is included?	Year	Duration Months	Size Customers	Critical peak % reduction	Daily peak % reduction	Overall load % reduction
SDG&E—IHD program	In home display	2007	12	300	N/A	N/A	13
Country Energy—customer response trial	Critical peak pricing, IHD, time of use tariffs	2006	18	150 homes	30	N/A	4% (Average), 8% (Median)
Hydro One—real time feedback pilot	In home display	2005	12	382	N/A	N/A	6.5
California—state-wide pricing pilot	Critical peak pricing, time of use tariffs, smart meters, IHD, automated systems	2004	12	2,500	14–50	18–34	5–12
Woodstock Hydro—pay as you go trial	In home display, prepaid billing	2004	12	2,500	N/A	N/A	15
Salt River Project—M-Power study	Prepaid electricity program, IHD, smart card	2004	12	2,600	N/A	N/A	11.1–13.8
Sarah Darby report—various feedback pilots	Direct feedback—Displays, smart meters, PCs, informative billing, audits, signals	2001	-	Up to 2,000	N/A	N/A	5-20

Note: Highlighted pilots are from Australia.

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Back cover (L-R) Solar heating panel (J. Knowles) Borders Rivers (A. Mostead) Capital Wind Farm (M. McAulay) Sustainable house in Lyneham (DEWHA) Hume Dam (T. Ierino)

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