ACCESS ECONOMICS
Pty Limited

The economic benefits of intelligent technologies

May 2009

Report by Access Economics Pty Limited for

IBM

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Executive Summary

This report reviews the potential economic benefits that may flow from the adoption of smart technologies and systems in different parts of the economy. Adoption is actively encouraged by the Australian Government, but as yet deployment is still in its infancy.

The amount of all forms of data that are regularly collected throughout the community rapidly expands on a daily basis. Intelligent systems have the capability of using these data to improve decision-making and co-ordination throughout society, thereby lifting economic efficiency and living standards.

The report considers five areas where intelligent technologies and systems may make a significant contribution. These are in electricity, irrigation, health, transport and broadband communications. The rollout of high speed broadband both enables the more effective implementation of smart technologies in other areas of the economy – including electricity, water, transport and health – as well as providing other direct and substantive benefits to individuals, businesses and the environment through the ability to deliver a range of commercial, government and information services more efficiently online.

The aim is to estimate the magnitude of the potential economic benefits that could be delivered through the widespread adoption of smart technologies and systems. The report does not identify specific policy actions that could foster this adoption although it does emphasise the importance of complementary microeconomic reforms in order for the technologies to realise their potential.

A considerable literature involving Australian and overseas studies of aspects of the economic benefits of the smart technologies has emerged in recent years. The findings from this literature have been used as a basis for estimating the economy-wide benefits of the adoption of smart technologies in each of the five areas identified. Access Economics' general equilibrium model of the Australian economy is used to analyse these economy-wide effects in a consistent fashion.

Given the difficulties involved in identifying and measuring many of the benefits that smart technologies are likely to deliver, a number of conservative assumptions have been adopted at various points of the analysis.

In each of the five areas, the benefits far outweigh the initial capital costs involved. The precise extent of the net economic benefits is dependent on the state of the economy that applies when the technology is rolled out. The closer the economy is to full employment, the more of the economic benefits will be reflected in higher productivity levels, while if the economy has spare resources, the benefits produce larger increases in employment. In addition, the total net benefits tend to be much larger in an economy that has spare capacity, as is currently the case in Australia where unemployment levels are rising.

Overall, the adoption of smart technologies and systems in the five areas identified are conservatively estimated to result in:

- an increase in the net present value (NPV) of Gross Domestic Product (GDP) of between $35 billion to $80 billion over the first ten years, with precise estimates depending on how much spare capacity is in the economy;
- in the case where the economy is operating at full employment, an increase of labour productivity of around 0.5% as the deployment of the technologies becomes widespread; and
- in the case where the economy is operating at less than full employment the impact on jobs is more pronounced as the technologies become widespread. In 2014 alone this results in more than 70,000 jobs being added to the economy.

The combination of higher productivity and employment levels represents an increase in standards of living.

The detailed results follow.

- An investment in smart grid technology in the order of $3.2 billion over seven years that results in lower electricity usage of around 4% would boost:
  - the NPV of GDP by between $7 and 16 billion over a ten year period; and
  - jobs by 17,600 in an economy operating at less than full employment.
- The adoption of smart systems through a $200 million investment in the irrigation areas of the Murray-Darling Basin that enables a 15% water saving would boost:
  - the NPV of GDP by between $420 and 670 million over a ten year period; and
  - jobs by 800 in an economy operating at less than full employment.
- The adoption of an integrated national electronic records system for health – which is only one aspect of how smart technologies could assist in the delivery of better health outcomes – through a $6.3 billion technology investment would boost:
  - the NPV of GDP by between $6 and 13 billion over a ten year period; and
  - jobs by 12,000 in an economy operating at less than full employment.
- The adoption of smart, integrated transport systems, accompanied by regulatory and governance reform, would boost:
  - the NPV of GDP by between $12 and 26 billion over a ten year period; and
  - jobs by 30,000 in an economy operating at less than full employment.
- As well as more effectively enabling smart technologies in other sectors of the economy, a $12.6 billion investment in the deployment of fibre-to-the-node broadband technologies throughout the community would conservatively boost:
  - the NPV of GDP by between $8 and 23 billion over a ten year period; and
  - jobs by 33,000 by 2011 in an economy operating at less than full employment.

While the focus of the report is on potential economic benefits that may be derived from these technologies, it notes an array of other benefits that may accrue including:

- reduced greenhouse emissions for the same amount of electricity consumption;
- better environment outcomes for Australia's inland river system;
- improved health outcomes for patients;
- improved convenience from smoother traffic flows in cities; and
- a richer range of commercial, government, educational and information services delivered more efficiently by high-speed broadband as well as additional workplace options for business and individuals.

To be effectively implemented, many of these technologies need the support of the government to co-ordinate decision-making throughout the economy. This arises because many of the smart systems need to be implemented through the relevant infrastructure for each area of the economy and left to its own devices, the private sector will find it difficult to make optimal investment decisions in such infrastructure.

For example, many individual procedures in irrigation areas have already adopted relevant sensor technologies, but to obtain the largest benefits from smart technologies, water flows throughout the irrigation system and not just on-farm flows need to be optimised. In the transport sector, the introduction of intelligent systems complemented by appropriate governance and regulatory changes would deliver significant benefits through the improved coordination of transport networks. Similarly, government involvement is needed in co-ordination of the rollout of e-health systems or comprehensive national broadband technologies.

Indeed, the promotion of smart systems, supported by a reinvigoration of the microeconomic reform agenda, provides the most promising path for Australia to lift its long term economic growth potential. A similar agenda involving a combination of technological advancement and microeconomic reform lifted economic performance in the mid-1980s and through the 1990s. There is a significant opportunity to once again lift Australia's long term growth rate and living standards using smart technologies.

Access Economics

1 Introduction

The introduction of new technologies combined with microeconomic reforms underpinned strong economic performance in Australia during, especially, the late 1980s and the 1990s. Over the past decade, this record has waned as epitomised by a marked slowing in productivity growth. The reinvigoration of microeconomic reforms and sustained efforts to modernise the Australian economy, including through the introduction of various 'intelligent technologies', are needed to restore Australia's long-term growth prospects.

The global financial crisis has naturally shifted attention from policies designed to address long-term needs to the immediate aim of containing the economic damage and minimising the loss of jobs. However, just as the International Monetary Fund (IMF) has emphasised in its latest forecasts for the global economy, any further stimulus that national governments will be called on to make to support their economies should be designed to also address longer-term economic needs[1]. The IMF emphasised spending on infrastructure but measures that foster the introduction of new, more efficient technologies also clearly have the potential to address the dual objectives of supporting employment over the next few years while lifting the growth potential of the economy.

Furthermore, intelligent technologies that could provide a boost to many areas of economic performance are already available and in production. Instead, the main challenges involve ensuring that the regulatory and policy environments are welcoming to the adoption of the intelligent technologies and promote their cost effective rollout.

This report evaluates the order of magnitudes of the economic benefits from the future adoption of intelligent technologies. It considers five areas of the economy which have the potential to profit from the introduction of intelligent systems over the next 5-10 years:

- electricity;
- transport;
- health;
- water in irrigation systems; and
- high speed broadband (HSBB).

The rollout of high speed broadband both enables the more effective implementation of smart technologies in other areas of the economy – including electricity, water, transport and health – as well as providing other direct and substantive benefits to individuals, businesses and the environment through the ability to deliver a range of commercial, government and information services more efficiently.

[1] In his comments at the Press Conference accompanying the release of the IMF's latest forecast, the IMF's Chief Economist, Olivier Blanchard, noted the importance of trying to use fiscal measures that address longer-term economic needs. He emphasised spending on all forms of infrastructure including on ICT. His argument applies with at least equal force to policies aimed at lifting long-term economic growth through promoting new technologies.

The estimated benefits presented in this report are conservative assessments of the full potential of the benefits that could flow from the adoption of intelligent systems. These systems can contribute to more efficient production throughout the economy and not just in the five areas selected here. Moreover, even within these five areas, not all potential benefits are readily identifiable and thus the estimates are likely to understate the full potential, especially in the longer-term. Even so, the estimates highlight that the net benefits are likely to be large and warrants active policy attention.

This report calculates the net economic benefits in two stages. Firstly, to gain a better idea of estimates of the direct costs and benefits of the technologies in each of the five areas, studies and examples from both Australia and overseas are reviewed. These then form the basis for inputs into a general equilibrium model of the economy which allows the net impacts to be ascertained in a consistent fashion.

The precise impact will be dependent on the state of the economy at the time of the investment. Two scenarios that will be examined in modelling are:

- an economy operating at near full employment; and
- an economy operating at less than full employment.

In the situation of an economy operating near full employment, the economic benefits of new technologies tend to be reflected in higher productivity growth, with existing resources being utilised more productively. There will be a modest boost to employment under this scenario, with the increased productivity translating into improved standards of living.

In an economy operating at less than full employment, as is rapidly becoming the case in the Australian economy today, the introduction of new technologies can act as an immediate stimulus to economic activity, and can help to lift levels of productivity in the longer-term. Consequently, the impacts on both the level of GDP and jobs will be greater than they would be if the economy were already operating near full employment.

Access Economics' in-house general equilibrium model, AE-GEM, will estimate the impacts of new technologies on key economic variables such as economic growth, investment and employment. Benefits will be quantified and presented in terms of Gross Domestic Product, Gross Domestic Product in net present value terms, and job creation. The employment impacts will mainly be examined in the context of an economy operating at less than full employment.

1.1 Nature of future microeconomic reform agendas in the context of intelligent technologies

As emphasised above, new technologies will have the greatest effect if introduced alongside appropriate regulatory changes. While there are a myriad of regulatory issues to be considered, two sets of issues stand out for future microeconomic reforms, namely:

- ensuring that producers and consumers face price signals that accurately reflect the costs of their actions. For example, price signals will be critical for the most to be made of intelligent systems in water, electricity and transport; and

- ensuring access to the relevant infrastructure for users on fair terms. For example, the greatest benefits to flow from the roll-out of broadband technologies will be derived from the effective use of the infrastructure by those providing applications and services of various forms rather than the efficiencies that the provider of the core communications services may achieve.

In its Treasury Consultation paper released late last year, Treasury identified the role of technology as an issue of consideration in the formation of Australia's future tax-transfer system. It was stated that emerging technologies have the potential to redefine the design and administration of the tax-transfer system, and can have strong implications for both operating and compliance costs.

In a recent speech, Treasury Secretary Ken Henry cited the explicit example of the introduction of smart technologies allowing price signals to be used to more efficiently charge for road use[2]. Economic benefits from this are expected to result in terms of improved traffic flows using, in particular, traffic diagnostic tools that enable improved flow in, effectively, real time.

Appropriate pricing can encourage the efficient use of these technologies. In addition, complementary policy action may also be required. For example, road pricing in Australian cities currently tends to be set in a very uncoordinated fashion across a range of owners of individual roads. The objective, however, should be to facilitate the smooth operation across road networks in each of our cities. Agencies responsible for the coordination of pricing – and with the ability to work with existing owners who are operating under tight terms and conditions – would be needed. Current contracts may complicate the exercise of pricing in terms of integrated networks, but paths to the optimal design of road pricing in a world using intelligent technologies are not difficult to conceive.

The report is structured as follows:

- Section 2 provides a brief overview of past productivity performance in Australia, emphasising the role of technology and microeconomic reform;
- Section 3 reviews evidence from Australian and overseas studies on the nature and magnitude of economic benefits that are possible from the adoption of smart technologies. Five areas of the economy are examined:
  - electricity;
  - water;
  - health;
  - transport; and
  - broadband;
- Section 4 incorporates this evidence into an analysis using Access Economics' general equilibrium model of the Australian economy to estimate the economy-wide potential of smart technologies; and
- a short conclusion rounds out the report.

[2] Henry, 2009.

2 Background – Australia's past productivity performance

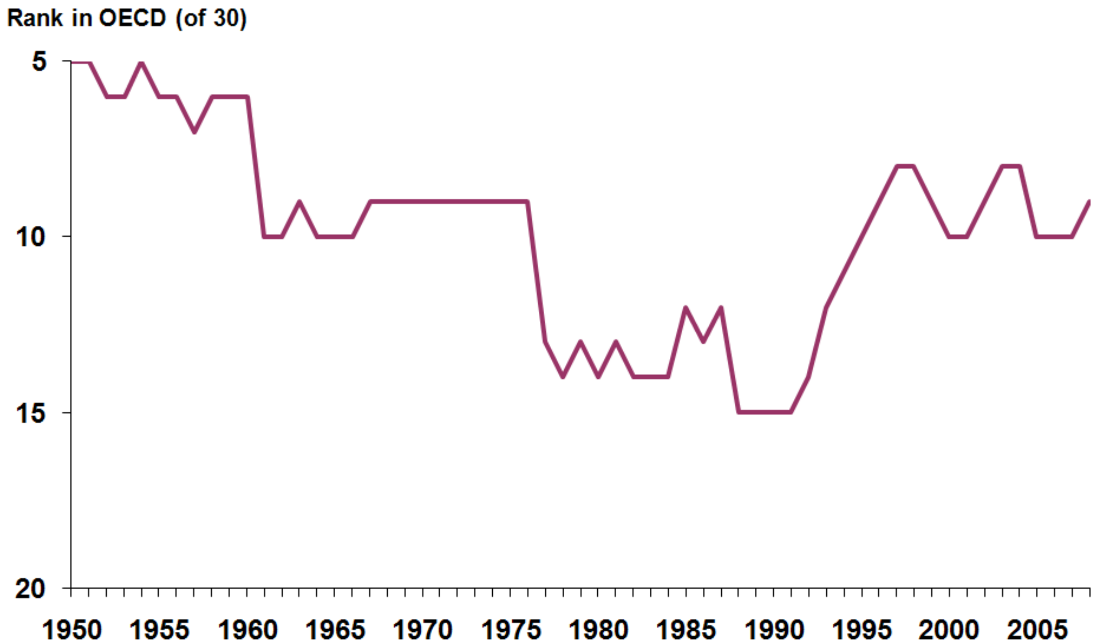
Over the second half of the twentieth century, there were three main phases to Australia's productivity performance:

- strong growth in productivity in the post-war period of reconstruction and expansion to the mid-1970s;
- a marked slowdown in productivity from the late 1970s to the early 1990s; and
- a strong surge in productivity from the early to late 1990s with record highs for both labour and multifactor productivity.

As the Productivity Commission concluded, a substantial factor behind Australia's slow productivity growth during the 1980s was the presence of structural weaknesses in the Australian economy at the time as a result of policies such as import protection and the centralised wages system. Australia 'penalized industries with the best growth prospects', 'fostered inefficiencies' and was 'ill-equipped' to respond to technological advance, globalisation and overseas competition[3].

The subsequent surge in Australian productivity growth in the 1990s was underpinned by the microeconomic reforms that began in the second half of the 1980s. These reforms laid the path for technological innovation, which further contributed to productivity growth. The acceleration in productivity growth over this period was more substantial in Australia than in other OECD economies resulting in a steady lift in Australians' living standards relative to others – see Chart 2.1.

Chart 2.1: Australia's living standards (GDP per head)



Source: www.ggdc.net

[3] Productivity Commission, 1999a, p21.

Two areas where microeconomic reforms were important in this period were electricity and transport. As the Productivity Commission (2006) has outlined, the electricity market underwent widespread reform over a period of around 20 years. These included reforms such as the structural separation of generation, transmission and distribution activities, privatisation and corporatisation of government-owned utilities and the removal of regulatory barriers to new market participants.

The Australian land transport sector was also subject to substantial microeconomic reforms, especially in areas of public transport and the reform of railway systems. Reforms in Australian railway services in 1991 were based on addressing a number of issues: government intervention, pricing, service quality problems, investment deficiencies, and monopoly and competitive neutrality concerns[4]. As a result of commercialisation and corporatisation reforms, rail operations in states underwent a transition from traditional process-oriented bureaucracy forms to commercial service businesses, exposed to competition.

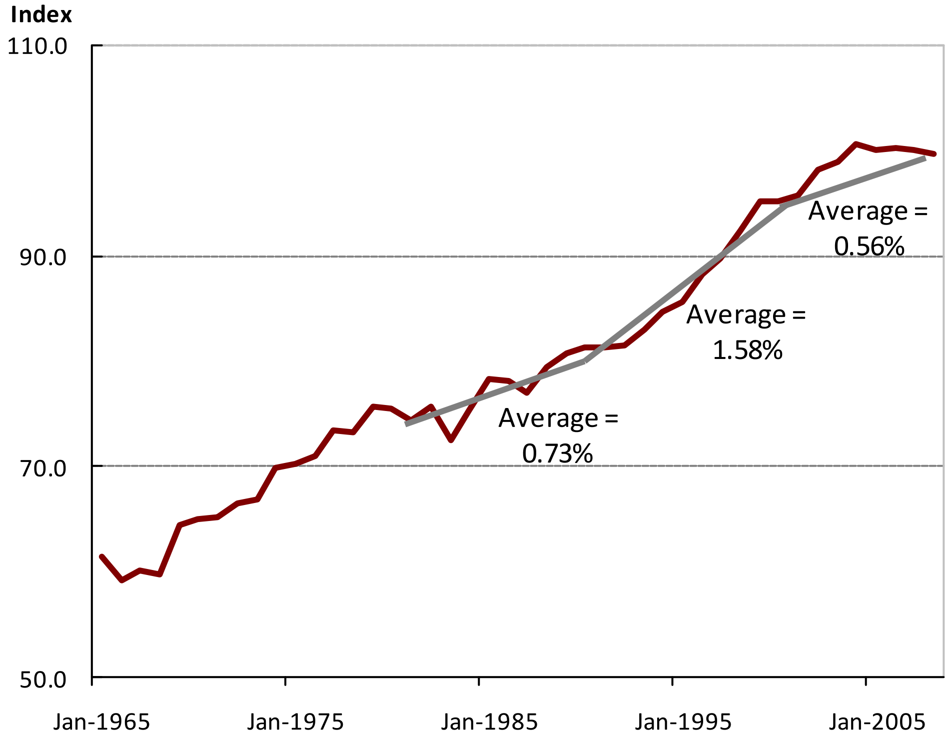
Such reforms also spurred the adoption of technologies, with NSW, for example, implementing a real-time train operating system for planning, programming, monitoring and stock control practices[5]. Investments in information and communication technologies in terms of new radio and satellite tracking systems were also undertaken.

As a result of various microeconomic reforms such as these, Australia's productivity figures showed strong growth over the 1990s – see Chart 2.2. More recently, however, productivity growth dipped during the past decade as the benefits from previous initiatives waned.

[4] Productivity Commission 1999b.

[5] Productivity Commission 1999a.

Chart 2.2: Multifactor productivity, Australia



Source: ABS 5204.0 - Australian System of National Accounts, 2007-08

The slowdown in productivity growth over the past decade emphasises the importance of developing a policy agenda aimed at again lifting Australia's long-term economic growth trends. The past successes indicate that an approach based on the adoption of new technologies complemented with microeconomic reforms provides the potential to achieve this and lift living standards.

3 Net economic benefits of intelligent technologies: sectoral level evidence

Intelligent systems allow considerable amounts of information to be used to improve decision-making, better coordinate networks and align production decisions with consumer demands. Microeconomic reforms that, for example, strengthen price signals can encourage the adoption of these technologies and ensure that the potential benefits are realised. Indeed, the benefits from the adoption of these technologies can far outweigh the initial capital costs and ongoing operational costs.

This section reviews estimated economic costs and benefits of the introduction of intelligent technologies in electricity, water, transport, broadband and health. Estimates and examples from Australian and overseas studies are included.

The estimates of the costs and benefits of the various technologies at the sectoral level as derived from the literature are then used as inputs into the economic modelling conducted in Section 4 using Access Economics' in-house general equilibrium model of the Australian economy. This allows the potential contribution of these smart technologies to the national economy to be assessed.

3.1 Smart grids in electricity networks

Australia's electricity sector has seen substantial reforms over the past two decades involving:

- the structural separation of generation, transmission and distribution activities; and
- either the privatisation or corporatisation of government owned electricity utilities.

These reforms yielded substantial improvements in productivity in the sector as has been highlighted in past research conducted by the Productivity Commission. In large part, these improvements are due to changes to industry structure and, in key parts of the sector, ownership changes have resulted in the existing capital stock being employed more intensively.

Future improvements in efficiency in electricity are likely to be obtained more through the adoption of advanced technologies rather than further changes in industry structure. Central to this will be the deployment of smart grids that will enable the better management and control of energy networks through real-time use of information throughout the grid. .

Smart grids entail the modernisation of electricity distribution networks through the introduction of information, communications and sensing networked technologies. Smart grids enable improved monitoring and control of the energy network as a supply chain, which means:

- reductions in energy losses;
- greater network operational efficiency;
- better quality and reliability of energy supply;
- greater customer control of their energy use;
- better management of highly distributed sources of energy generation (from greater solar and wind generation , for example); and

- reductions in greenhouse gas emissions .

Smart electricity meters are part of a smart grid environment and measure energy consumption by the consumer at short term intervals. They can allow two-way communication between energy providers and consumers so end users have greater control over their energy use. Smart electricity meters will enable:

- variable pricing so consumers can choose to use off-peak energy;
- energy companies to analyse customer energy usage and offer more customised energy services to meet user needs;
- customers to establish a 'smart home' so that appliances can be automatically turned on and off in response to needs and prices;
- customers to more actively manage their own micro power generation for using or selling back into the grid; and
- appliance manufacturers to innovate, creating new products that can interact directly with the energy grid in response to household energy usage preferences.

Summarising the early results of smart metering technologies from the experience in the United States and Europe, Energy Futures Australia (2007) concluded that:

> *Overseas studies suggest that a national rollout of advanced meters to all electricity consumers in Australia may achieve savings of between four and 10 percent in total national electricity use, with corresponding savings in GHG emissions.*

Advanced meters in this context includes the capability to implement time varying pricing schemes, seasonal price variation, remote switching of home appliances and price based demand response programs. These systems, when installed together, form the basis for the customer interface with a smart grid system.

The development and implementation of smart energy grids has been underway for some years in selected sites in Australia and overseas. This has provided the raw material for a number of interesting studies into the net benefits of the systems.

3.1.1 Studies of smart grid systems in the United States

A recent report quantified the net benefits of the implementation of thirteen key smart grid technologies for the San Diego region[6]. The range of benefits identified in this study included:

- reduced congestion costs;
- reduced probability of blackouts;
- lower forced outages;
- a reduction in demand at peak periods;
- better restoration times;
- job creation and GDP gains; and

[6] SAIC Smart Grid Team, 2006.

- reduced operations and maintenance costs due to the predictive analytics and self-healing nature of the system.

In all, the net costs and benefits of thirteen initiatives were estimated with the benefits calculated based on a 20-year horizon. Table 3.1 summarises the findings.

Table 3.1: Net benefits: San Diego Smart Grid Study

Benefits/Costs	Estimated Amount
System Benefits (20 years)	US$1433 million
Societal Benefits (20 years)	US$1396 million
Total Benefits	US$2892 million
Total Benefits per Year	US$141 million
Total Capital Cost	US$490 million

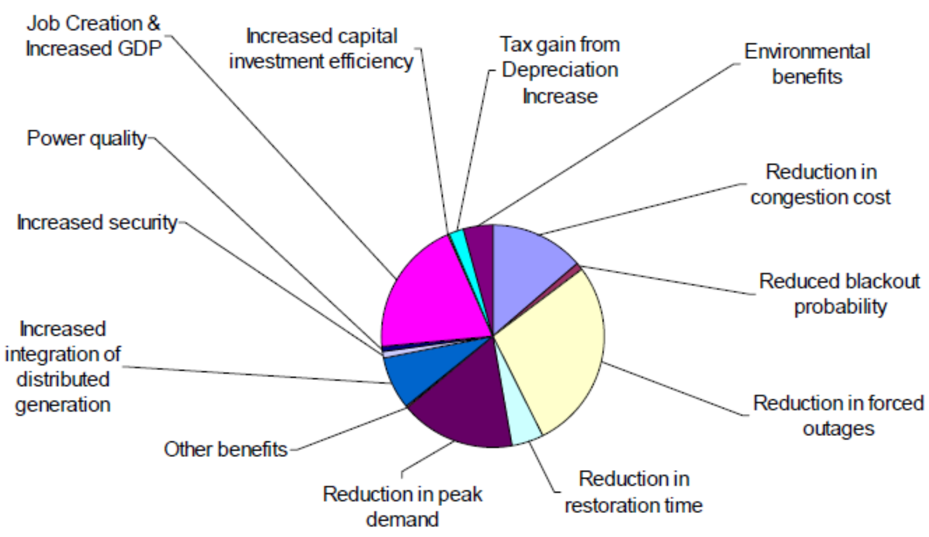
Source: SAIC Smart Grid Team, 2006

Some of the largest benefits were attributed to:

- reductions in forced outages (US$38.6 million in societal benefits annually);
- the direct improvement in GDP through job creation (US$28.3 million);
- a reduction in peak demand (US$25.6 million);
- increased integration of distributed generation resources resulting in higher capacity utilisation (US$14.7 million); and
- reductions in congestion costs (US$13.1).

The distribution of benefits is summarised in Chart 3.1.

Chart 3.1: Distribution of benefits: San Diego Smart Grid Study



Source: SAIC Smart Grid Team, 2006

A recent report by KEMA (2008) that used cost data from Duke Energy's filings of its Smart Grid system in Indiana found similarly large net benefits resulted from the technology.

3.1.2 Empirical studies in Australia

In April 2007, the Council of Australian Governments (COAG) committed to a national mandated rollout of electricity smart grids to areas where benefits outweigh costs[7]. As part of this initiative, the Ministerial Council on Energy (MCE) has undertaken work examining the likely benefits to be derived from this agenda.

Based on a detailed cost-benefits analysis conducted by NERA (2008), the MCE concluded that there would be sizeable economic and environment benefits to flow from the deployment of the technology:

- The net present value of these technologies was estimated to total between $4.8 billion and $7.5 billion over a 20-year period[8].

As with overseas studies, the majority of the benefits were estimated to relate to improvements in the distribution and retailing of electricity with more modest benefits derived from changes to consumer demands:

- approximately 33-37% of the benefits resulted from various improvements in efficiencies in distribution;
- a further 46-59% in efficiencies in electricity retail businesses; and
- 6-14% from demand responses.

The results from the MCE study form the basis of the inputs used in the economic modelling of smart grids in Section 4.2.

3.2 Water in irrigation systems

Australia's primary producers have a long history of adopting the latest technological advances in a continuing effort to maintain their place in a competitive international market place. This has been particularly important in the irrigation areas of the Murray-Darling Basin which face the dual challenges of limited water and problems of salinity. Improved irrigation systems involving more targeted use of water are part of the solution to both challenges. Sensors that are used to control the flow of water on-farm have been deployed on many properties for more than a decade.

More recently, intelligent systems have been developed that enable the water flows within an irrigation system to be coordinated much more effectively so that near 'on-demand water supply' becomes available. In the past, irrigators have tended to demand more water than necessary in order to ensure that, when it arrived some days later, there would be a sufficient supply. The water savings from being able to better coordinate flows, and match demand with the amount of water actually needed, can be substantial.

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[7] It should be noted here that the smart meter rollout incorporates those smart grid technologies required to facilitate time of day based pricing, more efficient allocation of resources, communications between the user and supplier, etc.

[8] MCE, 2008.

3.2.1 Evidence of potential savings in irrigation systems in the Murray-Darling

Irrigation accounts for 70% of Australia's freshwater usage. The willingness of individual producers to adopt new technologies and ideas has not always been matched in areas where collective decisions are required such as infrastructure. The coordination problems can hamper effective decision-making. This is the case in irrigation systems where the technology employed has not fundamentally changed in many years. It is based on gravity fed irrigation through open channels.

Mareels *et al* (2005) report on the benefits that accrue from the adoption of intelligent technology involving sensors at strategic points throughout the system, actuators and a communication network. Using this technology, the automation of irrigation systems can allow irrigation systems to provide near on-demand water supply which can increase distribution system efficiency in water. The result is a better matching of demand for water with needs as well as significant on-farm efficiency improvements.

Mareels *et al* report that overall water efficiency in irrigation, in terms of the ratio of volume of water used by crops and lifestock to the volume of water extracted from available freshwater resources, is estimated to be below 50%. It is stated that[9]:

> *In Australia, the losses are reportedly evenly split between the large scale distribution losses and on-farm losses. The latter are to a large extent due to poor timing of irrigation, a consequence of manual water scheduling on the supply canals. Furthermore, the on-farm losses if coupled with poor drainage lead to soil degradation (irrigation-drainage imbalance induced salination of soils).*

On-farm losses are reported to be largely due to poor irrigation timing from manual water scheduling systems on supply canals. As well as this, most distribution losses are reported to occur due to natural oversupply tendencies as a method of avoiding adverse yield effects. Oversupply in Australia can mean significant water losses, as water is no longer available for irrigation supply. The scope for water efficiency improvements from irrigation technologies is thus estimated to be significant.

Pilot projects in the Goulburn Valley in Victoria achieved an ability to meet water requests on-demand for more than 90% of total orders. The automated systems resulted in:

- savings in water usage per unit of output of an estimated 26%;
- a 38% increase in gross margins; and
- reduced peak demands on the delivery system.

The State Government of Victoria identified that advanced control technologies along these lines could save 400Mm^3 of water per year if implemented across all Victorian irrigation districts[10].

Whether the results achieved in the pilot studies would apply with equal force in other irrigation areas within the Murray-Darling remains to be tested. But even if a more

[9] Mareels *et al*, 2005, p2.

[10] See Mareels *et al* 2005.

conservative estimate of 15 – 20% improvement in water usage were achieved, the benefits would be substantial both in terms of the commercial returns and benefits to the environment:

- the water savings could be applied to provide existing irrigators with a more reliable supply of water or to develop new properties under irrigation which would raise the value of that land; while
- additional water could be used to increase the environmental flows through the river system. Also, as noted above, more targeted use of water that the automation would allow should help to lower water tables and reduce salinity problems within the irrigation areas.

3.3 Health

The health sector represents almost 10% of the national economy and that share is set to steadily grow over the coming decades as the population ages and health costs rise. Thus, any improvements in the productivity of delivering health services can yield substantial gains to the national economy. In addition, there will be potential benefits in terms of better health outcomes that are not captured by narrow measures of economic performance such as GDP.

One of the areas that the Productivity Commission emphasised in its examination of the health sector in 2005 was the potential that E-Health in its various dimensions offered[11]. More recently, Booz & Company in a report for DCITA has summarised a wide range of empirical evidence on this potential drawing on both Australian and international studies[12].

Among the dimensions within which improved use of information can assist the delivery of health services are:

- the use of electronic health records to assist the management and coordination of care throughout the nation;
- telemedicine; and
- the provision of personal health monitoring solutions which can, inter alia, facilitate better approaches for preventative care.

Table 3.2 presents a summary of the wide range of strategies to improve the provision of health services using better information and communications technologies.

[11] Productivity Commission, 2005a, 2005b.

[12] Booz & Company, 2008.

Table 3.2: Potential benefits from E-Health

National E-Health Strategy Summary

E-Health Solution Category	Priority Solutions	Description
Electronic Information Sharing	• Referrals • Event summaries including discharge summaries, specialist reports and notifications • Prescriptions • Test orders and test results • Care plans	Improving the capability of patient, clinical and practice management systems to support key electronic information flows between care providers. These key information flows provide a basis for improved care planning, coordination and decision making at the point of care.
	• Consumer demographics • Current health profile • Current medications list	The key datasets that provide the summary of a consumer's key health data and their current state of health, treatments and medications. These datasets will improve the quality of service delivery and will ensure that consumers do not have to remember or repeat this information as they navigate the health system.
Service Delivery Tools	• Decision support for medication management • Decision support for test ordering	Encouraging the development of specific tools that improve the quality of clinical decision making and can reduce adverse events and duplicated treatment activities.
	• Chronic disease management solutions. • Telehealth and electronic consultation support	Encouraging development of specific tools that improve the management of chronic disease and the accessibility of care delivery. Chronic disease management solutions enable timely identification and monitoring of individuals and support management of their condition by providing automated reminders and follow-ups. Telehealth and electronic consultation tools enable improved rural, remote and disadvantaged community access to health care services.
Information Sources	• Health care reporting and research datasets • Health information knowledge bases	Implementing improved datasets for health care management that provide access to longitudinal and aggregated information for analysis, reporting, research and decision making. Providing access to a set of nationally coordinated and validated health knowledge sources for consumers and care providers.
	• Individual electronic health records (IEHRs)	Implementing IEHRs that provide consumers with access to their own consolidated health information and provide care providers with a means to improve the coordination of care between multi-disciplinary teams. IEHRs can also support the collection and reporting of aggregated health information.

Source: National E-Health Strategy Summary, Australian Health Ministers Conference, 2008.

The National E-Health Transition Authority (NEHTA) was established by the Commonwealth and State and Territory Governments in 2005 to accelerate E-Health implementation in Australia including the development of better methods of electronic collection and secure exchange of health information. The Booz & Company report argued that Australia lags other developed countries in the national implementation of E-Health applications although it goes on to document a series of initiatives being implemented in different jurisdictions.

Given the range of possible applications of E-Health, each involving different upfront capital costs and potential economic and health benefits, it is difficult to derive a precise estimate of likely net benefits of any particular agenda. However, the studies that have been conducted uniformly conclude that the net benefits are sizeable. Indeed, many of the costs associated with the implementation of these technologies related to regulatory and administrative hurdles rather than the costs of the technology itself.

Against this background, the following briefly summarises some of the evidence that has been considered in deriving the inputs into the economic modelling presented in Section 4.

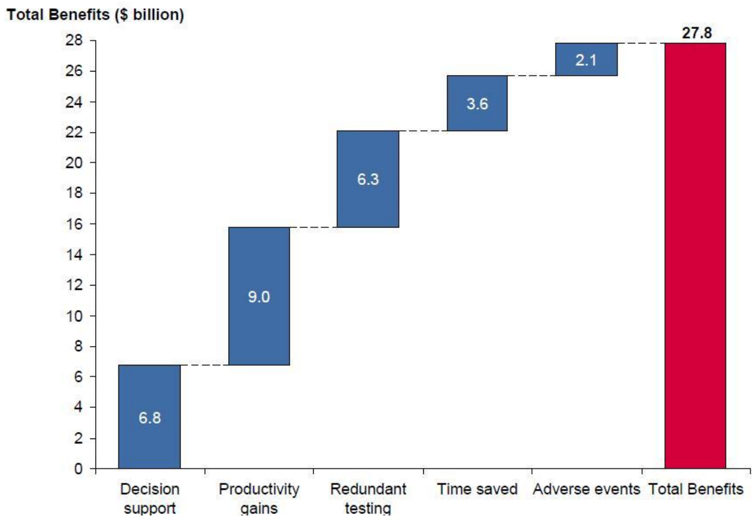
3.3.1 Australian estimates – electronic health records

The quantification of the potential benefits from E-Health initiatives in Australia has focused on electronic health record (EHR) systems. Cost savings would result from reduced fragmentation and duplication in the delivery of health care through the facilitation of exchange and access to quality information for healthcare providers and consumers.

Booz & Company (2008) summarise the results of two studies that were commissioned by the NEHTA into a National Shared Individual E-Health Record program. An analysis conducted by the Allens Consulting Group concluded that net economic benefits of between $7.5 and $8.7 billion would result for the first ten years due to benefits from increased productivity and reduced adverse effects. The study also estimated that real output in the hospital and medical services would be increased by between 4.8% and 6% over this period.

The other analysis conducted by KPMG found that the net benefits could reach between $5.6 billion and $20.8 billion over ten years depending on whether the implementation was conducted through a series of independent State-based initiatives or through a coordinated national approach. The KPMG study provided estimates of the various main contributors to the gross benefits from such an initiative which were estimated to sum to $27.8 billion over ten years – see Chart 3.2.

Chart 3.2: Gross benefits of a national HER for the first 10 years



Source: KPMG as reported in Booz & Company, 2008

3.3.2 International estimates

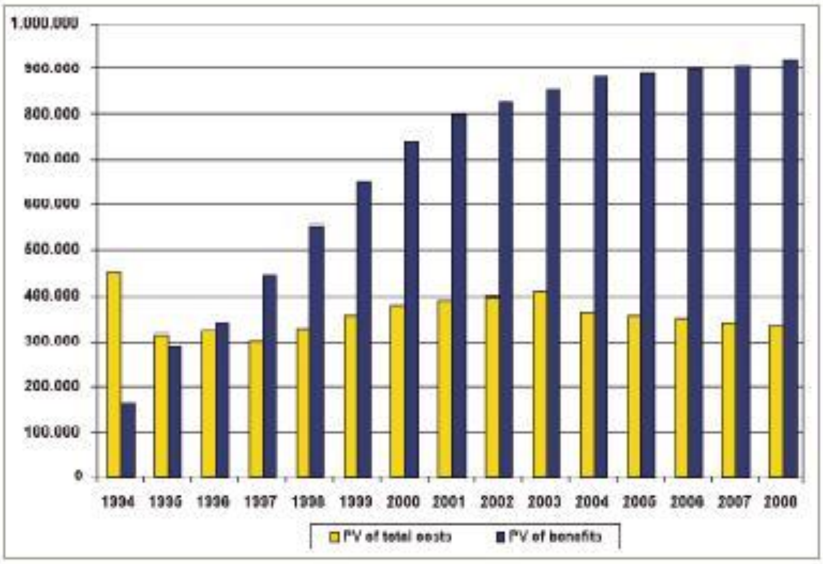
A recent study commissioned by the European Commission (2006) evaluated and attempted to quantify the economic benefits of E-Health solutions for ten European case studies. This study examined benefits in terms of the impact of E-Health on citizens, health providers, third party payers and other parties. Benefits were defined as improvements in quality, access or cost-effectiveness. All ten cases that were analysed showed a positive economic impact, measured as a net benefit at present values.

One of the case studies examined was the Danish Medcom Network, a data health network extending across all healthcare provider associations in Denmark. The European Commission study estimated that the network generated net benefits would exceed €75 million annually by

2008. Total annual costs were estimated to be approximately €50 million. Around 95% of the direct gains were estimated to be to care providers.

The following graph presents the study's economic benefit and cost profile generated for this e-health application. As can be seen, the profile shows that present value annual costs exceeded benefits for the first two years. Net benefits appeared around year three of the period and continued to grow, with annual costs remaining roughly stable.

Chart 3.3: Present values of estimated annual costs and benefits for Medcom (in € 000s)



Source: eHealth Impact Study, European Commission, 2006

3.4 Transport

The past productivity successes of transport over the late 1980s to 1990s were based on technological advances overlaid with responses to increasing regulatory and competitive pressures. Future productivity potential lies in the ability to successfully implement intelligent technologies across the transport sector in areas such as freeway management, arterial management and traveller information systems. Intelligent Transportation Systems (ITS) technologies encompass a range of wireless and wire line communications based information technologies that can be integrated into transportation system infrastructure.

ITS technologies have the potential to address a range of transport issues and can help in improving safety, improving efficiency, improving competitiveness and reducing environmental impacts of transport. In particular, technologies such as diagnostic traffic tools can help to improve the efficiency of traffic flows and save time and money.

Australian road authorities and transport agencies have implemented various intelligent transport initiatives in the past, such as those aimed at improving freight and passenger information systems, regulation and compliance management, and toll road pricing and collection systems[13]. However, Australia currently has no national implementation agenda for ITS projects or technologies.

A particular issue for Australia is that of rising and significant costs of congestion. Lower end estimates of urban congestion costs are over $5 billion annually in travel time and operating costs, with 75% of these costs occurring in Sydney and Melbourne[14]. In fact, recent estimates of 1995 costs for Australia's main cities have been over $12.5 billion[15].

In order to derive the greatest benefits from ITS, the regulatory and policy regimes need to encourage their effective use. Although pricing needs to be used to provide appropriate incentives, the interface across transport modes also needs to be as seamless as possible. (An example where this is important in the case of public transport is in ticketing and timetables across different modes.) This can be achieved through regulatory and operational reform of the transport sector which can underpin improved coordination of transport systems through technology.

3.4.1 Australian estimates for ITS

Ten years ago, a study on the benefits of Intelligent Transportation Systems for Australia was conducted by Booz Allen & Hamilton (1998). This study estimated that Australia's social, consumer and commercial gains from the effective use of ITS would total at least $14.5 billion in net present value terms to 2012. This is consistent with reducing the total costs of road accidents, congestion and vehicle emissions for 2012 by at least 12%, as compared to a reference scenario of no ITS implementation[16].

The composition of these estimated benefits is displayed below. As can be seen, the study estimated that the largest benefits would accrue from improving traffic flows leading to savings in travel time. It is noted that the environmental benefits figure is underestimated due to the exclusion of global warming contributions from motor vehicles. It is likely that current benefits and benefits in the near future from ITS can be assumed to be greater than those estimated in this study.

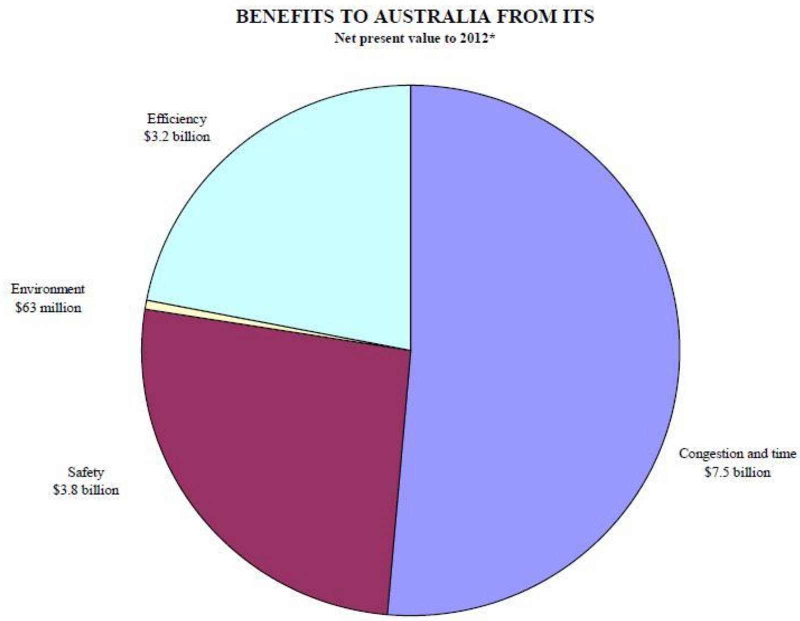
[13] Intelligent Transport Systems, 2008.

[14] Charles, 2002.

[15] Charles, 2002.

[16] Austroads, 1999.

Chart 3.4: Estimated benefits from ITS



Source: Austroads (1999), "National Strategy for Intelligent Transport Systems", estimates from Booz Allen & Hamilton Report (1998)

ITS technologies are estimated to make a difference to greenhouse gas emissions from improved traffic flows and vehicle management, and consequently reduced fuel consumption. It has been estimated that ITS technologies could produce fuel savings of 2% to 13% and lead to a reduction of emissions between 5% and 15%[17].

3.4.2 International estimates

Comparisons between Australian and overseas estimates are complicated by the fact that Australian research is generally based on more conservative assumptions[18]. Some international examples of the estimated benefits and costs of ITS technologies are presented below.

- The US Research and Innovative Technology Administration reports that metropolitan areas in the US that deploy ITS infrastructure such as dynamic message signs (DMS) to manage traffic and integrate traveller information with incident management systems were allowed to increase peak freeway speeds by 8 to 13%, improve travel times and improve trip time reliability with delay reductions ranging from 1 to 22%[19]. Also, ramp control systems in the US can potentially improve mainline traffic speeds by 13 to 26% and reduce crashes by 15 to 50% according to available data.
- Japanese estimates indicated that investments in relevant ITS can cut road tolls by 20% and reduce expressway congestion by 70%[20].

[17] Intelligent Transport Systems, 2008.

[18] Austroads, 1999.

[19] US RITA 2008.

[20] Austroads, 1999.

- The Houston TranStar transportation operations and emergency management operations system includes a number of ITS components such as a freeway management system and an arterial street incident management program. A 1997 study by the Texas Transportation Institute (reported by the US RITA, 1997) estimated that total annual estimated delay savings from this system were 572,095 vehicle hours, with an estimated economic value of US$8.4 million.

3.5 Broadband

The rapid development of information and communications technologies (ICTs) has been a major contributor to higher productivity in all major economies over the past two decades[21]. The latest and maybe most far-reaching manifestation of the wave of new ICTs is high speed broadband (HSBB). HSBB will deliver data at much faster speeds than the internet services that are currently available across much of Australia and on a consistent and reliable basis. This will open up new ways of communicating and delivering services whether by business, individuals or government. It will also allow the data that are used in smart systems and related technologies to be more effectively rolled out or managed.

The Australian Government is committed to the deployment of broadband technologies throughout the country. In early April, it announced that it would commit $43 billion to the rollout of a fibre-to-the-home based infrastructure that would cover over 90% of the population. The remainder of the population would be covered using a variety of other technologies.

As outlined by Senator Conroy, the adoption of broadband technology throughout the community will deliver widespread benefits that *inter alia*, will contribute to:

  - improving education;
  - reducing greenhouse gas emissions;
  - delivering better health outcomes;
  - regional development; and
  - supporting small and medium-sized businesses enter new markets and expand.

From an analytical perspective, the rollout of broadband would have a range of economic impacts involving[22]:

- the costs of constructing expanded HSBB networks;
- improvements in firm-level multifactor productivity (MFP), that is, in the productive capacity of labour and capital employed by firms, including through the better organisation of these resources;
- the introduction of an array of new services associated with HSBB;

[21] See Productivity Commission (2004) for a summary of the evidence for Australia.

[22] See Access Economics (2009) for more details.

- 'network' benefits whereby individuals and businesses are able to more effectively communicate and deliver services remotely with the widespread adoption of HSBB technologies; and
- improved convenience and choice for consumers who will be able to undertake various tasks (such as utilising shopping, banking, information and government services) over the network.

Indeed, HSBB can facilitate the implementation of some of the smart technologies that are referred to in the earlier discussion, especially in electricity and in E-Health.

There are insufficient data to accurately quantify the full economic benefits of HSBB at this time, but the qualitative evidence consistently points to large gains. The difficulty in determining precise quantitative evidence at this point reflects the newness of the deployment of HSBB anywhere in the world as well as the fact that the full extent of the benefits will only be felt over time as users take advantage of the technology, as well as develop new applications and services to maximise the opportunities that the platform presents[23].

While recognising these qualifications, Access Economics (2009) develops estimates for the net economic benefits under a series of rollout scenarios. This analysis is based on scenarios involving fibre-to-the-node (FTTN) rather than the Government's recently announced plan to have fibre-to-the-home (FTTH). At this point, Access Economics has insufficient data to assess how large the net economic benefits from the Government's plans to roll out FTTH will be. However it notes that:

- the various scenarios for FTTN would involve upfront capital costs (of $10–20 billion) compared with the Government's estimate of $43 billion for FTTH; while
- FTTH is designed to ensure that speeds of 100Mbps can be reliably delivered whereas the FTTN solutions were aimed at speeds of a minimum of 12Mbps, thereby ensuring a higher level of services and capacity.

That is, the development of a FTTH network would involve both higher costs and greater benefits than the FTTN network. Indeed, many of the potential applications and services that may be delivered though HSBB cannot be reliably anticipated in advance and the greater the speeds that can be reliably achieved, the more such services will emerge.

Given the uncertainties involved, rather than attempt to quantify the net economic benefits that an FTTH solution may deliver, the simulation results presented in Section 4.6 are based on the earlier results developed by Access Economics (2009) for the FTTN world.

Even for an FTTN network, however, not all of the economic benefits are amenable to quantifications. Indeed, of the five aspects of possible economic impacts outlined above, only estimates for the first two – the upfront capital costs and the direct productivity benefits – are provided. Accordingly, the estimates of net economic benefits should be viewed as conservative approximations of the potential of HSBB.

[23] Similarly, it took many years before the benefits of other ICTs were able to be ascertained empirically.

4 Estimating the economic impact of smart technologies

This section presents the results of a series of simulations that examine the potential economy-wide impact of the deployment of intelligent technologies and systems in the five areas of the economy outlined in Section 3. Access Economics' in-house general equilibrium model of the economy is used to ensure that both the direct and indirect impacts of the implementation of these technologies are captured in a consistent manner.

The section begins with a brief outline of the approach adopted for each scenario. The results for the five sectors are then presented separately followed by a brief discussion of the overall results.

4.1 The modelling approach

For each of the five scenarios, the aim is to simulate the impact of:

- the initial capital outlay; and
- the ongoing direct impacts on productivity in the relevant sector(s);

on demand and production throughout the economy. Estimates for both sets of inputs have been constructed using evidence from the literature as summarised in Section 3.

Given the paucity of empirical evidence for many of the specific investments under consideration, it has been necessary to use judgement and make simplifying assumptions at various points. Overall, the assumptions adopted are deliberately conservative, reflecting:

- the newness of the adoption of the technologies, meaning precise estimates of the potential benefits are not possible and some caution in predicting the benefits may be prudent;
- the fact that many of the potential benefits from the technologies will have small but widespread effects throughout society; and
- the observation that, even with conservative assumptions, the potential benefits are sizeable.

Three aspects of the design of the simulations warrant attention. Firstly, much of the equipment to be deployed is manufactured overseas. This is incorporated in the general equilibrium model.

Equally, however, there is a strong domestic component to the installation and rollout of intelligent technologies, and in the ongoing benefits that will result. Indeed, as shown below, the results tend to emphasise the dominance of the domestic elements leading to sizeable improvement in output and employment.

Secondly, the precise economic impact will be influenced by the state of the economy that prevails at the time of the deployment of the technology. The benefits will be less if the economy is operating near full employment and the investments need to compete with alternative uses of those resources, than if there are spare resources as is the case today with unemployment on the rise.

Accordingly, each of the sets of simulations consider two scenarios, namely:

- an economy operating near full employment; and
- an economy operating at less than full employment.

Under each scenario, the deployment of the new technologies will boost economic growth, productivity and, in turn, standards of living. The extent of the increases will be larger in the second scenario where underutilised resources can be employed.

The impact on jobs will tend to be modest in the scenarios where the economy is already operating near full employment simply because jobs can only be increased by lifting real wages and inducing new workers into the labour force. In contrast, when the economy is operating at less than full employment – as is the case in Australia in 2009 – the stimulus created by the investment in the new technologies can take advantage of the unemployed resources and boost jobs. Accordingly, the results presented below for the impact of the introduction of the smart technologies only consider the case of a less than fully employed economy.

Finally, many of the benefits to accrue from the technologies will only do so some time after the initial investment. This is especially the case where benefits are derived from there being a network of users.

In view of this, the results are presented for the net present value (NPV) of the impact on GDP over a ten year period as well as annual impacts. The calculation of NPVs will be affected by the choice of discount rate. In turn, this choice will vary according to who is making the investment. Public investments may be considered using a lower 'social discount' rate than for purely commercial decisions in the private sector where the risks involved will demand a higher price.

In what follows, net present values will be calculated using both an estimated commercial discount rate of 7% and an estimated social discount rate of 3%. Both these discount rates are expressed in real terms after adjusting for inflation.

4.2 Electricity

Smart grid technologies provide the potential to significantly improve efficiency in the electricity sector through better monitoring and control of the energy network as a supply chain through to end users, so less electricity needs to be generated to meet a given level of demand.

As noted in Section 3.1, there is growing evidence that the deployment of smart grids can yield sizeable economic and environmental benefits. The following analysis concentrates on the economic benefits.

Note, however, that a reduction in electricity generation will lower greenhouse gas (GHG) emissions thereby reducing the economic costs of meeting a given GHG target. These economic benefits have not been incorporated into the results presented here.

As foreshadowed above, the economic modelling involves two sets of inputs. Firstly, research undertaken for the Ministerial Council on Energy shows a capital investment in the order of $2.8 billion to $4.6 billion is needed to rollout smart meters and associated infrastructure across Australia. Much of the cost information is not publicly available, making it difficult to accurately estimate the costs associated with a particular type of rollout. For simplicity, the modelling is based on capital expenditure totalling $3.2 billion.

The timing of the capital spending is spread across seven years with relatively small spending in the early years, larger spending occurring during the medium term and lower spending nearing the end of the rollout phase.

This intertemporal variation in spending is due to the way in which the rollout occurs. In broad terms, the cost of deploying a smart grid can be broken into two components, smart meters and the 'back end' infrastructure required to interrogate them. The smart meter component of the rollout is relatively stable over time as the number of meters installed in any given period is fairly constant. The back end component of the build differs from this in that there are sizeable costs associated with its installation that are front loaded. These costs largely occur in the early years of the build and taper off towards the end, creating a hump in the mid years of the project. Table 4.1 shows the expenditure over time as assumed in the model.

Table 4.1: Capital expenditure on smart grids over time

Year	Expenditure ($m)
2009	123
2010	403
2011	611
2012	767
2013	637
2014	455
2015	208
Total	3204

Secondly, the direct impact on productivity of electricity usage has been based on an assessment of the experience found in studies in the literature. As noted in Section 3.1, overseas and Australian studies have found that smart grids may lower electricity needs (or raise energy productivity) by between 4% and 10%. The modelling presented here adopts the conservative assumption of an improvement of 4%.

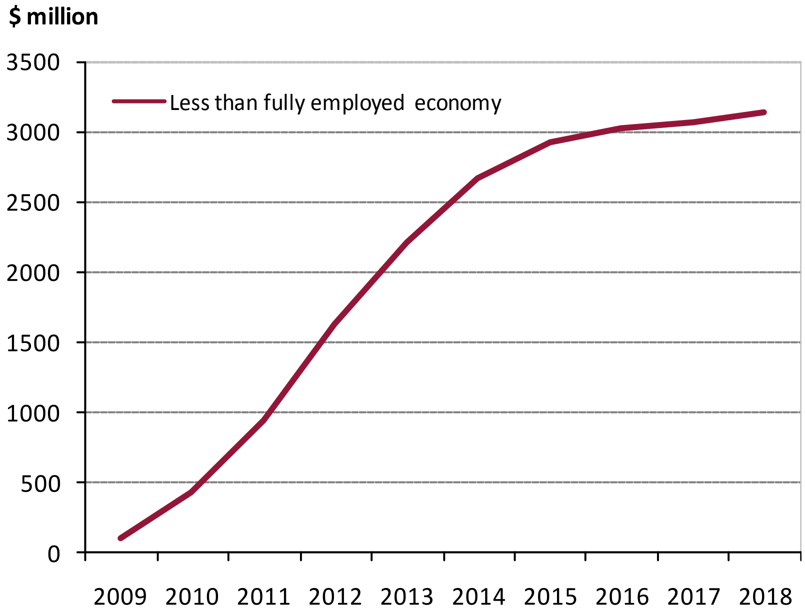
Also, the modelling here assumes the reduction in electricity generation is achieved with a one year delay based on the profile for capital expenditure. Table 4.2 shows this profile of productivity gains.

Table 4.2: Productivity gains for smart grids over time

Year	Productivity gain (%)
2010	0.15
2011	0.50
2012	0.76
2013	0.96
2014	0.80
2015	0.57
2016	0.26
Total	4.00

Chart 4.1 shows GDP will be boosted by between about $1.6 billion and $3.0 billion as the technology is fully implemented with the precise amount dependent on the prevailing state of the labour market. The impact is larger under conditions where there is unemployment as resources are more readily available to both roll out the technology and take advantage of the increased demand that flows from the higher standards of living that the lift in productivity generates.

Chart 4.1: Impact on GDP of the use of smart technologies in electricity



Source: Access Economics

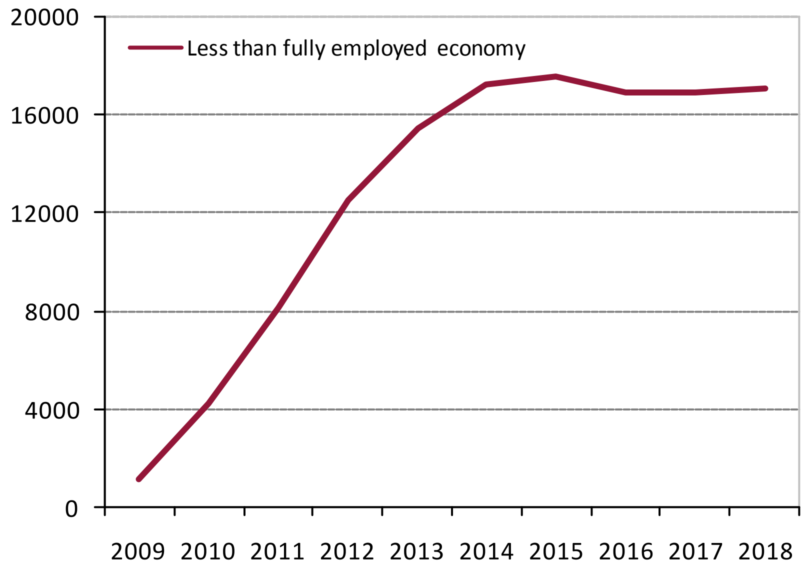
Table 4.3 shows the net present value of gains to GDP using discount rates of 3% and 7%. It shows that the NPV is of the order of $7.1 to 9.2 billion if the economy were operating at full employment and between $12.7 and 16.4 billion if there were unemployed resources that could be utilised.

Table 4.3: NPV of GDP for smart technologies in electricity 2009 – 2018 ($bn)

	Discount rates	
Labour market assumption	**7 per cent**	**3 per cent**
Near full employment	7.1	9.2
Less than full employment	12.7	16.4

There would also be an increase in employment due to the rollout of the technology. In an economy where there are unemployed resources, the early years of the rollout would result in the creation of 1160 jobs, with almost 17,600 jobs created at the peak in 2015 (see Chart 4.2).

Chart 4.2: Impact on employment of the use of smart technologies in electricity



Source: Access Economics

4.3 Water in irrigation areas

The research discussed in Section 3.2 outlined the potential benefits from introducing intelligent technologies in all irrigation areas. The research is based on research for the Goulburn Valley in Victoria but is also likely to be relevant for the remainder of the Murray Darling Basin (MDB).

It is unclear whether other regions such as the Ord in Western Australia and higher rainfall areas throughout Queensland would benefit in a similar way and thus the analysis here focuses on the MDB and omits these other regions. Note that the MBD accounts for about three-quarters of the nation's irrigation lands.

The scale of the investment needed is not known but, based on very partial information, a total investment of $200 million was assumed sufficient to cover all irrigation areas within the MDB. The expenditure was assumed to be spread evenly across five years.

This spending was further broken down according to the share of the MDB that falls into each state (see Table 4.4).

Table 4.4: Share of MDB in each state

State	Share of MDB (%)
New South Wales	57
Victoria	12
Queensland	25
South Australia	6

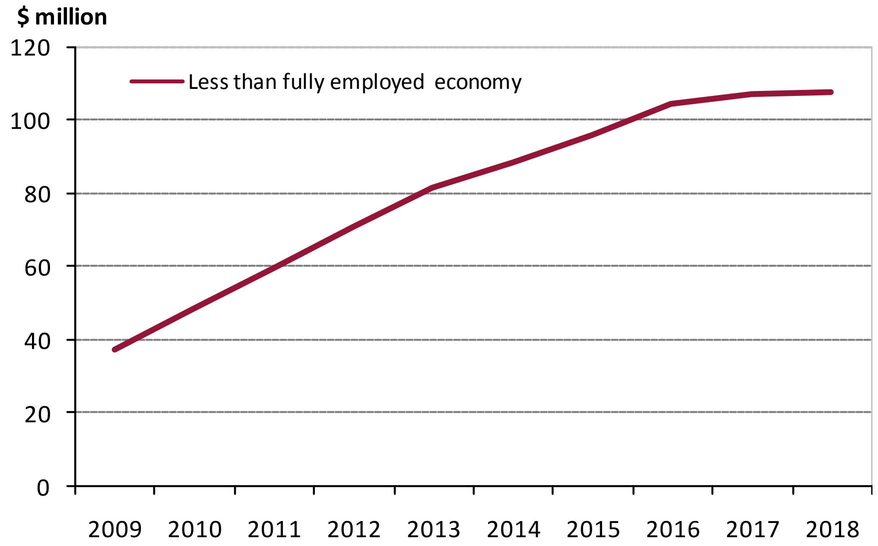
Source: http://www.mdbc.gov.au/about/basin_statistics

The evidence presented in Section 3.2 indicates that automated systems applied in the Goulburn Valley region could generate water savings per hectare of around 20%. In the modelling, a conservative estimate of 15% water savings has been adopted.

The resultant productivity improvements are assumed to become effective in the same year as the investment, as the individual water projects tend to be smaller and more immediate in nature. Given the even time profile of expenditure the productivity gains are also applied evenly over time. This gives an effective gain of 3% per annum over five years.

Chart 4.3 shows the impacts of smart technology in irrigation on GDP over time where there is unemployment. The net increases in GDP where there are unemployed resources are significant, rising to $108 million by 2018.

Chart 4.3: Impact on GDP of the use of smart technologies in irrigation systems



Source: Access Economics

Table 4.5 shows the net present value of these gains to GDP using discount rates of 3% and 7%. It shows that the NPV is of the order of $500 million if the economy were operating at full employment and around $600 million if there were unemployed resources that could be tapped.

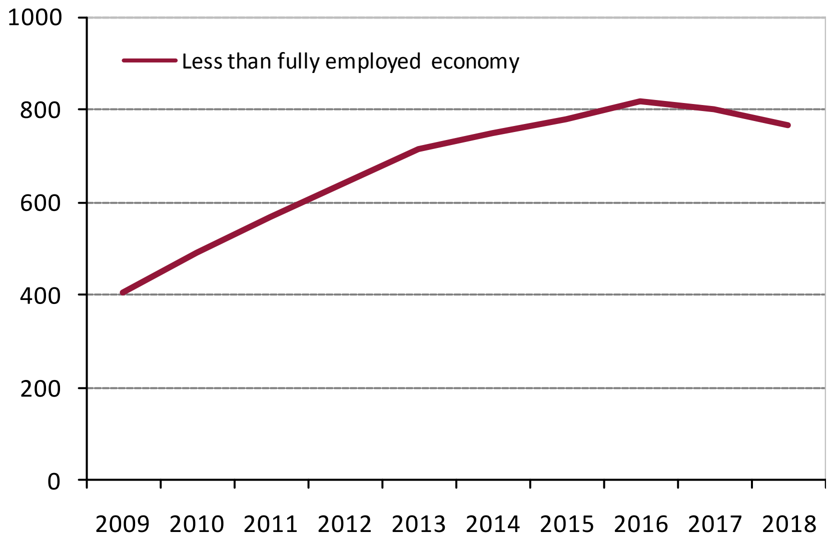
Table 4.5: NPV of GDP for irrigation 2009 – 2018 ($m)

	Discount rates	
Labour market assumption	7 per cent	3 per cent
Near full employment	428	545
Less than full employment	530	666

Source: Access Economics

The low labour intensity of agriculture means the employment effects are relatively small compared with the other scenarios which are directed at more labour intensive sectors of the economy. Yet, Chart 4.4 indicates that around 800 extra jobs may result at its peak.

Chart 4.4: Impact on employment of the use of smart technologies in irrigation systems



Source: Access Economics

4.4 E-Health

The health scenarios were modelled somewhat differently to the other sectors due to the limited amount of information available on the topic. As discussed in Section 3.3, the various studies that have been conducted both in Australia and overseas examine different aspects of E-Health in quite different circumstances. Accordingly, the data available from these studies are not directly applicable for the current exercises.

Instead, the approach adopted here has been to develop estimates of one aspect of E-Health – namely the implementation of a national electronic record system – drawing on information from the Australian studies referred to in Section 3.3 and data from Canada. The assumptions adopted for the potential productivity gains are a little lower than the estimates that appear to underlie the Australian studies, in part in recognition of the practicalities involved in implementing the EHR. Also, the results focus on the economic benefits and do not attempt to fully estimate the benefits to health outcomes.

As with electricity and water, the scenarios incorporate estimates of the capital costs involved and the direct impact on productivity. A system to improve the flow of information in Canada's health system was estimated to have cost around $10 billion[24]. Canada's population is approximately 33 million compared with Australia's 21 million. For simplicity, a simplifying assumption was made that, based on population differences, costs for a similar system in Australia would be proportional, that is, of the order of $6.3 billion.

The capital expenditure was spread evenly across nine years based on the Canadian experience and across states according to the population shares shown in Table 4.6.

Table 4.6: Australian population shares by state

State	Population share (%)
New South Wales	33.5
Victoria	25.2
Queensland	20.1
South Australia	7.7
Western Australia	10.1
Tasmania	2.4
Northern Territory	1.0

Productivity gains were assumed to sum to 2.5% over the ten year period. As the technology becomes more widespread, the network effects are assumed to become larger. Following this logic the early years of investment will net small gains with larger gains following. As the investment reaches marginal areas of the health network, the additional gains will begin to shrink once again. The schedule of gains applied to the model is shown in Table 4.7.

Table 4.7: Productivity gains from technology use in health

Year	Productivity gain (%)
2009	0.04
2010	0.21
2011	0.34
2012	0.41
2013	0.44
2014	0.42
2015	0.41
2016	0.21
2017	0.04

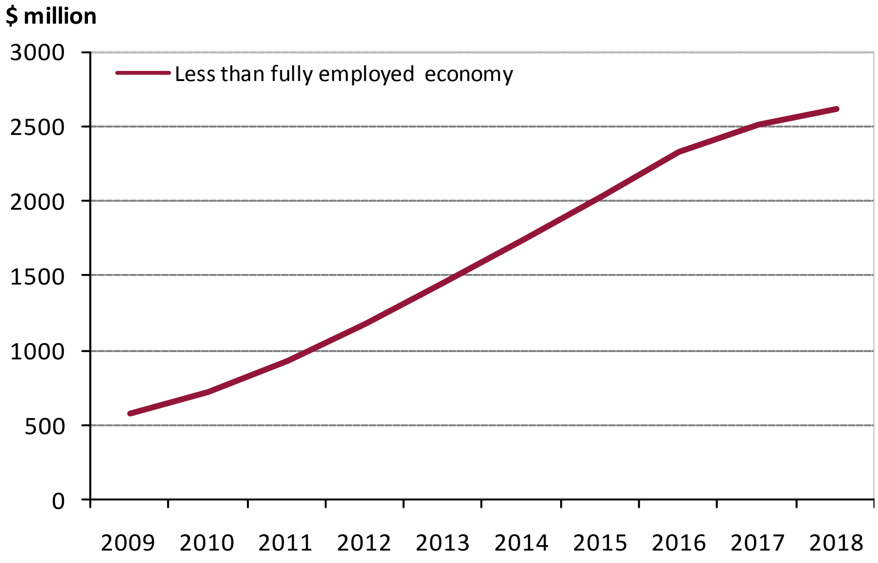
Source: Access Economics

Using these capital expenditure and productivity estimates as inputs into the general equilibrium modelling, Chart 4.5 depicts the net impact on GDP under the labour market

[24] Booz & Company, 2008.

assumption of less than full employment. It shows that the gain in GDP would grow by around $2.6 billion per year by 2018 if there were unemployed resources in the economy.

Chart 4.5: Impact on GDP of e-technology use in the health sector



Source: Access Economics

The net present values of these gains are presented in Table 4.8 assuming a discount rate of both 7% and 3%. In the case of a fully employed economy, the NPV is estimated to be between $5.7 and 7.4 billion[25]. The net benefits are larger where there is unemployment, with the NPV of the lift in GDP estimated to lie between $10.3 and 13.2 billion.

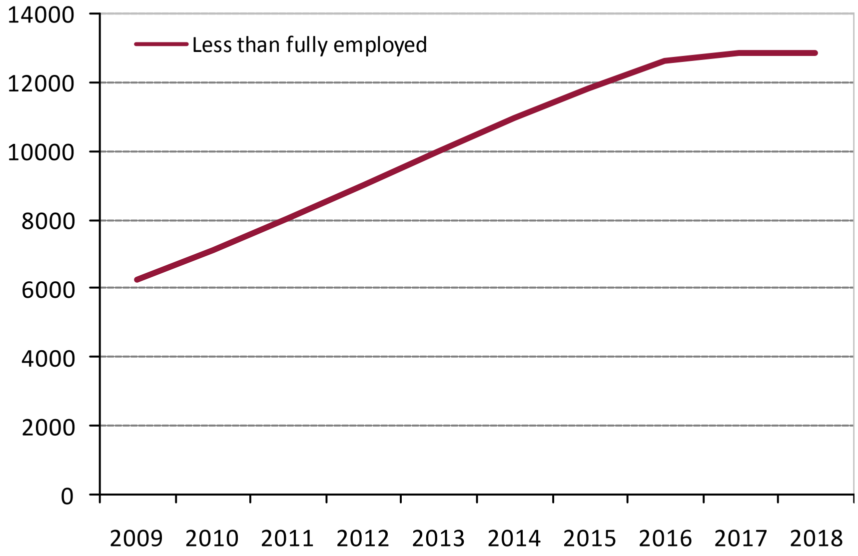
Table 4.8: NPV of GDP for E-Health scenario 2009 – 2018 ($bn)

	Discount rates	
Labour market assumption	**7 per cent**	**3 per cent**
Near full employment	5.7	7.4
Less than full employment	10.3	13.2

Finally, employment would be lifted, especially in the case where there are unemployed resources. In this case, the boost to employment would exceed 12,000 within a few years (see Chart 4.6.)

[25] These estimates are similar in scale to those found by the Allens Consulting Group as reported in Booz & Company (2008).

Chart 4.6: Impact on employment of e-technology use in the health sector



Source: Access Economics

4.5 Transport

The benefits in transport will accrue from the investment in smart technology use in a range of applications and across many industries. The approach used here does not attempt to identify where this investment may take place or who may benefit from it. Rather, we simply assume it has taken place without quantifying it and instead attempt to replicate the results of third party studies via the implementation of productivity improvements. This enables the examination of the GDP and labour impacts from the use of smart technologies in transport.

The productivity gains applied in the model have been based on an assessment of previous studies in Australia and internationally. They are consistent with economic benefits that are a little less than those found in the Booz Allen & Hamilton (1998) study. While, as noted in Section 3.4, there is little hard evidence on which to estimate the economic impact of a specific investment in ITS, there is plenty of evidence that highlights the gains to be had by improving traffic flows (or reducing congestion) through technologies including traffic diagnostic tools.

The particular estimates have been constructed to lift GDP over time and achieve gains of 0.2% by 2014 in the case of a fully employed economy. Table 4.9 details the productivity shocks applied.

Table 4.9: Productivity gains for transport

Year	Productivity gain (%)
2009	0.24
2010	0.36
2011	0.48
2012	0.48
2013	0.60
2014	0.72

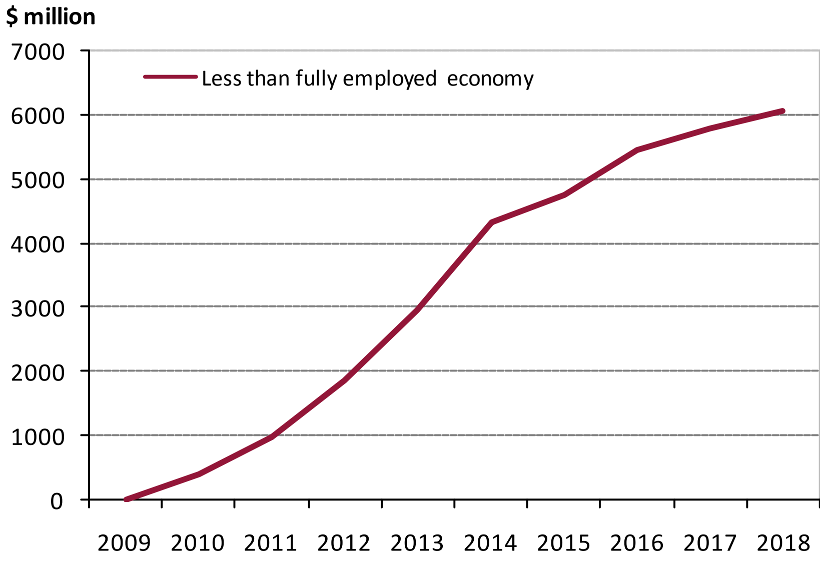
From 2015 onwards, GDP gains are held at a relatively stable level and do not exceed the baseline level by more than 0.24% in any given year. Table 4.10 shows the actual GDP gains (in percentage change form) for each year.

Table 4.10: GDP gains for transport

Year	GDP gain (%)
2009	0.00
2010	0.02
2011	0.06
2012	0.10
2013	0.16
2014	0.22
2015	0.22
2016	0.24
2017	0.24
2018	0.24

Once the productivity gains required to achieve the estimated GDP gains are calculated, the labour market assumptions were relaxed and the same shocks were applied to the case where there were unemployed resources. In 2014, the gains to GDP increase to $4.3 billion in a less than fully employed economy (see Chart 4.7.)

Chart 4.7: Impact on GDP from integrated transport systems



Source: Access Economics

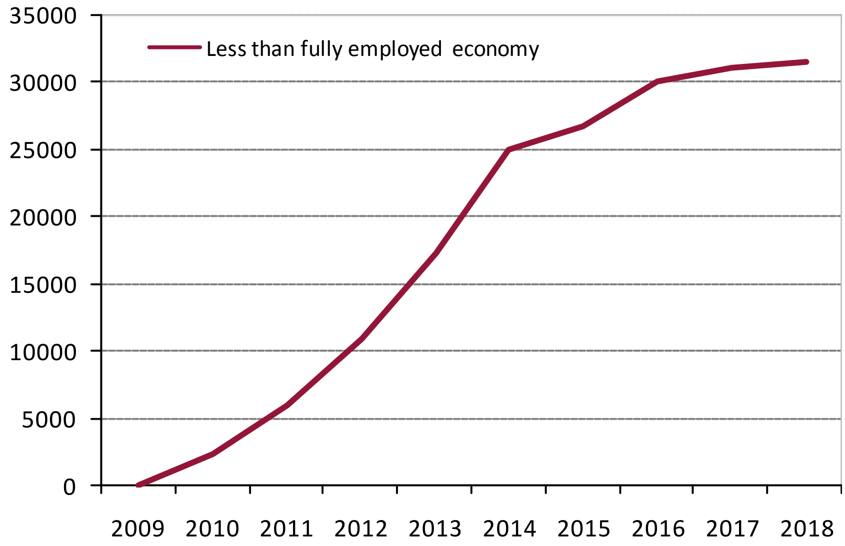
Table 4.11 shows the NPV of GDP for productivity improvements arising out of the use of ITS. Using a discount rate of 7%, the NPV is $12.5 billion and $19.9 billion for the cases where resources are fully employed and underemployed respectively.

Table 4.11: NPV of GDP for transport 2009 – 2018 ($bn)

	Discount rates	
Labour market assumption	**7 per cent**	**3 per cent**
Near full employment	12.5	16.3
Less than full employment	19.9	26.3

Chart 4.8 shows the increase in employment for the scenario involving a less than fully employed economy. The number of jobs created grows to over 30,000.

Chart 4.8: Impact on employment from integrated transport systems



Source: Access Economics

4.6 High speed broadband

As foreshadowed in Section 3.5, insufficient data are available to quantify the net economic benefits of a comprehensive rollout of HSBB using a fibre-to-the-home technology for most of the population along the lines of the Government's recent announcement. Instead, this section assesses the net economic benefits of a less ambitious agenda based on a fibre-to-the-node network. In particular, the estimates are taken from an earlier study conducted by Access Economics involving the deployment of a carrier grade network to nodes throughout the country.

The results discussed here are based on the 'Scenario 1' (Carrier grade network) and 'Adjusted Scenario 1' (Carrier grade network in a time of higher unemployment) simulations presented in the above study. The Scenario 1 simulation is akin to the base setup adopted in the current report which assumes a fully employed economy.

The simulation incorporates a carrier grade network rollout commencing in 2009. The rollout is completed in 2016 and results in 12Mbps access being available to 90% of the Australian population via a fibre-to-the-node network. Deployment begins in those areas with the highest population density and progressively extends to lower density areas. The Adjusted Scenario 1 is equivalent to the simulations that assume unemployed resources. For a more detailed discussion of the setup see Access Economics (2009).[26]

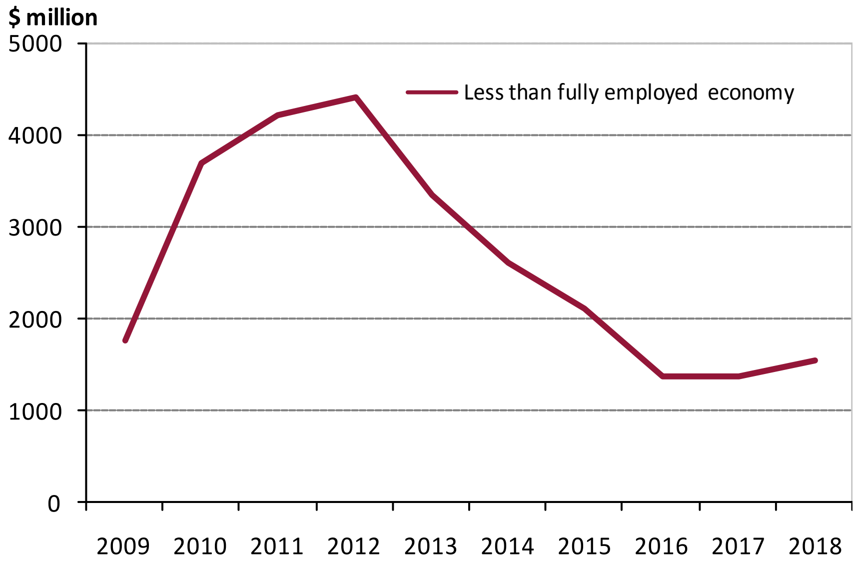
Although the details of the HSBB network recently announced by the Government are unclear, of the scenarios modelled in the initial analysis Access Economics believes these to be the most appropriate to apply here.

[26] A copy of this report can be found at http://www.nowwearetalking.com.au/library/pdf/news/final-report_impacts-of-a-national-hsbb-network_march-2009.pdf.

The combined costs associated with nodes, cabinets, CAN rehabilitation, backhaul and customer cutovers that would be required are estimated to amount to $12.6 billion. These capital outlays are assumed to be spread between 2010 and 2016 with some front-loading of the spending. There are considerable jobs created during the building phase of the project. This is reflected in the measures of GDP presented in Chart 4.9 below. As the effects of the initial capital works fall away, the impact of the improvement in productivity slowly builds:

- Note that, as outlined in Section 3.5, many of the longer-term benefits that are likely to flow from the introduction of HSBB are difficult to quantify at this time and so have not been included in this analysis. Accordingly, Chart 4.9 is likely to significantly understate the potential longer-term benefits.

Chart 4.9: Impact on GDP of a national HSBB network



Source: Access Economics

The net present values of these GDP gains are given in Table 4.12 based on discount rates of 3% and 7%. The estimates range between $8.6 billion for the case where resources are fully employed with a discount rate of 7% through to $23 billion for the case where there are unemployed resources and the discount rate is 3%.

Table 4.12: NPV of GDP for HSBB 2009 – 2018 ($bn)

	Discount rates	
Labour market assumption	**7 per cent**	**3 per cent**
Near full employment	8.6	8.9
Less than full employment	19.4	23.0

The majority of the employment effects of the network occur early in the building phase of the project (see Chart 4.10). In the scenario where there are unemployed resources, the rollout of an HSBB on a FTTN basis would add 33,000 jobs in 2011 before falling to 9,000 above the baseline by 2018.

Chart 4.10: Impact on employment of a national HSBB network

Source: Access Economics

More detailed discussion on these broadband results (and other scenarios) are provided in the earlier report mentioned above.

4.7 Aggregate impact on output and employment

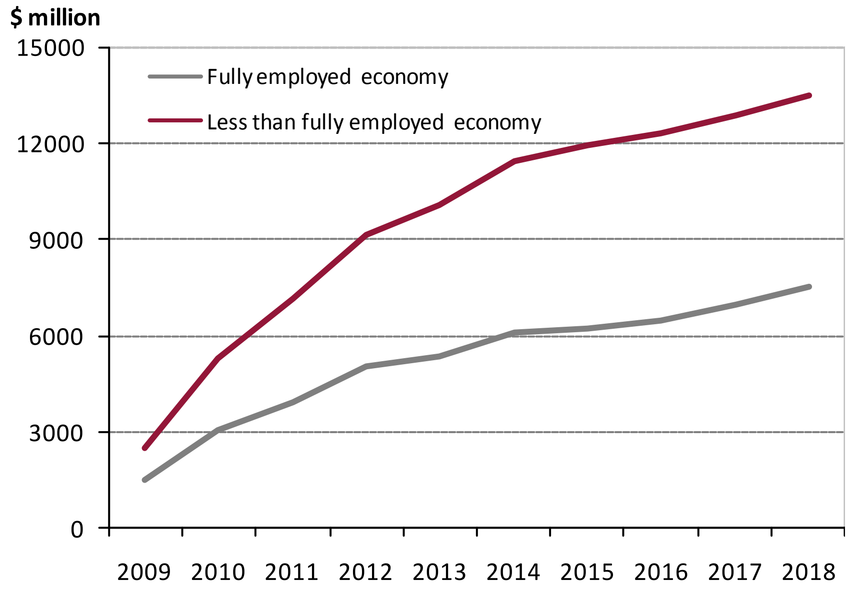
The five scenarios presented here provide a sense of the potential economic benefits of an agenda promoting the deployment of smart technologies in different parts of the economy. As stressed in the introduction, the benefits will be greatest if the deployment of the technologies is complemented by reforms involving, *inter alia*, suitable pricing and access regimes.

The sum total of the results for the five scenarios provides an order of magnitude for the benefits. In practice, the scenarios would interact both through some competition for resources and reinforcing the effectiveness of each. For example, the broadband rollout would be an enabler for some of the other technologies to be widely adopted.

Strictly speaking, such interactions should be taken into account when aggregating the results across the scenarios. However, the illustrative nature of the design of the scenarios means that a straight summing of the results will present a good indication of the magnitude of the impacts. In fact, as emphasised throughout, deliberately conservative assumptions have been adopted in deriving the estimates, and the estimates are likely to understate the full potential of the widespread adoption of smart technologies.

Overall, the estimates imply that employing these technologies in the five areas of the economy identified would add $13.5 billion to GDP in 2018 if the economy were operating with less than full employment – see Chart 4.11. This is equivalent to around 1½% of the current level of GDP. With full employment, the effect would be to add around 1% of current GDP in 2018.

Chart 4.11: Aggregate GDP effects of the five scenarios



Source: Access Economics

This increase in GDP translates into a substantial lift in national wealth as indicated by the net present value of the boost in GDP over the following decade:

- In today's dollars, the net present value of the benefits over the first ten years would be between $35 billion and $80 billion with the precise estimate depending on whether the discount rate used was a social or commercial discount rate and whether the economy was operating near full employment.
- In current circumstances where unemployment is rising, the net benefits would be towards the top of this range.

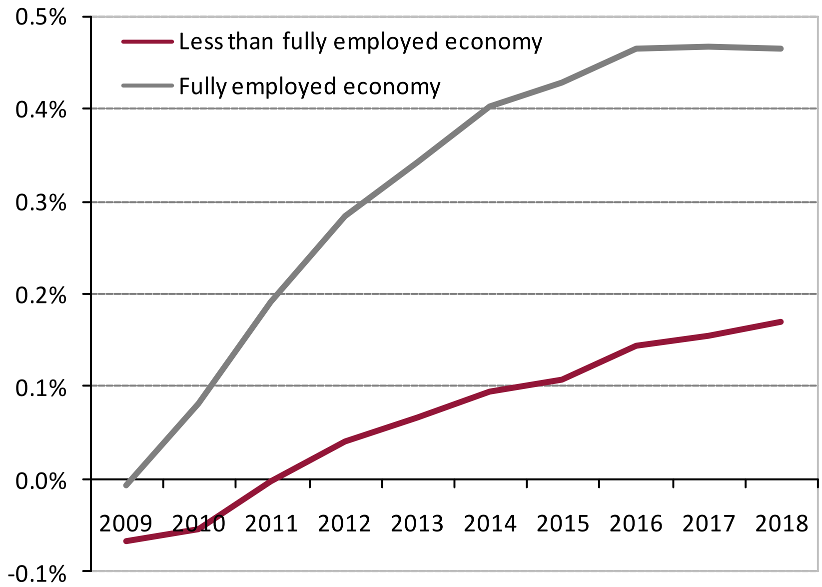
The boost to GDP will raise living standards. It will be reflected in a combination of:

- an increased number of jobs; and
- higher labour productivity, that is, the ratio of GDP to employment.

In an economy operating near full employment, most of the lift in GDP will show up in higher levels of productivity since any additional jobs needs to come through additional people being attracted to the workforce (because of higher real wages). In contrast, much of the improvement in GDP and living standards in an economy operating at less than full employment will show up in higher employment levels.

Chart 4.12 shows labour productivity increases by around 0.5% after the technologies are deployed in a fully employed economy. The impact on productivity is lower in a world where there is unemployment since the benefits are felt more in the lift to jobs numbers.

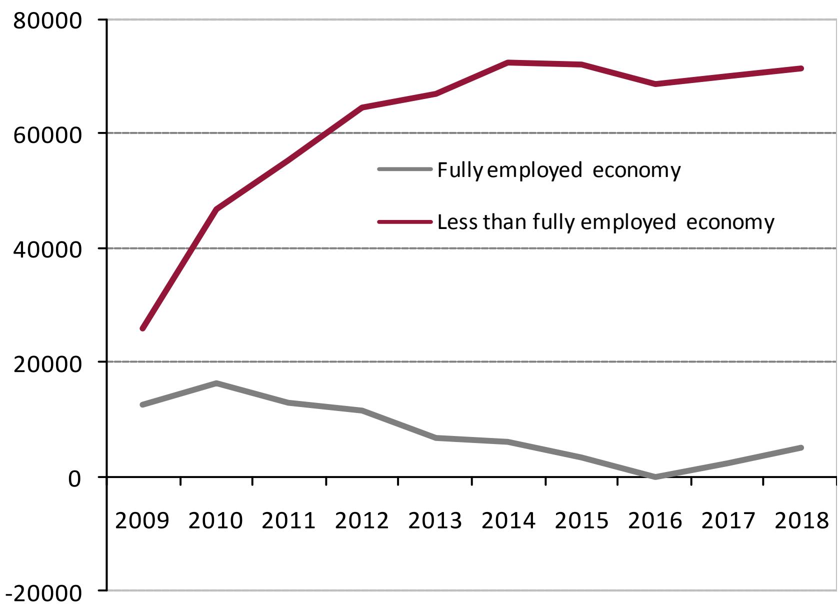
Chart 4.12: Aggregate labour productivity effects of the five scenarios



Source: Access Economics

The impact on employment levels is, naturally, dependent on the state of the labour market when the investments occur. In circumstances where the economy is operating below full employment and the investment will provide the wherewithal for people to move back into work, an estimated 70,000 jobs would be created by the end of the rollout period (which is assumed to be five years) – see Chart 4.13.

Chart 4.13: Aggregate employment effects of the five scenarios



Source: Access Economics

5 Conclusion

This report has attempted to provide an order of magnitude in potential economic benefits from the implementation of intelligent technologies across selected parts of the economy. As seen with the rapid progress made in information and communications technologies over the past few decades, technological advances can underpin a nation's development and creation of wealth.

The amount of data collected today in all areas of human activity is vast and is expanding rapidly. The ability to make effective use of these data through smart technologies and systems provides the potential to radically alter how economies and societies are altered, for the better. Combined with microeconomic reform, they provide the scope for more informed decision-making by both business and consumers.

The report focuses on five areas of the economy, namely electricity, irrigation, health, transport and broadband. Conservative assumptions have been made when considering the potential of the technologies. Even so, the potential benefits are sizeable.

In the circumstances that confront Australia today with rising unemployment, the effective deployment and adoption of these technologies within these five areas would add an estimated 1½% to the level of GDP within a few years. Over a ten year period, the net present value of boost would be equivalent to around $80 billion (with the precise amount dependent on the discount rate assumed.) An additional 70,000 jobs would be created.

As stressed, these estimates should be viewed as providing an order of magnitude of advancing the broad agenda of adopting smart technologies. The paucity of firm empirical evidence on the economic impacts of specific investments means that the estimates are inevitably imprecise. Efforts are underway in all of the areas identified in this report to strengthen the empirical understanding of the impacts of specific initiatives. It is desirable that these efforts be supported in order for the smart systems to be rolled out in an effective manner and deliver all of the potential benefits that they could provide to the Australian economy.

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