A Climate Risk Report

Towards a High-Bandwidth, Low-Carbon Future

Telecommunications-based Opportunities to Reduce Greenhouse Gas Emissions

Climate Risk Pty Ltd provide specialist professional services to business and government on risk, opportunity and adaptation to climate change.

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Disclaimer
Climate Risk provides professional services in relation to climate change risks and opportunities. Our technical and professional staff endeavour to work to international best practice standards using experienced scientists, sector specialists and associated experts.

This document is intended to stimulate ideas and generate discussion amongst business government and society about the role telecommunications can play in reducing carbon emissions. While the information contained is drawn from reputable sources in the public domain, Climate Risk cannot take responsibility for errors or inaccuracies within original source material.

This report does not consider individual investment requirements or the particular needs of individuals, corporations or others and as such the report should not be relied upon as the basis for specific commercial decisions.

Telstra and Climate Risk support a constructive dialogue about the ideas and concepts contained herein.

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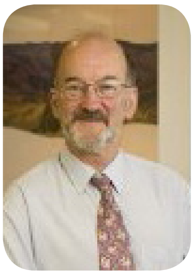

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Foreword

The 2007 Lowy Institute Poll found that tackling climate change is as important to Australians as improving standards in education - and more so than improving the delivery of health care, ensuring economic growth and fighting international terrorism.

This Report is a first attempt at a nationwide quantification of the carbon savings and financial benefits resulting from using telecommunications networks to conserve energy and increase clean energy use at home, in the workplace and in ways we connect people, enterprises and communities.

The analysis presented in this report finds that the telecommunications sector is uniquely placed to provide important services that can yield nationally significant reductions in greenhouse gas emissions. Indeed a key finding is that many of the telecommunication solutions for living and working in a future carbon-constrained world can actually lead to cost savings for business and the consumer.

There is scant information in the public domain that quantifies the opportunities presented by telecommunications to reduce greenhouse gas emissions. This report does.

This report is not the last word on telecommunications and carbon emissions, but one of the first. We welcome a robust public dialogue around the ideas presented in the report – including critiques by national and international specialists who may provide more detailed insights and more refined ideas. Climate Risk, the authors of the report, and Telstra are committed to raising the level of public discourse and to capture and share learning that can result. This dialogue will, we hope, lead to a more comprehensive understanding of how we can work together to achieve the benefits of a high bandwidth, low carbon society.

Time is of the essence as we find innovative solutions to reducing carbon emissions. We are delighted to offer this study into the marketplace of ideas and we invite you to share your reactions, insights and ideas with us and with each other through forums, the media and private discussions.

Philip M. Burgess, Ph.D
Group Managing Director
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Executive Summary

Key Findings

1. This report provides an analysis of the opportunities for Australian society to achieve nationally significant greenhouse gas abatement using telecommunication networks.

2. The report identifies that the scale and scope of telecommunication network services and users provide a unique opportunity to harness economies of scale to achieve meaningful emission reductions.

3. Many of the carbon-opportunities identified lead to energy and other cost savings for commercial and residential customers, and in some cases will enable the on-selling of newly created carbon credits[i] and electricity management commodities.

4. The estimated abatement opportunity calculated herein is almost 5% (4.9) of Australia's total national emissions, making the use of telecommunication networks one of the most significant opportunities to reduce the national carbon footprint.

5. The estimated energy and travel cost savings are approximately $6.6 billion per year, and value of the carbon credits created may be between $270 million and $1.2 billion subject to the future price of carbon.

6. Some of these carbon-opportunities can be realised immediately; others are contingent on the roll-out of a national fibre optic network to residential and commercial consumers.

7. In combination with other measures being implemented by Government, a deployment of the carbon-opportunities in the period 2008 to 2014 would have the additional effect of stabilising national emissions in the period up to 2014 in keeping with the findings of the IPCC and the Stern Review, as shown in Figure i.

> "The scale and scope of the telecommunication sector's operations unlock the ability to aggregate multiple distributed initiatives to achieve nationally significant emissions savings."

CARBON-OPPORTUNITIES

Throughout this document carbon-opportunities is used as a short hand for 'carbon dioxide emission abatement opportunities' which include an activity that provides real and measurable reductions in, or avoidance of, greenhouse gas emissions. They do not include the use of offset mechanism to reduce emissions.

> "The opportunities outlined in this report result in total greenhouse gas reductions equivalent to approximately 4.9% of Australia's total national emissions."

i When pollution levels are capped, in some schemes, it may be possible to trade greenhouse gas pollution rights referred to as 'carbon credits'. Currently NSW has a greenhouse gas emissions trading scheme, the Federal Government has announced plans to introduce a national scheme in 2012 and there are also voluntary abatement markets.

Figure i: Combined effect of telecommunication networks Carbon-Opportunities

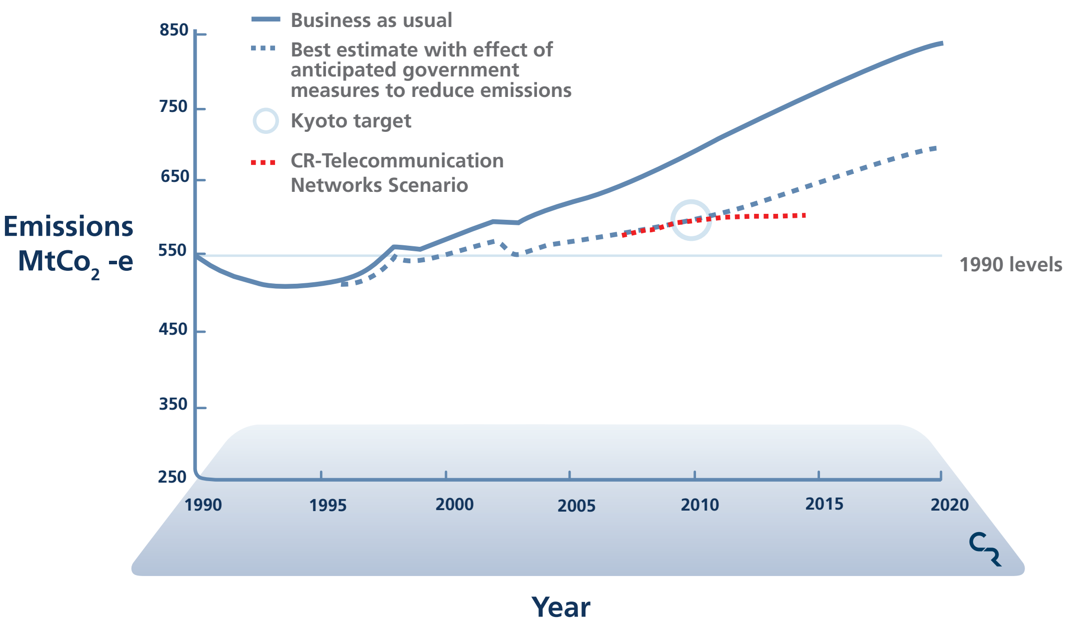


Figure i. If the seven carbon-opportunities identified in the report were deployed, over the period 2008 - 2014, the effect would be a stabilisation of national emissions in the period 2011 - 2014. Graph is a modification based on AGO 2007a.

QUANTIFYING EMISSIONS: $MtCO_2$-e

Mega-tonnes carbon dioxide equivalent ($MtCO_2$-e) is the internationally recognised measure used to compare the emissions from the various greenhouse gases. This measure factors in differences in global warming potential and converts them to a carbon-dioxide equivalent. For example, the global warming potential for a tonne of methane over 100 years is 21 times that of a tonne of carbon dioxide.

Table i: Summary of emissions abatement from Carbon-Opportunities

Carbon-Opportunity (in order of size)	$MtCO_2$-e saving	Percentage of national emissions
Increased Renewable Energy	10.1	1.81
Personalised Public Transport	3.9	0.70
De-centralised Business District	3.1	0.55
Presence-Based Power	3.0	0.53
Real-time Freight Management	2.9	0.52
'On-Live' High Definition Video Conferencing	2.4	0.43
Remote Appliance Power Management	1.8	0.33
Total	27.3	4.88

Table i. Summary of emissions abatement from carbon-opportunities

Beyond Carbon Neutral

This report goes significantly beyond 'holding the line' goals of corporate carbon neutrality and carbon. Instead it sets out a suite of opportunities that would allow telecommunications providers to play a leadership role in decarbonising the Australian economy and equipping the nation to prosper in a carbon constrained future. All of the strategies and opportunities are based on avoiding the release of fossil carbon into the atmosphere; they are not based on off-setting emissions.

Seven options are proposed to build on existing and next-generation networks. The realisation of opportunities outlined in this report would result in telecommunications providers assisting Australian businesses and households achieving total greenhouse gas reductions equivalent to approximately 4.9% of Australia's total national emissions. Some of the opportunities identified in the consumer space can be achieved using existing network services and others are contingent on the roll-out of fibre to the node (FTTN) broadband infrastructure. Overall the initiatives identified in this report present the opportunity for one of the single largest reductions in Australia's carbon footprint by an Australian corporation.

Companies seeking to maximise their carbon emission reduction could leverage the existing and next-generation networks already built by Telstra.

The Climate Challenge

The latest statement from the Intergovernmental Panel on Climate Change (IPCC 2007) indicates the next ten years are critical in meeting the challenges posed by climate change. For the first time, scientists and governments are now agreed that global emissions must be stabilised by 2015 if climate change is to be effectively addressed. Similarly the global economic Stern Review concluded that "to stabilise at 450ppm[ii] CO_2-e, without overshooting, global emissions would need to peak in the next 10 years" (Stern 2006, p. 193). Reducing greenhouse emissions requires major commitments from both the public and private sectors as well as the government.

In 2005 Australia's net annual emissions totalled 559 mega-tonnes of CO_2 equivalent ($MtCO_2$-e) from all activities, which equates to 1.4% of the global total. In the short term, it appears that Australia will stay close to its Kyoto Protocol target of no more than an 8% increase above 1990 emission levels (AGO 2007b). However, the underlying trend is that Australian emissions will increase at about 1.3% per year.

The use of fossil-fuels in stationary-energy[iii] and transport applications is the nation's major source of emissions. The trend is not declining or stabilising, but continuing to grow significantly. If deep cuts in emissions are to be achieved, emissions from the energy sector are Australia's greatest greenhouse challenge.

THE KYOTO PROTOCOL AND AUSTRALIA'S TARGET

The Kyoto Protocol is an agreement made under the United Nations Framework Convention on Climate Change (UNFCCC). The main objective of the protocol is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." The first commitment period of the Kyoto Protocol requires industrial nations to reduce greenhouse gas emissions by at least 5 per cent below 1990 levels by 2012. Australia received a 108% target above 1990 levels.

GREENHOUSE GASES (GHG)

Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic (man made), that contribute to increasing the global mean temperature of the earth. Greenhouse gases including water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere. There are a number of entirely human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances.

ii Associated with a 50% chance of exceeding 2°C warming above pre-industrial levels.

iii Stationary energy includes emissions from electricity generation, the use of fuels in manufacturing, construction and commercial sectors, and residential heating. It excludes transport fuels.

Telecommunication's Significance in Climate Change Mitigation

Telecommunication operators are a major conduit for new technology and infrastructure. Australia has the only national wireless broadband network in the world.

The scale and scope of the telecommunication sector's operations unlock the ability to aggregate multiple distributed initiatives to achieve nationally significant emissions savings. The anticipated greenhouse emission constraints coincide with the government's plans for next-generation networks, which provides synergies for new emission reduction opportunities.

This report identifies seven carbon-opportunities appropriate for Australian businesses and households, which have the potential for viable carbon abatement using existing and next-generation networks. These carbon-opportunities have relevance for energy consumption in buildings, road transport, renewable energy production and aviation.

Buildings

Today electricity consumption in homes and the workplace accounts for one fifth of total national emissions (ABS 2007, AGO 2007b); in both locations there are two significant sources of energy wastage. Firstly, standby power, in which numerous appliances that appear to be 'off' are still consuming energy, typically this accounts for over 11% of electricity use in an average home.

Secondly, devices and appliances which are on, but not being unused, may also waste large amounts of electricity (estimated herein as 15%), we refer to this as 'orphaned' energy. We have identified two relevant commercial opportunities:

Carbon-Opportunity: Remote Appliance Power Management

Broadband can provide both the monitoring and control of electrical networks down to the electric switch box or even plug socket and in addition facilitate analysis and management elsewhere on the network. Standby switching can be centralised to allow electricity to be halted to devices on standby, such as a phone that has finished charging, a TV that has not been used for an hour, or a hot water system which is on, even though no one is in the house. While this is not appropriate for all devices, it is applicable to many.

Annual Saving: The estimated emissions saving of Remote Appliance Power Management[iv] is 1.8 $MtCO_2$-e, or 0.33% of total national emissions. The financial value of the avoided electricity spending is $170 million and the value of the carbon credits would be in the range of $18 million to $92 million.

Carbon-Opportunity: Presence-Based Power

It is very common for any energy consuming devices to be left on even though the user may not be present.

> The underlying trend is that Australian emissions are forecast to increase at about 1.3% per year.

NATIONAL EMISSIONS AND PER CAPITA EMISSIONS

Greenhouse gas emissions vary considerably, especially between developed countries and developing countries, both at a national level and per person. Australia has the highest emissions per capita of any developed country (OECD) with the equivalent emissions of 26 tonnes per person carbon dioxide per year. China is one of the worlds biggest greenhouse gas polluters, but this is largely due the high population. On a per capita basis a Chinese person is responsible for about 2.5 tonnes per year.

> With Presence-Based Power the supply of energy follows the person, not the appliance.

iv Assumes broadband-based Remote Appliance Power Management solutions are used to reduce standby emissions by 50% in 1/3 of Australian homes and commercial buildings.

However, the supply of energy can be made dependent on the presence of a person. For example, most office meeting rooms remain air-conditioned while no one is using them and computers stay on when the person is at lunch. Significant reductions in energy consumption can be achieved if devices are deactivated when people walk away, and turned back on when the person returns. This 'Presence-Based Power' can use a person's mobile phone or company identification tag to register their presence meaning the supply of energy is linked to the presence of the person, not just the appliance.

Annual Saving: The estimated emissions saving of Presence-Based Power[v] is 3.0 $MtCO_2$-e, or 0.53% of total national emissions. The financial value of the avoided electricity spending is $270 million and the value of the carbon credits would be in the range $29 million to $150 million.

Transport

Today road transport produces nearly 70 $MtCO_2$–e of emissions per year, around 14% of total national emissions[vi]. Three quarters of Australians drive to work; of these only 4% share a car (ABS 2005). Though significant attention has focused on making traffic flows more efficient, this often only increases traffic volumes. Meaningful emissions abatement requires the provision of more compelling alternatives to car use.

Major emissions also result from the movement of freight totalling about 5% of national emissions. Overall, freight vehicles are empty for 28% of the kilometres travelled (ABS 2005).

For all of these emissions we have identified three commercially-viable opportunities:

Carbon-Opportunity: De-centralised Business District

Broadband-enabled homes, suburbs and regional centres can either remove or significantly reduce the emissions generated by people travelling to and from work. At one end of the spectrum, people would be working from home one day a week or more; at the other end, people would be working in suburban or regional centres where minor commuting is involved. In the latter case, people would continue to enjoy employment in a national or international company with no career disadvantage. A hybrid is the telework business centre, open to staff from many different businesses and placed in locations close to where people live but able to offer all of the amenities of a large office.

Annual Saving: The estimated emissions saving of De-centralised Business Districts[vii], from reduced travel emissions only, is 3.1 $MtCO_2$-e or 0.55% of total national emissions. The financial value of the avoided fuel spending is $1.2 billion and the value of the carbon credits would be in the range $30 million to $150 million.

THE VALUE OF CARBON

Greenhouse gas emissions trading will be operational in Australia by 2012. This will create a cost for the right to emit greenhouse gas pollution. Reciprocally it will create a value for greenhouse gas abatement. The value of greenhouse gas abatement will depend on the cuts in emissions specified by the government and will be set by the market. In this report we use a range of possible carbon prices from $10 to $50 per tonne of carbon dioxide based on analysis by the CSIRO and ABARE.

v Assumes network enabled Presence-Based Power solutions are used to reduce 'orphaned' energy emissions by 50% in 1/3 of Australian homes and commercial buildings.

vi Much of this is caused by the sheer size of the nation. Other continentalised nations, such as the US and Canada, also have comparatively high transport-linked emissions. This may also affect vehicle type and choice.

vii Assumes that De-Centralised Workplaces are used by 10% of employees who have telework suitable jobs, and their commuting emissions are reduced by at least 50%.

Carbon-Opportunity: Personalised Public Transport

Wireless-broadband can facilitate public transport on demand. Personalised Public Transport allows the user to order public transport provided by an integrated network of multi-occupant taxis, minibuses, buses and trains, which starts at the front door. The personal efficiency of Personalised Public Transport can exceed that of using the private car, with faster speeds door-to-door, greater flexibility and lower costs. Further, Personalised Public Transport can greatly increase the catchment of other public transport options, such as bus and rail, resulting in significant opportunities for greenhouse gas abatement.

Annual Saving: The estimated emissions saving through Personalised Public Transport[viii] is 3.9 $MtCO_2$-e per annum, or 0.7% of total national emissions. The financial value of the avoided fuel spending is $1.6 billion and the value of the carbon credits would be in the range $39 million to $200 million.

Carbon-Opportunity: Real-time Freight Management

Wireless-broadband allows freight and freight vehicles to be monitored in real time. Consolidating this information allows more freight to be assigned to unladen, or underladen, vehicles. Real-time Freight Management creates an integrated clearing house for multiple suppliers of freight services.

Annual Saving: The estimated emissions saving of Real-time Freight Management[ix] is 2.9 $MtCO_2$-e per annum, or 0.52% of total national emissions. The financial value of the avoided fuel spending is $1.1 billion and the value of the carbon credits would be in the range $29 million to $150 million.

Renewable Energy

Today Australia's energy supply is dominated by fossil fuels. However deep cuts in Australian emissions will require a transition to low and zero emission sources of power supply. Despite being plentiful, low-cost renewable energy sources like wind power are hampered by the variability of the supply; this has in part prompted restriction of new wind farm development in South Australia and has been used in the advocacy of higher-cost nuclear generation. The report identifies a means by which next- generation networks can dismantle such barriers to renewable energy uptake.

Carbon-Opportunity: Increased Renewable Energy

Australia's extensive broadband networks allow a link to be made between renewable energy supplies and active load management of heating, cooling and other appliances in buildings and homes across Australia. This can be used to create 'virtual' energy storage to effectively neutralise aspects of short-term variability, turning such renewables into 'stable and predictable generation'. This in turn would enable renewables to contribute an increased component of the electricity supply.

RENEWABLE ENERGY CONSTRAINTS

Europe, US states and developing countries like India and China have established very high targets for renewable energy. The Australian government has recently announced a target for about 30,000 gigawatt hours of electricity per year to come from renewables. Some of the most successful renewable energy sources, like wind power, produce constantly varying amounts of energy. Properly managing this variation can limit the amount of renewable energy which can be installed in certain locations or increase the value of such energy.

> "The report identifies a means by which next generation networks can dismantle barriers to renewable energy uptake."

viii Assumes that wireless broadband-facilitated Personalised Public Transport is able to capture 10% of car-based commuters and assumes that the relative emission intensity of public transport is 90% lower than personal car travel in the urban environment.

ix Assumes that Real-time Freight Management effectively avoids 25% of unladen truck kilometres.

Annual Saving: The emissions abatement from using Increased Renewable Energy[x] is at least 10.1 $MtCO_2$-e or 1.8% of total national emissions, though this could be considerably higher. The financial value of the avoided fuel spending is $86 million and the value of the carbon credits would be in the range $100 million to $300 million.

Aviation

Aviation emissions are amongst the fastest growing in the energy sector. Domestic aviation alone produces 5.1 million tonnes of CO_2 per year and international aviation using fuels procured in Australia give rise to approximately twice these emissions. Yet because aviation emissions occur at altitude the warming effect is as much as 2.7 times higher. Based on international studies about 50% of short haul air travel may be for business (Mason 2000).

Carbon-Opportunity: 'On-Live' High Definition Video Conferencing

Long-distance, short-duration travel can be effectively replaced with 'in-person' high-definition, high fidelity, online conferencing that is significantly more efficient in cost, time, energy and emissions.

Annual Saving: The emissions saving of 'On-Live' High Definition Video Conferencing[xi] services in avoided domestic and international air travel is 2.4 $MtCO_2$-e per annum through direct fuel use reduction (equivalent to 6.5$MtCO_2$-e per annum when the increased warming effect of aviation emissions at altitude or 'up-lift' is included). Excluding up-lift, the avoided emissions are equivalent to 0.43% of total national emissions.

The financial value of the avoided spending on air travel is $2.2 billion and the value of the carbon credits are in the range $24 million to $120 million.

Real World and Industry Examples

For each of the carbon-opportunities identified above, the report provides international examples of current applications of the required technology or systems.

To illustrate the opportunities and barriers in achieving the carbon cuts from the use of Telstra's existing and next-generation networks, four industry perspectives have been presented:

1. Housing: The Genesis residential housing development in South East Queensland
2. Education: Catholic Education Parramatta which administers 127 schools
3. Business: Telstra which has approximately 36,000 full-time equivalent employees in Australia
4. Health: Information Communications Technology (ICT) networks in regional and rural health services

> "Because aviation emissions occur at altitude the warming effect is approximately 2.7 times higher."

Each of the industry examples demonstrate that there have already been carbon emission savings through the use of ICT networks. In many cases this has been a side effect of reducing costs or improving productivity. These examples show considerable scope to apply the carbon-opportunities identified in this report to create much deeper emission abatement in these sectors and also to unlock costs savings in energy, fuel and infrastructure.

x Assumes that one-third of homes and commercial buildings are broadband enabled and that they have agreed to have their discretionary (non-time-sensitive) loads managed by Telstra. Assumes that on average, 15% of the total loads across residential and commercial buildings are discretionary at any one time.

xi Assumes 1/3 of business air travel can be replaced by 'On-Live' meetings using high speed, high definition video links.

Figure ii: Breakdown of abatement contribution from seven Carbon-Opportunities

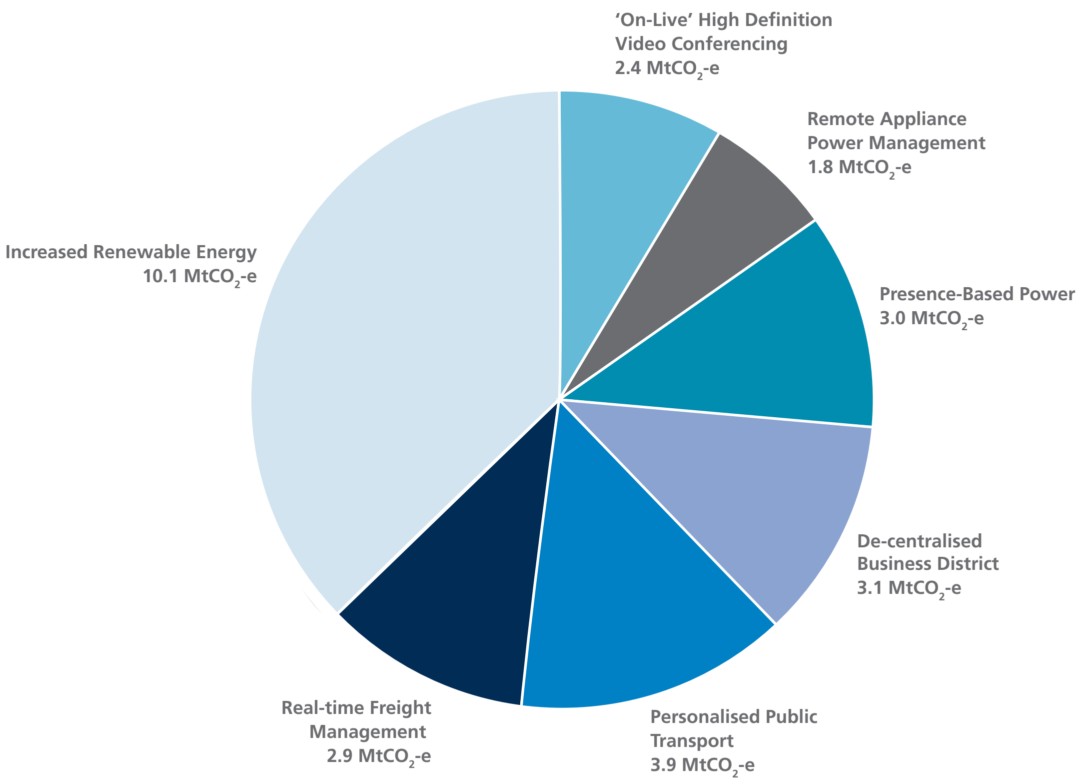


Figure ii. Annual avoided emissions from each of the identified carbon-opportunities ($MtCO_2$-e).

> "The IPCC have concluded that global emissions must not continue to increase past 2015 if the global mean temperature increase is to be contained between 2.0 and 2.4°C above pre-industrial levels."

Figure iii: Aggregated value for each of the Carbon-Opportuntes

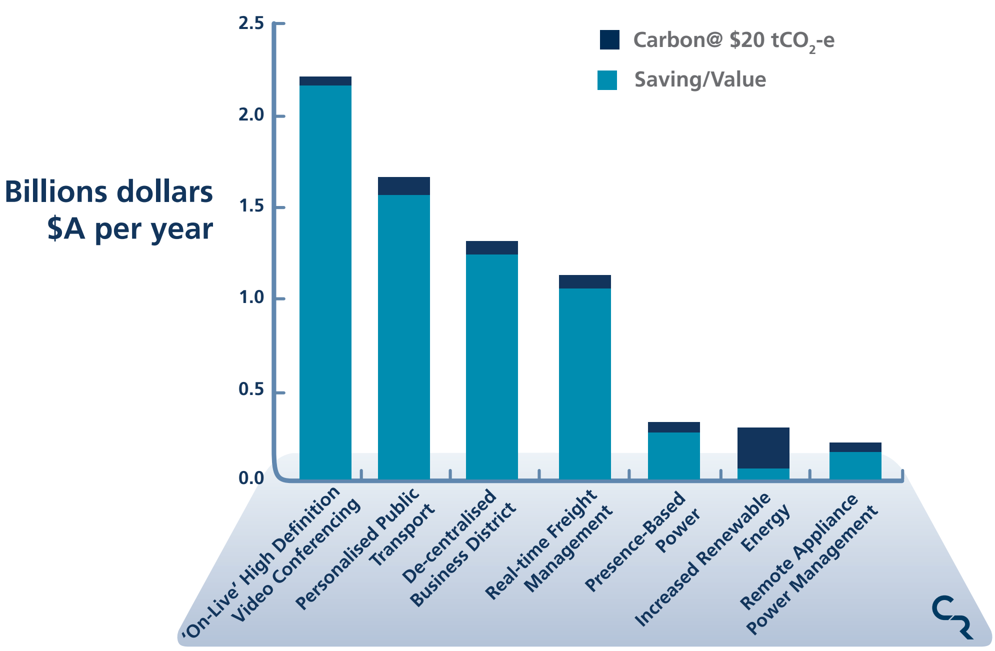


Figure iii. Each of the carbon-opportunites creates value from avoided fuel use or increased energy value, as well as revenue from carbon credits created and other ancillary services.

> "To stabilise at 450ppm CO_2-e, without overshooting, global emissions would need to peak in the next 10 years [before 2016] (Stern 2006, p. 193)."

Part 1

Climate Change - The Challenge

In this chapter we explore the basic rationale for a low carbon society. We present an overview of climate change science and mitigation strategies.

The Global Consensus

In this report we assume that Australia, along with most other countries, is starting down a path toward a carbon constrained future.

This starting assumption is founded on the science behind climate change, the rapid evolution of public opinion around the world and the actions and commitments occurring in the political domain. There is now a global consensus that climate change is a challenge that will have to be addressed forthwith.

This consensus extends to the business community which is increasingly recognising the risks posed by climate change and seeking the opportunities created by a carbon constrained society.

Any solution to climate change will require international agreement, which has not yet been achieved. In any international agreement Australia will likely be a target taker, rather than a target setter. Unlike the USA, the EU, China, India or Brazil, as one of the world's smaller emitters Australia is unlikely to play a central role in the architecture and targets established in future international agreements. However, as one of the world's highest per capita emitters, Australia is highly vulnerable to international binding targets that may lead toward a convergence in per capita emissions. For example, Australia's per person emissions are approximately 10 times that of the average Chinese citizen and the highest in the developed world.

Nevertheless, the societal pressure for unilateral actions in many countries means that measures to reduce emissions are gathering pace on almost every continent, and Australia is no different. There is now bi-partisan political support for greenhouse gas emissions trading, energy efficiency standards and the expansion of renewable energy. All of these present opportunities for the telecommunications sector as we shall explore in this report.

> "Global warming could shrink the global economy by 20%, but taking action now would cost just 1% of global gross domestic product"
>
> - Stern 2006

What is the 'greenhouse effect'?

The atmosphere is semi-transparent to solar energy, allowing some sunlight to reach and warm the Earth's surface, absorbing the rest as infrared radiation, and emitting it back to Earth or out into space. This radiation budget is adjusted as the concentration of greenhouse gases change in the atmosphere.

This natural 'greenhouse effect' keeps the average surface temperature on Earth at a comfortable 14°C. To get a sense of its importance, our nearest neighbour, the Moon has an average temperature 32°C lower than Earth. Although the Moon is about the same distance from the Sun as Earth, it does not have an atmosphere, and no natural 'greenhouse effect' to keep it warm.

The scientific convention is for global warming levels to be expressed relative to pre-industrial levels, nominally set as 1850. Temperature increases are different across the globe, lowest at the equator and highest at the poles, consequently the scientific convention is to refer to global average temperature increases. Unless otherwise stated these conventions are adhered to in this report.

The composition of our atmosphere is crucial for trapping heat to the levels which Earth's ecosystems and human civilisations are now adapted. The atmospheric composition is 78% nitrogen, 21% oxygen, 0.93% argon as well as some other trace gases. One of these trace gases is carbon dioxide, comprising 0.04%.

Almost all (99%) of air is made up of simple double molecules – oxygen (O_2) and nitrogen (N_2) – which neither emit nor absorb infrared radiation. Molecules with more than two atoms of different elements - like water vapour (H_2O), carbon dioxide (CO_2), or methane (CH_4) – can trap heat by emitting more infrared radiation back to Earth (Figure 1). These are known as the greenhouse gases.

While carbon is a trace element in the air, vast amounts are cycled between the Earth and the atmosphere by geological and biological processes, and transferred by plant growth into the oceans, soils, and forests. **Millions of years in favourable geological conditions have turned decaying plant matter into the carbon-rich fossil fuels we know as oil, coal and gas.**

Burning fossil fuels releases carbon dioxide back into the atmosphere. Here the carbon dioxide acts as a particularly effective heat radiator because of its molecular structure. The amounts in the atmosphere are so small they are measured in parts per million (ppm), but a slight change in CO_2 concentration makes a large difference to the heat balance. The increased CO_2 adds to the natural greenhouse effect of the Earth – and causes the human induced global warming or 'enhanced greenhouse effect' we now have to address. In essence the CO_2 that was taken out of the atmosphere by plants over hundreds of millions of years is now being released back into the atmosphere in a matter of decades.

The Complexity of Climate Change

The United Nations sums up climate change science as follows:

"The average temperature of the Earth has been increasing more than natural climatic cycles would explain. This episode of "global warming" is due to human activity. It began with the industrial revolution, two centuries ago, and accelerated over the last 50 years. Fossil fuel burning is mostly responsible, because it releases gases (particularly carbon dioxide) that trap infrared radiation. This "greenhouse effect" creates a whole system disturbance, that we call climate change". (UNEP 2005)

The climate change process and risks are part of a complex interaction with human activities and the physical dynamics that define the global climate itself. The complexity of these interactions is explained in Figure 2.

Over the past century, average global temperatures have increased by approximately 0.74°C (Figure 3) and scientific evidence suggests this will continue (IPCC WGI 2007).

If, as predicted by current IPCC projection models, there is a doubling of atmospheric carbon dioxide, **the average global temperature is expected**

"In essence, the CO_2 that was taken out of the atmosphere by plants over hundreds of millions of years is now being released back into the atmosphere in a matter of decades."

Figure 1: An overview of the mechanism and scale of the greenhouse effect

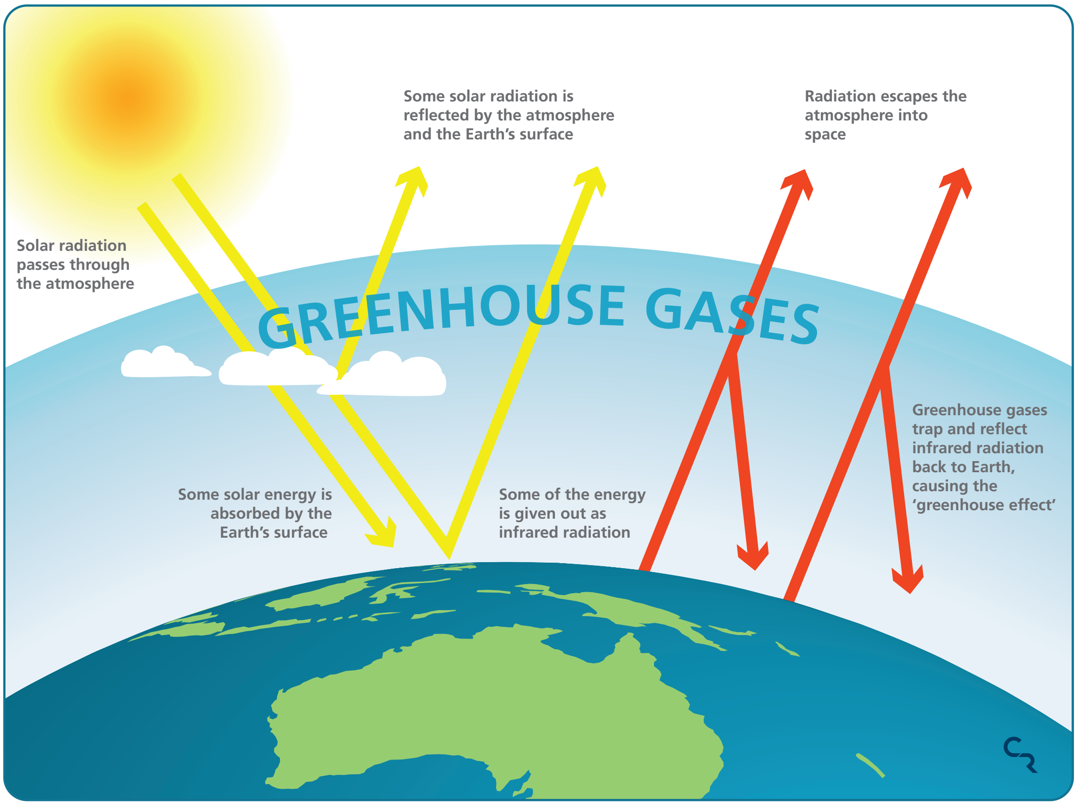


Figure 1. The diagram illustrates the process of warming which is driven by incoming solar radiation which is trapped by the atmospheric greenhouse gases.

to rise between 2°C – 4.5°C by 2100, with extremely serious implications for the global environment, society and economy (IPCC 2007a; Stern 2006; Houghton 2004).

Climate Change in Australia

The past century has seen Australia experience an average warming of 0.7°C and a significant reduction of coastal precipitation that is reducing the water supplies of our urban settlements and agricultural regions (Preston & Jones 2006). This warming trend is set to continue with predictions that relative to 1990 levels, average Australian temperatures could increase by between 0.4°C to 2°C by 2030 and between 1°C to 6°C by 2070 (Preston & Jones 2006) (Figure 4).

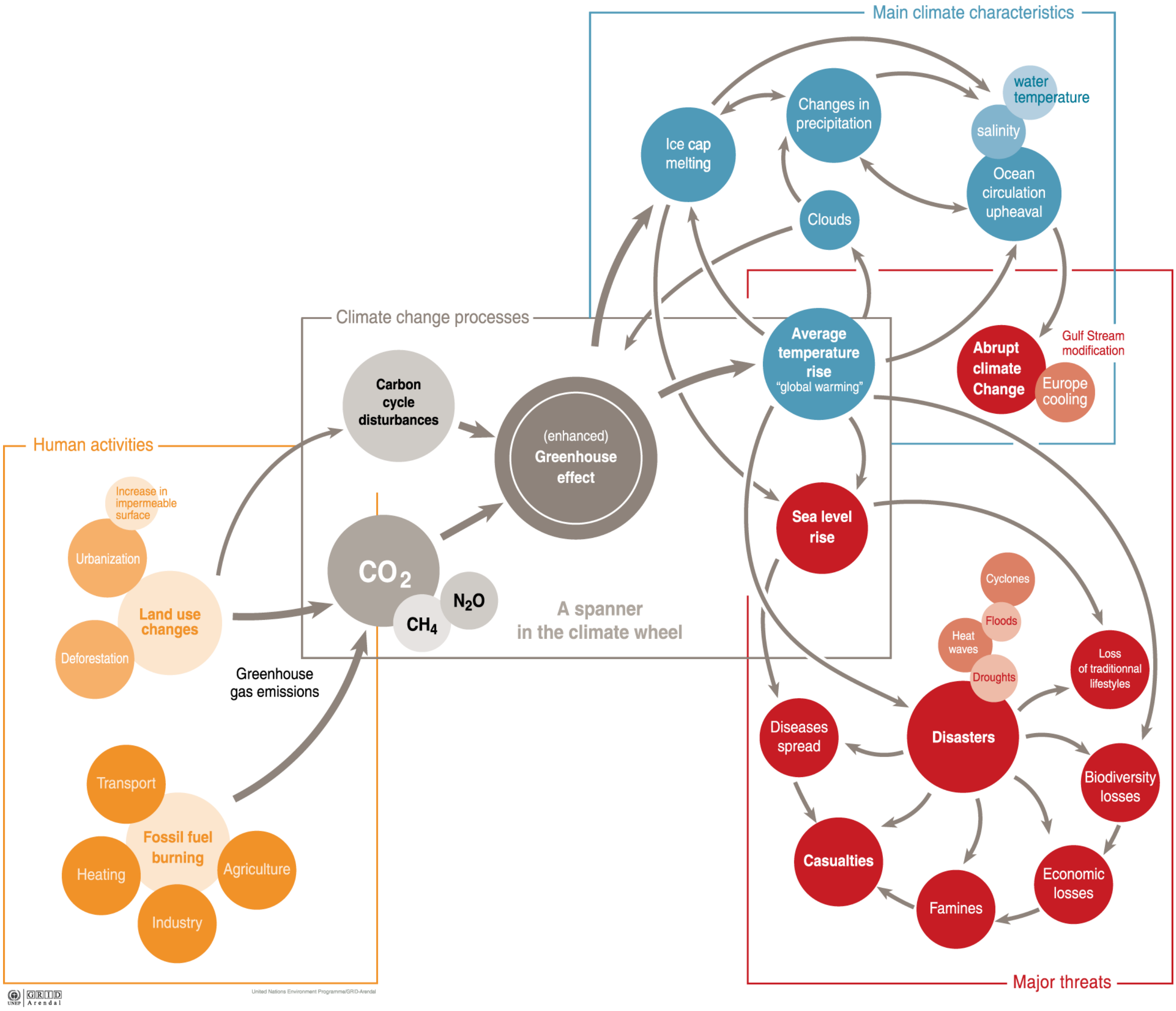
According to the Australian Greenhouse Office (AGO), climate change will place considerable strain on Australia's coastal communities including sea level rise and increased storm surges, changes to marine and coastal biodiversity and changes to fisheries (Voice *et al.* 2006).

Relevant impacts for Australia, based on a range of research include:

- **Reduced urban water supplies or increased costs (CSIRO 2006).**

Figure 2: The complexity of interactions that influence climate change and its impacts

Figure 2. The climate change processes and risks are part of a complex interaction with human activities and the physical dynamics that define the global climate itself (UNEP/GRID-Arendal 2006).



Soucrce: UNEP/GRID Arendal 2006

Figure 3: The changing global average temperatures since 1850

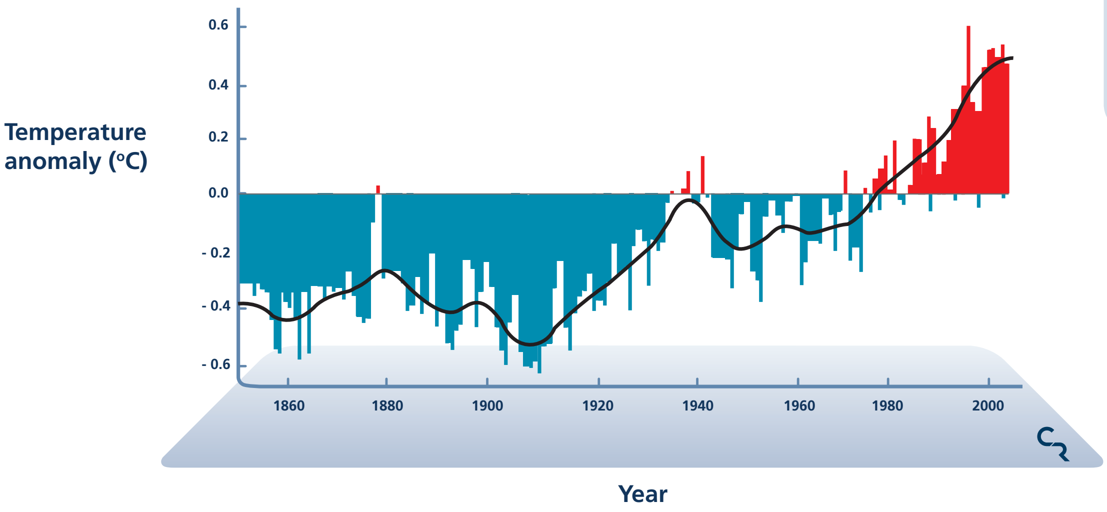


Figure 3. There is a discernable increase in global temperatures since 1900 as the black line with multi-year smoothing shows (Brohan *et al.* 2006).

- **Rural and agricultural community economic dislocation (Nelson 2006).**
- **Increase in extreme weather events (CSIRO 2006).**
- **Sea level rise and storm surge impacts on coastal settlements (Church 2006).**
- **A southerly movement of mosquito-borne diseases including Ross River Fever (Lyth 2006).**
- **Disruption of food security (Preston 2006).**
- **Loss of biodiversity including extinction of endemic species (Williams 2005).**
- **Reduced ecosystem services including water quality and availability; and decreased natural pollination of crops (Houghton 2004; Pittock 2005; Flannery 2005).**
- **Destabilisation and regional conflict in the Pacific including mobilisation of environmental refugees (Edwards 1999).**

What Does 'Avoiding Dangerous Climate Change' Actually Mean?

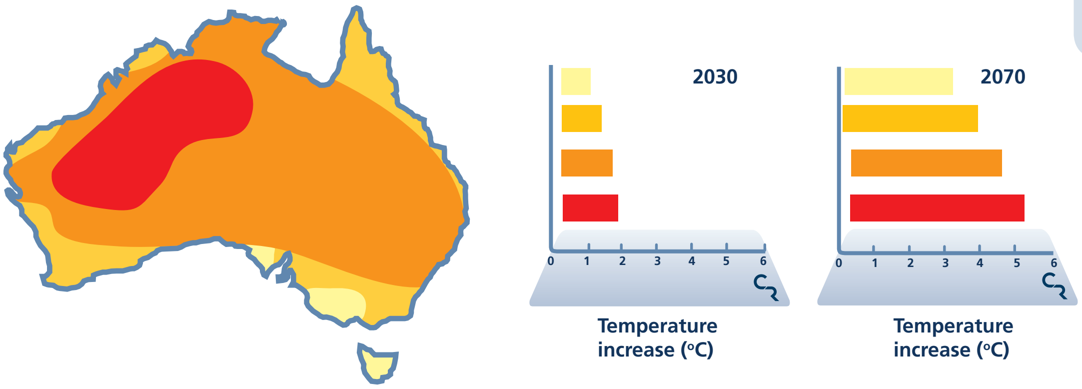
The latest IPCC report suggests that atmospheric CO_2 concentration alone (i.e. not including other gases) has increased from pre-industrial levels of 280 parts per million (ppm) to 380 ppm in 2005, which "exceeds by far the natural range over the last 650,000 years (180 to 300 ppm) as determined from ice cores." (IPCC WGI SPM 2007).

The term 'dangerous' climate change was introduced in the 1992 United Nations Convention on Climate Change (UNFCCC), from which the Kyoto Protocol was born. It calls for stabilisation of greenhouse gases to:

"prevent dangerous anthropogenic

Figure 4: Forecast average temperature increases in Australia

Figure 4. The changing mean temperatures around Australia based on modelling by the CSIRO.



interference with the climate system.... Such a level should be achieved within a time frame sufficient:

- to allow ecosystems to adapt naturally to climate change;
- to ensure that food production is not threatened, and;
- to enable economic development to proceed in a sustainable manner".

(UNFCCC 1992)

The UNFCCC and IPCC refer to, but do not define, 'dangerous climate change'. There is a general agreement that dangerous changes will occur with warming in the vicinity of 2°C above pre-industrial levels.

The European Union has formally resolved that:

"to meet the ultimate objective of the UNFCCC to prevent dangerous anthropogenic interference with the climate system, overall global temperature increase should not exceed 2°C above pre-industrial levels" (European Council 2004).

Understanding Emission Cuts

The recent IPCC statement on emissions abatement potential concludes that temperatures could be stabilised below 2.4°C provided that emissions stop increasing by 2015 and are then reduced by between 60-95% by 2050[1] (IPCC WGIII 2007). This is the first time that scientists and governments, through the IPCC, have nominated a deadline beyond which emissions cannot continue to grow if certain levels of climate change are to be averted.

Greenhouse gas emissions accumulate in the global atmosphere and will therefore have to be managed by international agreement. However,

"There is a general agreement that dangerous changes will occur with warming in the vicinity of 2°C above pre-industrial levels."

1 Converted from the range 50-85% relative to levels in the year 2000, and assuming that global emissions have increase by approximately 10% between 2000 and 2007

emissions cuts will have to be implemented at a national level.

The latest figures released by the Australian government (AGO 2007b) indicate that forecast emissions even 'with measures' will not see any stabilisation before 2015, nor any reduction within the foreseeable future (Figure 5).

National Emissions and Per Capita Emissions

Greenhouse gas emissions vary considerably, especially between developed countries and developing countries, both at a national level and per person (Figure 6). Australia has the highest emissions per capita of any developed country (OECD) with the equivalent emissions of 26 tonnes per person carbon dioxide per year. China is one of the worlds biggest greenhouse gas polluters, but this is largely due the high population. On a per capita basis a Chinese person is responsible for about 2.3 tonnes per year.

Adaptation and Mitigation

Strategies to deal with climate change generally consist of two elements: adaptation and mitigation (Pittock 2005).

The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as an 'adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities' (Metz *et al*. 2001, p.708). Mitigation is defined by the IPCC as 'an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases.' (Metz *et al*. 2001, p. 716)

Figure 5: Australian current and projected annual net greenhouse gas emissions

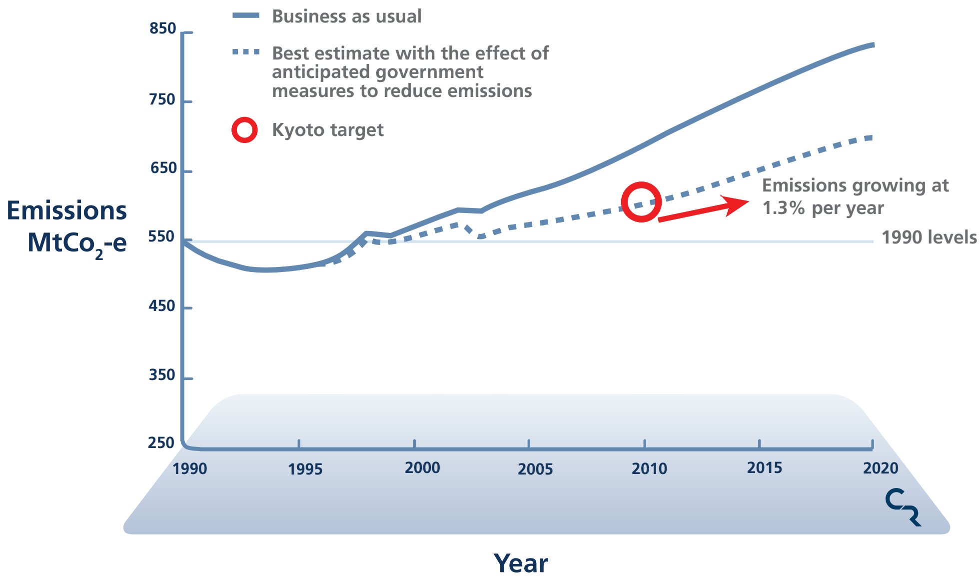


Figure 5. Australia may meet its Kyoto Target, but government projections indicate that emissions will not have been stabilised (AGO 2007a).

'WITH MEASURES'

The term 'with measures' refers to government initiatives with allocated budgets, timetables and, if necessary, supporting legislation which are used to adjust projections of future emissions.

Figure 6: Variation in national emissions across the world

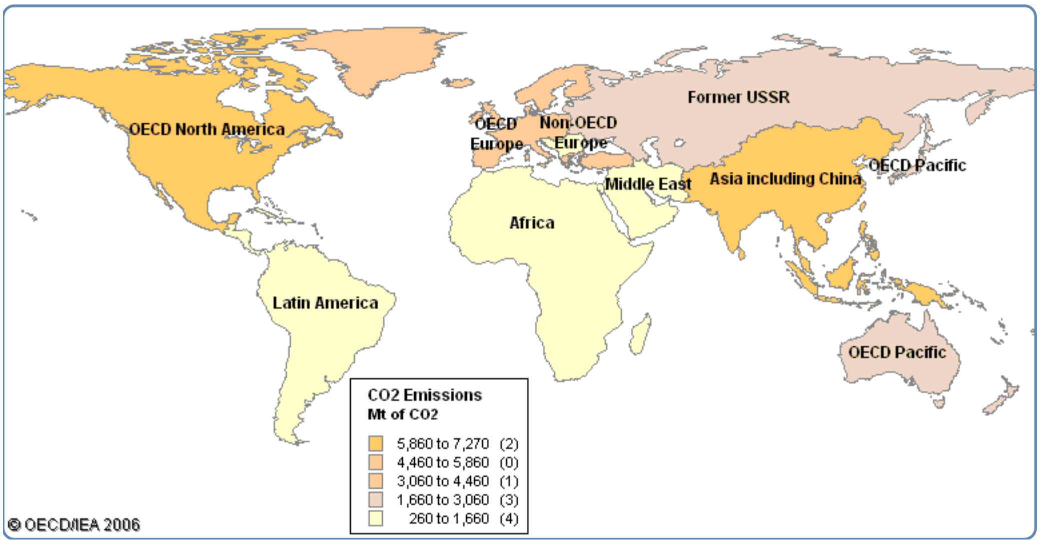


Figure 6. Though Australia has comparatively low emissions at a national level, on a per capita basis its emissions are amongst the highest in the world due in part to high levels of coal use, fugitive emissions from fossil fuel extraction, energy intensive industries such as metals and minerals processing and land use activity that causes large amounts carbon to be unlocked as forests are cleared (OECD 2006).

The connection between adaptation and mitigation is often overlooked. Environmental lag time means that climate change is not only already underway, but several decades of increased warming are unavoidable. Human beings must adapt to current and future changes that are already locked in. Mitigation strategies can only reduce the speed, magnitude and severity of future impacts and may seek to ensure that the future climatic change that occurs is within our capacity to adapt (Pittock 2005). In a summary for the IPCC advocate that adaptation and mitigation need to be considered together in any climate change response (Banuri *et al.* 2001, p.52).

A Carbon Price

The regulation of pollutants has a long history in developed countries and there are many established mechanisms for control. In some cases pollutants are banned, in other cases regulation is used to specify the legal amount of a pollutant that can be released into the environment. A more recent innovation is the use of trading markets to control emissions, such as those in the US used to control sulphur dioxide emissions (which causes acid rain). It is also possible to introduce pollution taxes which force up the cost of the polluting technology to the point where alternative technologies become viable.

For greenhouse gas emissions, key mechanisms under development are:

a. ‘emission caps’ which place a legal limit on the amount that a country may emit;

b. carbon taxes which are designed to place a cost on pollution; and

c. emissions trading in which the total rights to emit greenhouse gases under a national cap can be bought, sold and traded.

Emissions Trading

There is now bi-partisan support for the introduction of emissions trading in Australia. Under this system a cap will be placed on the amount of emissions that can be released across the country, and the rights to emit will be given out and/or auctioned. As the cap gradually reduces over time the market value for the right to emit will gradually increase. In this way the emissions trading scheme creates a 'price of carbon' which reciprocally creates a value for greenhouse gas abatement.

In some cases, it may be possible to create a tradeable abatement commodity, often referred to as a 'carbon credit'. An existing example of a tradeable carbon credit in the Australian market is the 'Renewable Energy Certificate' which is regulated by the federal government. The types of abatement that will be tradeable will depend on the rules of the Emissions Trading Scheme which are yet to be established, however abatement which is not tradeable will still have a value consistent with the 'price of carbon'. This report uses carbon prices developed by the CSIRO, ABARE and the Energy Futures Forum based on several emission scenarios in Australia (Figure 7).

Figure 7: Projections for carbon prices for several emission cut scenarios modelled by the CSIRO and ABARE

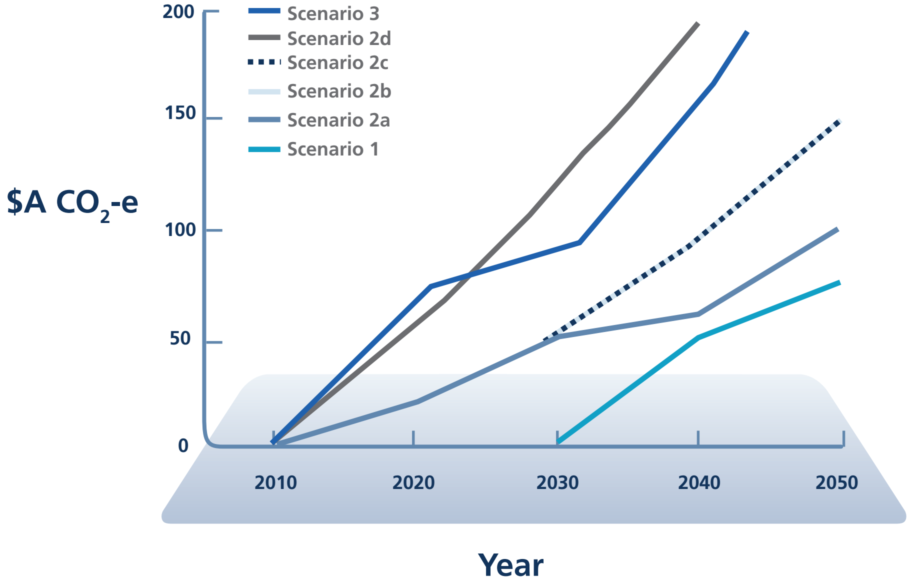


Figure 7. The CSIRO recently convened an Energy Futures Forum of major energy industry participants and stakeholders to develop long term scenarios affecting Australia's energy future. The scenarios were modelled by the CSIRO and ABARE. These results are used as the basis for the three carbon price points used herein, namely $10, $20 and $50 dollars per tonne CO_2-e (CSIRO, 2006).

Part 2

The Emissions Signature of Broadband

Telecommunications is a large user of energy. The most recent survey of Australian businesses indicates that their Information and Communications Technology (ICT) use is responsible for about 7.9 MtCO_2-e, or about 1.4% of national emissions (ACS 2007). Emissions arising from Telstra's operations account for about 0.21% of Australia's total emissions (Telstra 2006). While this may seem negligible in comparison to other sectors, a major expansion of networks and usage could lead to significant changes in emissions. In this section we seek to establish how significant. We do not consider life-cycle emissions or embodied energy (e.g. the energy or materials used to make a modem), which although significant are dwarfed by the energy flows in the ICT sector.

Understanding Telecommunications Networks

Telecommunication networks and broadband are best understood by considering three key elements:

1. Content – such as emails, music or videos as well as the applications and services that are needed to access this content;
2. Networks – the systems that transfer content from one place to another; and
3. Devices – such as computers, Personal Digital Assistants (PDA) and mobile phones.

Content

All electronic content is comprised of data. Data is measured in bits– kilobytes (KB), megabytes (MB), gigabytes (GB) and terabytes (TB). Data requirements vary widely among different kinds of media content. For example:

- Text-based **email** contains about 10-25 KB of information
- An **SMS** contains only 1.5 KB for a 160 character SMS
- A medium-sized **novel** contains about 5 MB of information
- A **song** contains about 5 MB of information
- A 3-minute, high-quality music **video** clip contains around 60 MB of information
- A **movie** at DVD quality contains around 7-10 GB of information for dual-layer discs
- A **library** contains 1-30 or more TB of information

Content data can be stored on devices, for example the hard drive of a computer, the memory of an iPod® or the address book in a mobile phone. Data can also be stored in a network or on server, for example much of the information available on the Internet like videos on YouTube™ and the photos on FaceBook™.

Networks

Telecommunication networks carry content from one place to another. Networks connect landline telephones, mobile phones and computers. They also connect consumers to businesses and businesses to businesses, both in Australia and overseas.

The performance of networks can be thought of like the performance of water pipes. Big pipes carry more water than small. Transferring data is like transferring water which need a network of pipes, and the quality of the architecture and size of the pipes will determine the volume and speed at which data is carried. In a telecommunications network the size of pipes or network capacity is known as 'bandwidth'.

Unlike a water system, data needs to flow in two directions. The amount of bandwidth coming "in" (called "download") has traditionally been greater than the amount of bandwidth going "out" (called "upload"), as there are more users who want to get content than create content. However this is changing with businesses and consumers starting to "upload" larger packets of information or data – for example, large video files (like videos placed on YouTube™) and e-mail attachments (like digital photographs) are now routinely sent out (or "uploaded"). In this way networks are evolving as the Internet becomes more like a two-way highway.

Devices

Devices include computers, modems, wireless turbo cards, mobile phones, PDAs – effectively anything that plugs into a network to receive and send data.

The speed at which content can be accessed is determined by the amount of content, network and the devices using the network.

The capacity of the device is part of the overall performance of the system, for example, there may be a lot of network capacity to handle a digital file, but unless the device has the capacity to process the data quickly, the overall performance will be limited. For example, if a video conference is occurring between a mobile phone and computer, the capacity of the mobile device and the computer will contribute to the clarity of the video.

Broadband

Broadband is sufficient data transmission speed to utilise applications, services or content effectively relative to the user's access device or capabilities (KPMG 2004).

Broadand covers systems running over fixed connections such as copper, coaxial cable or fibre optic cables as well as wireless links such as those that mobile devices use (e.g. 3G or the Next G™ wireless network).

> "Information Communications Technology appears to have been causing significant decreases in the energy intensity of economic activity across the wider economy."

Three Ways to Consider the Issue

Emissions effects from ICT networks are considered in three ways.

1. A review of a macro-economic assessment of the effects of ICT on national emissions in the USA.

2. A review of energy demand impacts from ICT network operation in the United Kingdom and the secondary impacts on broadband-based customer activities.

3. A review of the status and trends for energy consumption (and therefore emissions profile) of relevant devices.

Macro-economics of ICT from the USA

In the USA ICT brought about a partial decoupling of economic growth from energy consumption. In order to explain this interaction we need to consider the period prior to the major expansion of ICT in the US.

From 1992 to 1996, US economic growth averaged 3.4 % a year while energy use grew by 2.4% a year (Romm 2002) - consistent with the opinion that a growing economy needs ever more energy. However from 1996 to 2000, Romm reports an apparent anomaly in US energy statistics. The US GDP growth increased to over 4% a year, but during the same period, energy demand only increased by 1.2% a year. The energy intensity of economic growth - energy consumed per dollar of GDP - decreased by more than half (1997 and 1998 saw decreases of 3.7% and 3.9% respectively)[2]. Except for the oil shocks of the 1970s, this discontinuity in the connection between growth and energy was unprecedented in post-war US economic history.

The critical change that occurred during this period was the introduction of the internet, which was being deployed alongside the PC systems introduced in the previous part of the decade. Major economic growth was occurring online. Expansion of ICT deployment did require increased energy, in 2002, office ICT equipment across the US used 3% of total electricity (Roth 2002, p. 143).

The conclusion from these macro-economic studies of broadband energy issue is: if energy in ICT use was increasing, yet the energy intensity of the economy was decreasing, then ICT appears to have been causing significant decreases in the energy intensity of economic activity across the wider economy.

Power use for ICT has continued to increase through the broadband revolution. Analysis in 2006 notes an increase in energy demand from home/consumer ICT (Roth 2006, p. 53-54), ascribed to PCs and related equipment being 60% to 100% more than in previous studies, with most of the additional demand arising from devices being left on overnight. This is an issue we will consider in more detail later in the report.

2 It should be noted that weather related factors may have accounted for some of the changes not exceeding 0.5% (Romm 2002).

Looking forward, while ICT networks and applications need energy it appears that they can realise much greater reductions in energy use across the wider economy.

The UK Broadband Environmental Audit

Similar concerns about burgeoning energy use from broadband application in the United Kingdom led to British Telecom (BT) commissioning British environment group Forum for the Future to assess the environmental impacts of broadband (Forum of the Future 2004). The results are summarised in Figure 8.

The Forum found that the top four negative impacts were climate change, network energy use, customer energy use and waste. The authors suggest that indirect impacts on energy use are 14 to 27 times higher than direct energy use (as defined in Figure 9). Clearly the critical issue is the extent to which the 'secondary' and 'tertiary' effects are positively or negatively correlated with broadband.

The BT report claimed that teleworkers for the British Airports Authority had saved approximately 100 kilometres of car travel each week. The report projected that teleworking could cut peak-hour travel by between 1.6% and 5.4% by 2010. The report's view is somewhat ambivalent: there is the "potential for environmental savings", but they "can only be realised through

Figure 8: Environmental impacts of broadband use in the UK

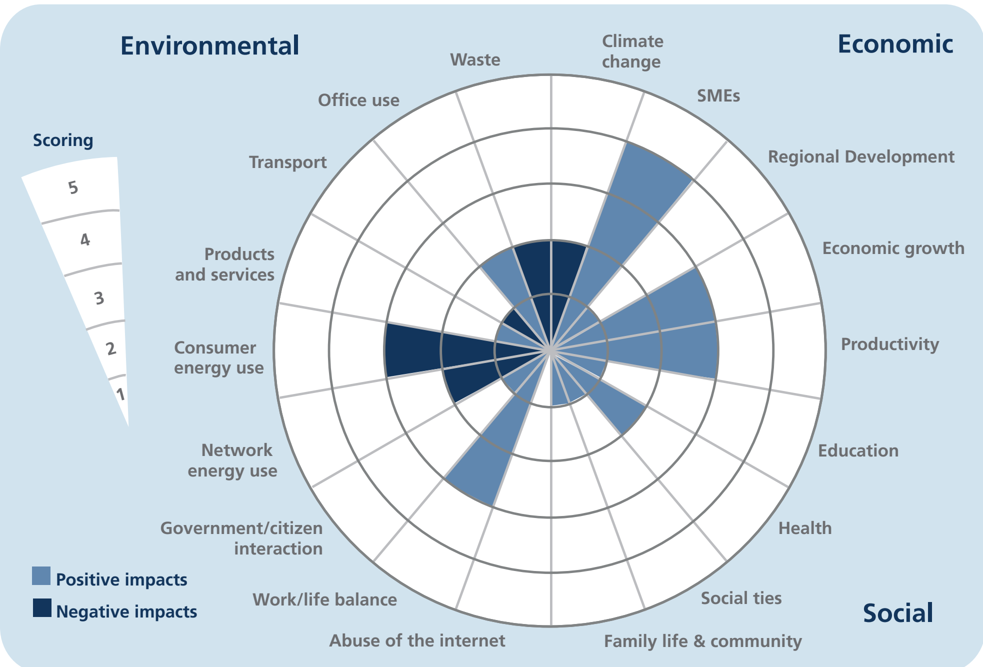


Figure 8. Forum for the Future concluded that broadband use would have negative impacts on climate change, consumer energy use, network energy use and waste (Forum of the Future 2004).

Figure 9: Definition of direct and indirect impacts from broadband usage

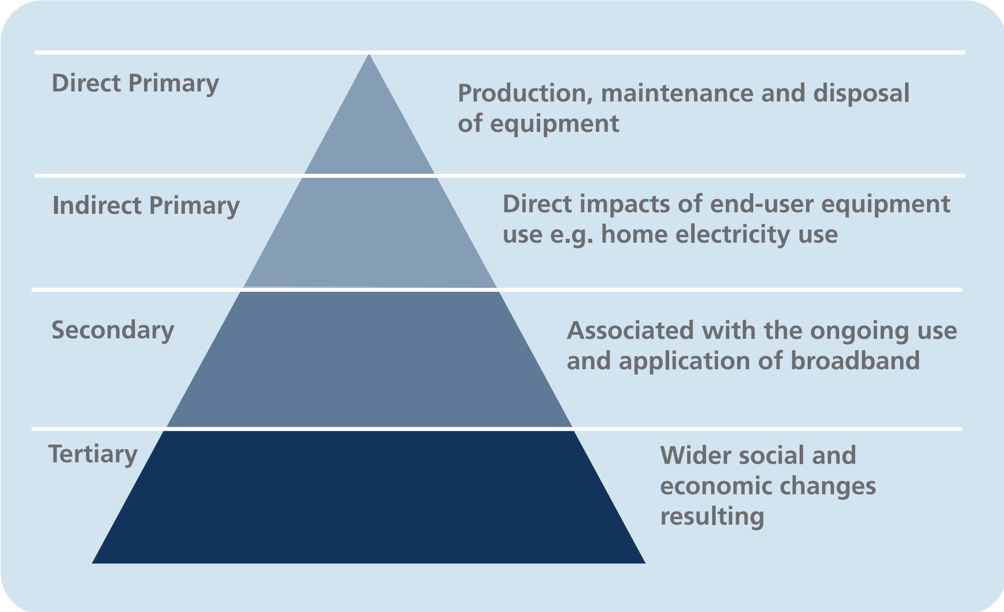


Figure 9. Forum for the Future concluded that the key aspects for assessing the 'whole' impact of networks will include the secondary and tertiary impacts (Forum for the Future 2004).

changes in behaviour and corporate policy." It contends that even with telework and reduced commuting, car use would continue to grow, presumably due to other unrelated factors.

The report also notes that telework could reduce office space demands by 15%, which clearly has commensurate impacts on energy demands in commercial workplaces. The critical observation in the context of this report is that even the projected direct and indirect emissions associated with broadband expansion represent only a "tiny percentage of UK emissions… secondary and tertiary impacts are likely to be much greater, e.g. an increase in transport intensity is ten times more significant for CO_2 emissions than all primary broadband impacts."

The overall conclusion was that the delivery of environmental outcomes "could swing either way" but that the key element affecting this swing would be the associated [customer] behaviour and corporate policy.

To some extent this conclusion is in contrast with the US results, which indicated that a fundamental dematerialisation of energy use happened even without an environmental objective. Since this report was released, the process of 'unintended' dematerialisation has continued. For example, energy demand is significantly reduced in the transition from motor driven physical storage (e.g. the CD) to chip storage. Nonetheless, it is clear that coordination could have a critical role in enabling an intended outcome regarding carbon emissions, and a lack of such an objective could lead to a swing to negative outcomes.

Status and Trends in Underlying Devices

The energy trajectory of the devices that underpin broadband is influenced by incremental and step changes.

Incremental changes are those in which the same device becomes steadily more efficient. Often this is achieved by more expensive technologies being pulled into the market as economies of scale are achieved, and this can be aided by technology standards or targets. Table 1 shows the evolution in energy demand between two successive product specification years and the incremental changes delivered.

To drive incremental change, the EU has issued a code of conduct setting out power consumption targets for a wide range of broadband equipment under 10 watts per device (Table 1) (European Union 2006). As broadband devices evolve, their specifications show significant reduction in energy usage despite increased processing capacity.

Step changes are major shifts which often accompany a switch in underlying technology, such as CD to MP3, or tube to flat screen monitor. Reductions in energy usage typically follow step changes.

There is ongoing technology push and pull in the ICT space. Cisco Systems, a leading provider of data network equipment, point out that data routing equipment (used by organisations such

> "An increase in transport intensity is ten times more significant for CO_2 emissions than all primary broadband impacts. (Forum of the Future 2004)"

Equipment	Tier 1: 1.1 - 31.12.2007		Tier 2: 1.1. - 31.12.2008		
	Off	On	Off	Standby	On
ADSL/VDSL-modem USB powered	0 W	1.5 W	0 W	0 W	1.5 W
ADSL/modem (Ports: 1 DSL, 1 Ethernet 10/100, 1 USB Device, 1.1/2.0 firewall), Cable Modem, PLC modem	0.3 W	6.0 W	0.3 W	2.0 W	4.0 W
VDSL-modem (max ports: 1 DSL, 1 Ethernet 10/100, 1 USB 1.2/2.0 firewall)	0.3 W	8 W	0.3 W	2.0 W	6.0 W
Each additional function of the following: WLAN 802 11h/g, WLAN 802 11a FXO, FXS/VoIP, hubswitch for several ports, DECT, Bluetooth		2.0 W			2.0 W
WLAN access points	0.3 W	6.0 W	0.3 W	2.0 W	6.0 W
VoIP Device	0.3 W	5.0 W	0.3 W	2.0 W	5.0 W
Small printer server	0.3 W	5.0 W	0.3 W	2.0 W	5.0 W
Small hubs and switches	0.3 W	5.0 W	0.3 W	2.0 W	5.0 W

Table 1. Power Consumption Targets of end use equipment for networks (European Union 2006).

as Internet Service Providers) has seen an increase of data throughput of 233% in 10 years for the same amount of power (Cisco 2005).

Not only can step changes reduce the energy intensity of ICT devices, but they also result in 'smarter' devices. In early 2007, Sky (the UK's largest satellite broadcaster) released a satellite set-top-box with automatic functionality to turn itself off completely, rather than go into standby mode when not being used.

The Balance of Network Impacts

The key conclusions from a consideration of the greenhouse gas impacts of network use are as follows:

1. The previous research presented indicates that there is evidence of a strong link between telecommunication networks and a reduction in the intensity of society-wide/economy-wide energy use and therefore greenhouse gas emissions.

2. The assumption that the use and extensive growth of ICT networks gives rise to major increases in energy consumption is not valid. The large rise in ICT use in the US was a major part of economic growth during a period when the energy intensity of economic activity actually decreased.

3. The trends in new technologies around energy consumption in data networks indicate that energy consumption reductions of 90% are possible (see Figure 10) and are now coming through to the market. However these ongoing reductions are occurring at a time when the volume of use is increasing significantly.

4. The most significant impacts from networks will be in how the networks are used by business and residential consumers and the consequent impacts on their emissions footprint. These impacts will be at least an order of magnitude larger than any direct impacts from energy related to using ICT networks.

5. There is very little evidence that the ability of networks to leverage emissions cuts has been deliberately attempted thus far. Society wide emissions and abatement have not been made a central part of the decision-making for network outcomes in the global telecommunications sector. There have been however significant attempts to reduce energy consumption in order to reduce operation and infrastructure costs and so emissions reductions have occurred as an 'unintended' but beneficial side-effect.

6. There are warnings from some analysts that without intent and coordination the positive outcomes seen thus far could swing the other way into increased relative emissions. For example the current trend towards flat screen monitors may decrease monitor emissions if

> "The most significant opportunities to reduce emissions from networks is through the leveraging of emission reductions in the wider society via the use of network enabled applications."

LCD screen monitors are adopted, or increase emissions if plasma based monitors are chosen instead.

7. One of the major conclusions to be drawn from reports just a few years old is the profound inability to second-guess future technology change and therefore not to assume that the future will be based on the past or present. If technology developments are guided by governments or corporations, future changes in performance and use are likely to have a lower emission signature than would otherwise be the case.

The key conclusion, in the context of this report, is that although the direct impacts of broadband are large, they are dwarfed by the secondary and tertiary impacts that they stimulate in the wider society. The most significant opportunities to reduce emissions from networks is through the leveraging of emission reductions in the wider society via the use of network enabled applications.

Figure 10: Analysis of ICT energy use

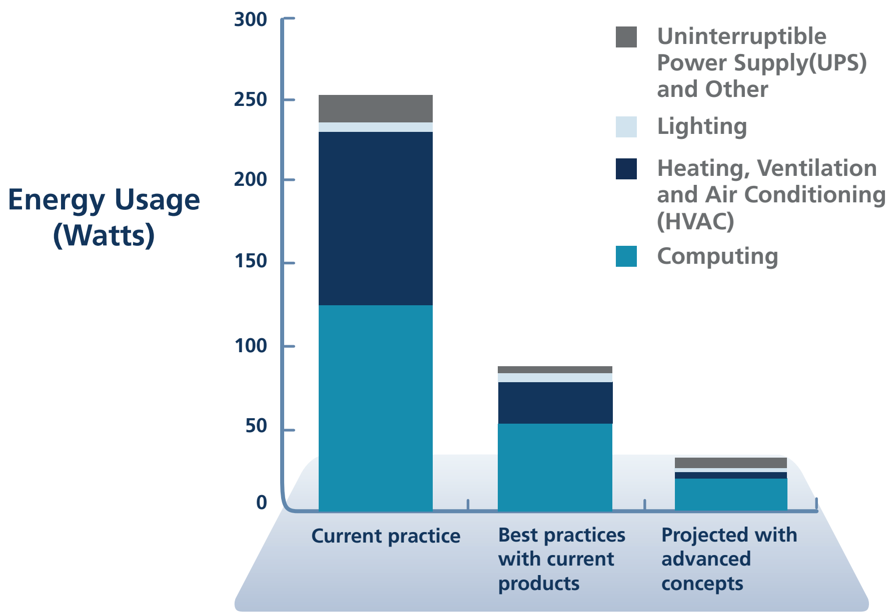


Figure 10. Industry research into reducing the energy demand from ICT use shows opportunities for reducing energy consumption by up to 90% (Integrated Design 2003).

Part 3

Identifying Carbon-Opportunities for Telecommunication networks

The genesis of this project was the recognition that a movement towards teleworking should contribute to reduced greenhouse gas emissions due to reduced transport use. A review of the emerging broadband technology revealed that network-related innovations may facilitate further emission reductions. Telstra commissioned Climate Risk to quantify the potential of existing and next-generation networks and applications for carbon abatement, and the opportunities for telecommunication networks to play a role in climate change mitigation in Australia.

The idea that ICT networks can reduce greenhouse gas emissions is not new, but still nascent. Excellent high level work published internationally has highlighted several ways in which ICT may assist emissions abatement (ETNO 2006). In this report we have built upon this research to pragmatically re-consider the types of opportunities available, the plausible market uptake of new technologies and services, the scale and significance of these opportunities at a national level and the costs and benefits to telecommunications providers and their customers. We also present several new opportunities to reduce emissions which are potentially larger in scale than any opportunities previously identified, as well as being internationally applicable

In order to provide a consistent methodology to identify opportunities and maximise carbon abatement potential, Climate Risk adopted the following process:

Step 1: Review Australian National Greenhouse Gas Inventory, identify relevant sectors, discount less relevant sectors and identify 'target' emission sources.

Step 2. Review current and emergent network technology and applications for the sectors identified.

Step 3: Overlay the results of steps 1 and 2, to identify telecommunication network opportunities which reduce carbon emissions and create financial value for end users.

Step 1. Identifying Relevant Sectors

In 2005 Australia's net greenhouse gas emissions were 559 MtCO_2-e, about 2.2% above emission levels in 1990.

Table 2 shows the major emissions by category. By inspection, broadband can provide only a limited role in agriculture, land use, land use change and forestry (LULUCF), industrial processes and waste. There may be some relevant applications, but these are not in the main target markets typical for network services. For example an area where ICT networks could contribute significantly to these emissions sectors is through 'dematerialisation', i.e.

Sector and subsector	CO_2-e
Stationary energy	279.4
Agriculture	87.9
Transport	80.4
Land use, land use change and forestry	33.7
Fugitive emissions from fuel	31.2
Industrial processes	29.5
Waste	17.0
Total net emissions	559.1
All energy (combustion & fugitive)	391.0

Table 2. Australia's net greenhouse gases by sector (AGO 2007b).

ways in which the requirement for new materials is avoided.

The stationary energy[3] and transport sectors represent 64% of emissions (Figure 11). These sectors also experienced the largest growth in emissions between 1990 and 2005 (energy grew by 43% and transport by nearly 30%). They are highly relevant sectors in the context of this report.

The dominant work in the mitigation of greenhouse gas emissions from energy and transport tends to rest on three pillars:

a. Decreasing the amount of energy needed – through efficiency or changed demand

b. Increasing the provision of renewable/zero emission energy

c. Decarbonising the emissions from the use of fossil fuels.

Step 2. Reviewing Current and Emergent Network Technology

This step requires a review of current and emergent network technology and appliances.

What can reasonably be expected in the future is that the push and pull of demand and supply will drive up speeds and volumes of network use, and drive down relative costs. Consequently the same can be expected of the applications that these networks provide.

There are two other relevant trends. The first is the trend towards distributed intelligence, where decision-making occurs at any point within a network.

3 Stationary energy includes emissions from electricity generation, the use of fuels in manufacturing, construction and commercial sectors, and residential heating. It excludes transport fuels.

Figure 11: Breakdown of Australian energy emissions by sector

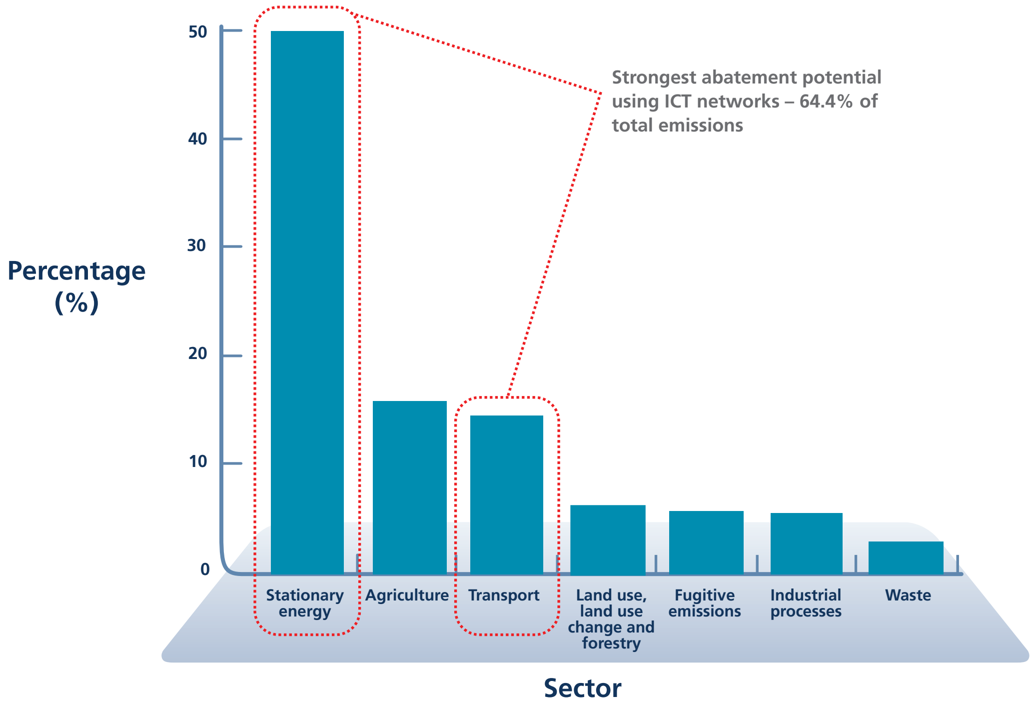


Figure 11. Contribution to net CO_2-e emissions by sector 2005 (AGO 2007b, p.3).

> This combination of smart devices and netwrok control is a potentially powerful tool in energy management.

The second is the process of intelligence moving into devices. Devices that were once passive, increasingly have the capacity for communication and distributed control. This combination of smart devices and network control is a potentially powerful tool in energy management.

The task of forecasting applications in terms of energy use is driven by basic human needs and activities. We can reasonably expect that whatever the new technology, people will be wanting energy for light, heat, cooling and devices that allow them to communicate and travel for work and recreation. This report will focus on broadband solutions that can assist with addressing the energy or emissions footprint of these basic human needs.

Step 3. Major Carbon-Opportunities for telecommunication providers: Overlaying emission sources with network technologies

Based on steps 1 and 2 we can conceptualise the overlaps between emission sources and network technologies occurring in three distinct but interrelated areas: the home, the workplace and the transport of people, goods and services (Figure 12).

Figure 12: Interdependence of building and transport energy emissions

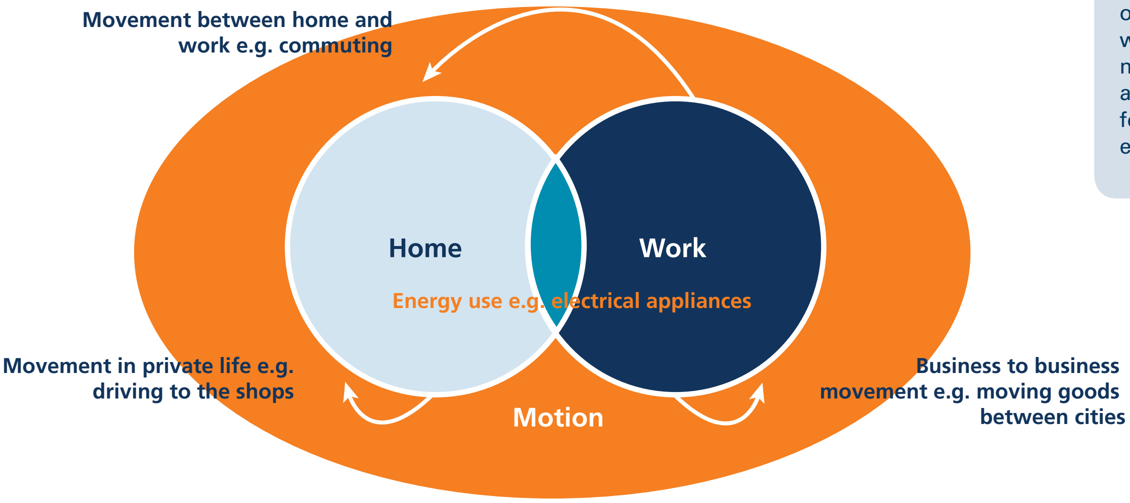


Figure 12. The carbon footprint of home and workplaces are often separate, but may overlap for people who work from home. The motion of people, goods and services accounts for a large proportion of emissions.

The home includes all of the activities that happen inside the home that use energy or affect energy use. The workplace includes many of the same needs and activities, however as noted above this does not include emissions related to 'industrial activity'.

The carbon footprint of homes and workplaces are often separate, but may overlap for people who work from home.

The transport of people, goods and services accounts for a large proportion of emissions. Broadband has the capacity to reduce transport needs and therefore reduce greenhouse gas emissions (Figure 13).

To identify specific telecommunications enabled opportunities which are realistic and can deliver meaningful greenhouse gas abatement, the following criteria were used:

1. The opportunity is economically viable;
2. Each opportunity has the potential to reduce Australia's total net emissions by 1.5 MtCO_2-e.
3. The telecommunication sector's scale and scope can facilitate the full utilisation of opportunity.

On this basis we see significant opportunities related to buildings, air travel, road transport and renewable energy.

A final group of seven carbon-opportunities are presented here[4].

1. Remote Appliance Power

4 The appendices provide a more detailed explanation of the identification, elimination and consolidation process and a wider list of the additional greenhouse gas abatement options.

Figure 13: Pathways to reduce building and transport energy emissions

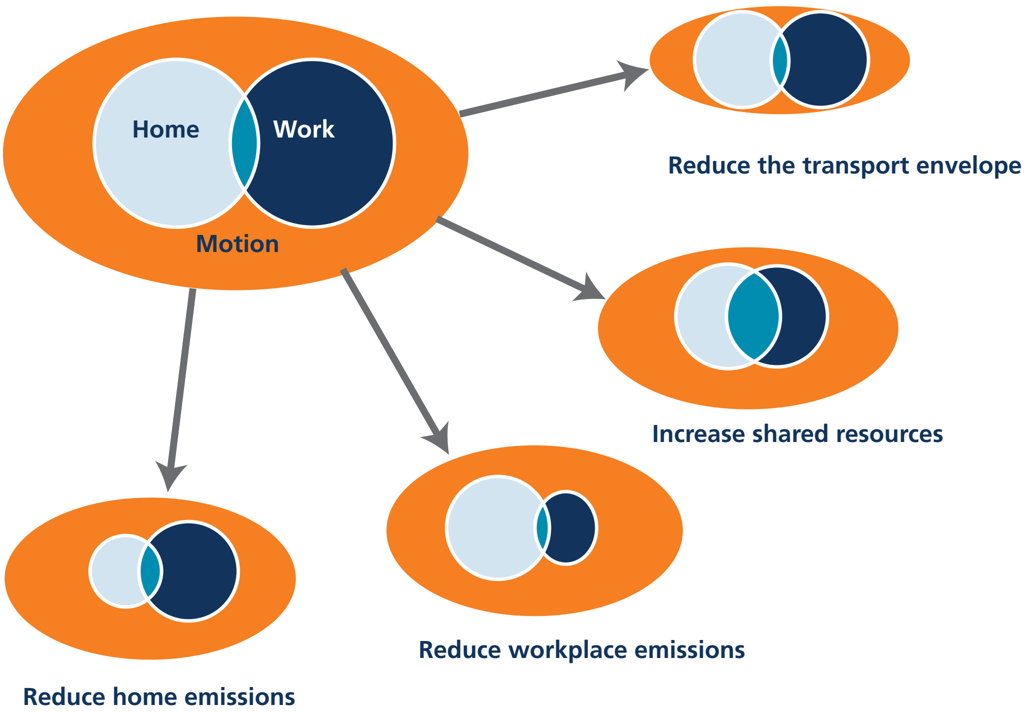


Figure 13 . A conceptual framework for residential, commercial and transport emissions and how they may be abated.

Management – The opportunity to drive monitoring and control downstream to the power supply system in the home and workplace, while pushing intelligence and management upstream into the network as a way of identifying and then eliminating standby power wastage.

2. Presence-Based Power - The ability of broadband-enabled buildings and devices to allow a user-focused energy flow, in which only devices inside the physical range of interaction of the user are activated.

3. De-centralised Business District - The capacity for broadband enabled homes, suburbs and regional centres to either remove or significantly reduce the emissions of people getting to and from their place of work.

4. Personalised Public Transport - The potential for an integrated network of transport modes (eg bus, train and taxis) to provide Personalised Public Transport. Faster speeds door to door, high flexibility and lower costs, are accompanied by significant opportunities for greenhouse gas abatement.

5. Real-time Freight Management - The potential of broadband-enabled vehicles and load monitoring to

reduce unladen (empty) and under-laden trips.

6. Increased Renewable Energy - The potential for extensive broadband networks to monitor and facilitate the management of heating, cooling and other loads. This load management can be undertaken by an integrated mobile and fixed broadband platform and be used to effectively neutralise the short-term variability of renewable energy supplies, turning them into 'stable and predictable' power generation.

7. 'On-Live' High Definition Video Conferencing - The opportunity for long distance, short duration travel to be effectively replaced with 'in person' quality online conferencing that is considerably more cost, time and energy efficient, with significantly reduced emissions.

Viability and Implementation

The carbon opportunities identified in the report have been selected in part because of the practicality of their implementation, i.e. that there are technologies, products, services or systems that can readily assimilate the identified innovations and deliver them to market. In some, but not all cases, there is assumed to be market pressure for reduced emissions through carbon pricing and a premium value for renewable energy. These assumptions are plausible given current statements by political leaders in Australia.

Beyond an initial screening for viability, this report does not set out a business strategy or road-map for commercially realising the carbon-opportunities identified, and so a detailed analysis of implementation options and barriers is not provided or implied.

Part 4

Major Carbon-Opportunities for Telecommunication Networks

Carbon-Opportunity 1: Remote Appliance Power Management

At a Glance

This opportunity reduces wasted electricity by networking the monitoring and control of power use in the electrical systems of homes and workplaces.

Status and Trends

Homes and commercial premises currently consume approximately 108,000 Gigawatt-hours of electricity per year (based on ABS 2007), creating roughly 100 million tonnes (assuming a little under 1 tonne CO_2 per megawatt hour) of greenhouse gas emissions, or about one fifth of the country's 559.1MtCO_2–e of emissions (AGO 2007b; CAIT 2007).

In homes and offices around the country, devices on 'standby' consume power even when they are not being used. Standby energy wastage ranges from 4%-6% in offices to 12% of total consumption in homes (Harrington & Kleverlaan 2001; AGO & ICLI 2005).

Currently there are efforts to reduce the energy consumption of devices on standby (Energy Efficient Strategies 2006), and campaigns to change behaviour by turning devices off at the plug to avoid drawing power when unused. Both approaches require changes to thousands of different

> "Devices on 'standby' consume power even when they are not being used. Standby energy wastage ranges from 4% to 12% of total consumption."

Figure 14: Standby and conversion loss by end-use appliances

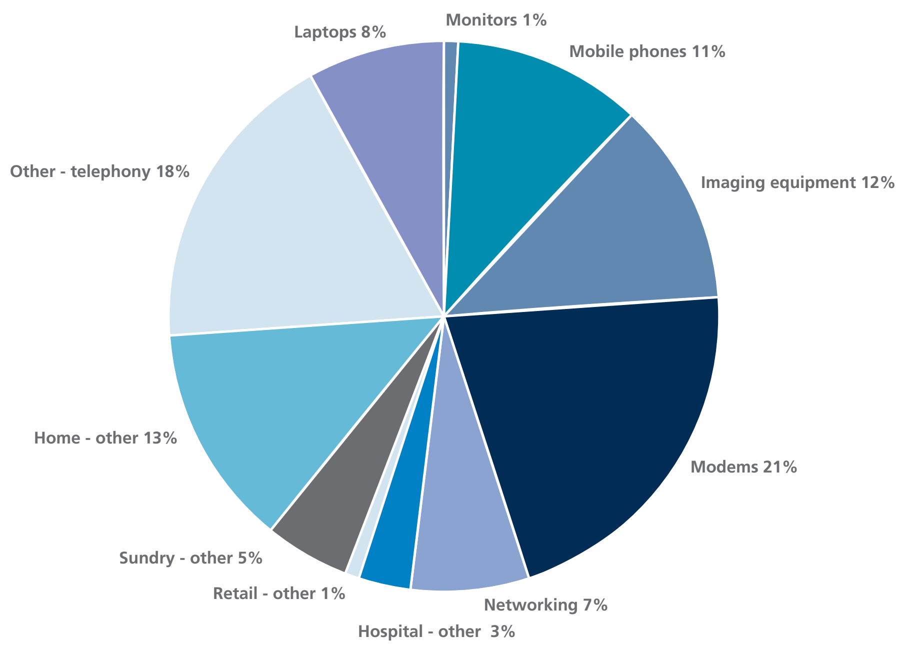


Figure 14. Energy is lost while devices are on standby and also in converting voltages between the outlet and the device 'conversion loss'. The chart shows the relatively high level of energy waste from ICT devices (Punchline Energy 2007).

product types and modifying the behaviour of millions of people, making reductions difficult. Standards are being developed to reduce the energy consumption of various devices while they are on standby, however current trends indicate that by 2020 Australian electricity demand may increase by as much as 40% (ABARE 2005). Consequently, wasted energy from devices that are on standby may still increase.

The Carbon-Business Confluence

Reducing energy use means reducing greenhouse emissions, which in turn represents cost savings. The value of wasted standby energy is of the order of $A1 billion per year[5].

The Telemetry Application

Telecommunication providers have existing telemetry products that can be extended to monitoring and controlling energy distribution networks in buildings. These products could move energy management away from individuals or devices to intelligence in the communications network.

The distributed management of energy could occur either inside the building or anywhere online. In practice, this could mean combining outlets for power and broadband into a unified socket or inserting an intermediate networked plug/socket such as the one shown in the breakout box. Both of these would allow intelligent control from anywhere on the global broadband network. For example, charging tools in a garage; the outlet or switching box is able to monitor the energy being drawn and management elsewhere on the network can tell when the charging is finished. Rather than leaving the charging transformers running, the remote management sends a signal for the outlet to turn off, halting the flow of standby power.

The application draws on a broadband-enabled home or workplace, but also requires the telecommunications provider to engage in the home electrical market and building industry to deploy appropriate products in new and refurbished homes or provide simple retrofit products.

“Rather than leaving the charging transformers running, the remote management sends a signal for the outlet to turn off, halting the flow of standby power.”

“The value of wasted standby energy may be over 1 billion dollars per year.”

REAL WORLD EXAMPLE

Networks and remote intelligence can allow a more sophisticated level of intervention. A small company in Oxfordshire UK has created a single-point handheld device that allows the user to send a radio frequency signal to switch off all products (plugged into specially designed socket adapters) that are in standby mode when they leave the house or go to sleep. The company, ‘Bye Bye Standby’, states that the device can save large amounts of greenhouse gases through lower energy consumption, reduce electricity bills and decrease the risk of home fires (BBSB 2007).

5 Calculation is based on 11.5GWh of standby energy at a delivered price of $100 per MWh (at the lower end of non-industrial delivered electricity prices in Australia), which gives a total value of $1.15 billion

Challenges and Barriers

This is an example of shifting from an incidental to deliberate specification of network enabled energy management. The ability to have the necessary information and control to intercept standby energy wastage requires devices that are both networked and controllable or power supply switches that are networked and controllable.

Such devices and switches already exist, however the large scale uptake requires the ability to retro-fit such switching at low cost. It also requires applicable future devices to be suitably networked and controllable.

Carbon-Opportunity 2 : Presence-Based Power

At a Glance

Electricity flows in the home and workplace are currently device-focussed. Once the appliance is on, it draws the energy that it demands. If no-one is in the room to enjoy the lighting or the air-conditioning, this can be thought of as 'orphaned' energy. Broadband-enabled buildings and devices allow a user-focused energy flow (a 'Presence-Based Power'), in which only devices inside the physical range of engagement of the user are activated. This innovation could reduce an estimated 15% of energy use currently wasted as 'orphaned'.

Status and Trends

Homes and commercial premises currently consume approximately 108,000 Gigawatt-hours of electricity per year (ABS 2007), causing roughly 100 million tonnes (assuming a little under 1 tonne CO_2 per megawatt hour) of greenhouse gas emissions or about one fifth of the country's 559.1 MtCO_2 –e of emissions (AGO 2007b; CAIT 2007).

Devices which are on but unused (orphaned) are wasting energy in homes and offices. For example, a typical plasma television uses the equivalent energy of an electric heater even when no-one is in the room. Computers are on in offices when people have left for a meeting; lights and air conditioning are on in rooms or entire floors where no one is present. Current trends indicate that by 2020 Australian electricity demand may increase by as much as 50%. Consequently, 'orphaned' energy from devices that are on but unused can be expected to increase by a similar amount.

The Carbon-Business Confluence

There is very little work on how much energy is wasted in 'orphaned' appliances. To some extent, this will vary with the definition of what period of non-use is applicable. Climate Risk estimate that, separate from standby power, about 15% of energy use may be categorised as 'orphaned', extrapolated from analysis by the larger product manufacturers in the field.

The Telecommunication Mobile Network Opportunity

Presence-Based Power may be understood as the aura that lights up the room when a charismatic person arrives. The 'intelligent building' is aware as the person moves between spaces. Devices, lights, heating, TVs or computers are on when required by the person, but 'go to sleep' after the user leaves.

The user, identified via their mobile phone or a key tag, can personally define an 'aura' size - perhaps a 2 metre radius in the office. Any device inside that sphere will be active, but a device outside the person's designated 'energy radius' will be off until such time as the person comes back into proximity to the device. The system can be extended to

> "A typical plasma television uses the equivalent energy of an electric heater even when no-one is in the room."

Household emissions		Commercial emissions	
Category	**%**	**Category**	**%**
Transport	31	Transport	-
Appliances	25	Appliances	7
Water heating	16	Water heating	34
Space heating/ cooling	13	Space heating/ cooling	32
Waste	5	Waste	0
Lighting	5	Lighting	27
Standby	5	Standby	-

Table 3. Breakdown of emissions from homes and commercial buildings based on Next Energy (2006). Commercial standby is not included in this source but is estimated as 4-8% by the AGO 2005.

include time-based intelligence e.g. to turn off hot water systems when people are at work.

The approach eliminates a large fraction of the energy consumption of 'orphaned' appliances without the need for any behavioural change on the part of the user and in a way that users can customise to their own needs without loss of amenity.

The breakdown of household and commercial emissions (Table 3) gives some idea of the target applications which include space heating/cooling, appliances, lighting and water heating (59% of household emissions and 100% of commercial emissions).

Challenges and Barriers

Critical elements of success include:

- The volume of customers participating,
- The range of devices that can be managed through external signals,
- Customer trust in privacy.

"Climate Risk estimate that, separate from standby power, about 15% of energy use may be categorised as 'orphaned'."

REAL WORLD EXAMPLE

Presence Based Power techniques have been applied in some parts of the USA (ThomasNet 2006). It uses currently available technology including broadband to the home and workplace; broadband-enabled appliances, switches and sockets; radio frequency identification (RFID) tags and telemetry; and motion sensing, combined with software to predict normal behaviours (people leaving the house in the morning or going to bed).

Carbon-Opportunity 3: De-centralised Business District

At a Glance

Network-enabled homes, suburbs and regional centres can remove or significantly reduce the emissions generated by people travelling to and from their place of work.

This carbon-opportunity considers only the reduced greenhouse pollution arising from reduced or higher efficiency travel to and from the workplace. Its does not assume any reduction of emissions at the workplace which may simply be transferred to a different location.

Status and Trends

Australians travel 43.5 billion kilometres a year commuting to and from their place of work using private vehicles (ABS 2007, based on 2004 data). The dispersed urban form of Australian cities means that the average distance travelled by a worker, to and from work in a year, is 7,200 kilometres and this travel generates approximately 2.6% of Australia's total greenhouse gas emissions (AGO 2006a; ABS 2007).

Although Climate Risk does not have direct information on trends in commuting levels in Australia, an increasing trend can be inferred via the general growth in car use. This coincides with a general increase in the percentage of travel on public transport. Figure 15 shows the increasing level of car use causing close to 8% of national greenhouse gas emissions. Emissions from car use have increased by 500,000 tonnes of carbon dioxide equivalent (500,000 t CO_2 –e) per year since 1990, the baseline year for the United Nations and Kyoto Protocol measurements.

> "Travel to and from work generates approximately 2.6% of Australia's total greenhouse gas emissions."

Figure 15: Australian emissions from passenger car use since 1990

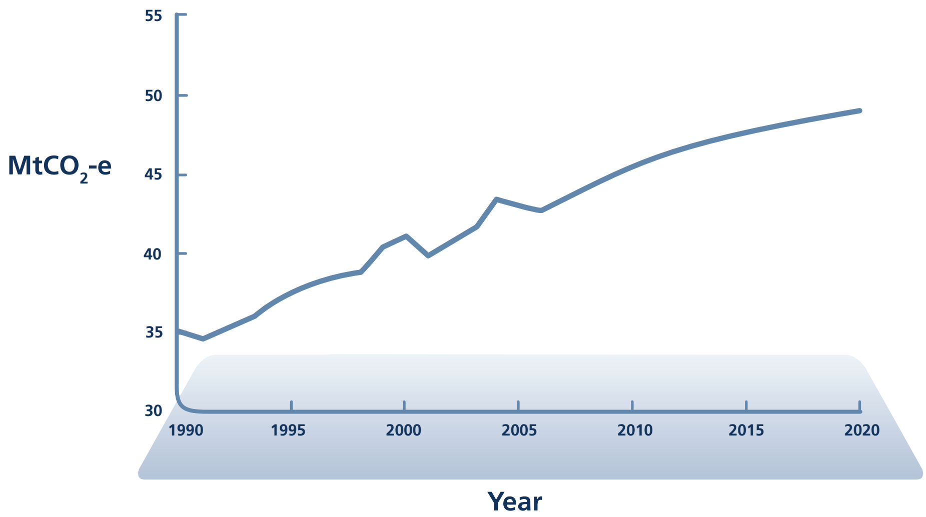


Figure 15. Trends in passenger car emissions over time ('with measures') showing sustained increases since 1990 (AGO 2006a).

'WITH MEASURES'

The term 'with measures' refers to government initiatives with allocated budgets, timetables and, if necessary, supporting legislation which are used to adjust projections of future emissions.

The Carbon-Business Confluence

There is a direct carbon impact from the reduced use of vehicles for commuting. A direct value from reduced time spent by workers commuting also accrues either to the company or to the individual, and can be monetised in terms of the hourly rate that the person would otherwise earn for their time.

Australia is experiencing a skills and labour shortage across many sectors as a result of continued economic growth and an aging population. More flexible hours and locations of work can partly redress this shortage by enabling new workers previously excluded by the time barrier of commuting. The economy will benefit from the deployment of such additional resources in any labour-constrained market.

Reduced time spent commuting may encourage workers to relocate to regional centres. This has a secondary financial benefit to employers and employees in that it allows people to settle in places with lower housing prices than Australia's major cities. This improves affordability, reduces wage pressures and results in more disposable income.

The Telecommunication Network Opportunity

Telecommunication providers have many existing products and services that can reduce the time spent commuting, or can provide viable alternatives to physical commuting. The two solutions considered here are teleworking and de-centralised working. We do not include traffic efficiency due to Jevons' Paradox.

JEVONS' PARADOX

William Stanley Jevons (1835-1882) was an English economist and logician who analysed the impacts of the last Industrial Revolution. In The Coal Question (1865) he maintained that technological efficiency gains—specifically the more "economical" use of coal in engines doing mechanical work—actually increased the overall consumption of coal, iron, and other resources, rather than "saving" them, as many claimed (Alcott 2005, p.9). As this outcome ran counter to Jevons' intuition, it is known historically as 'Jevons' Paradox'.

Telework:

Telework allows people to work from home or local business centres without the need to physically commute. According to the Australian Telework Advisory Committee (ATAC), telework is defined as:

"encompassing work arrangements which take place between a remote worker and a central business location, including where these arrangements:

- involve a worker located at home, either as an employer connecting to a work location, or as a self-employed worker, connecting to clients; and
- are enabled by ICT, such as a PC and network connectivity; and
- occur within the context of the Australian economy (e.g. not

'off-shoring' or 'time-shifting' arrangements); and
- involve full-time, part-time or casual work; and
- occur within the context of an employment relationship; and
- are either formal or informal; and
- are voluntary or compulsory." (ATAC 2006, p.14)

According to ATAC (2006), the benefits of telework typically include:

- **Increased productivity,**
- **Decreased workplace costs**
- **Flexible work hours (e.g. for the over-65 age group),**
- **Removal of distance as a barrier to employment,**
- **Increased opportunities for people with disabilities,**
- **Decreased travel times, costs and emissions.**

A quarter of the 9.5 million people in the workforce work at least some of their hours from home (ABS 2007). Of the 725,000 people who identify themselves as 'working from home', only about 195,000 are employees, the remainder being small business owner-managers. Teleworking creates an important overlap between the home environment and the workplace, with consequent reductions in emissions as outlined above. Furthermore, empirical research suggests that teleworkers produce more work per hour than their work-based colleagues (ATAC 2006).

The De-centralised Workplace:

A variation on teleworking is the ability of people to work not at home, but close to home at a 'telework centre' or regional centre. This workplace decentralisation yields considerably reduced commuting distances, travel time and transport emissions. For example, the average commute time in Sydney is 4.7 hours per week, compared to 2.9 hours per week for the rest of NSW (MIAESR 2002). Furthermore, the lower levels of traffic should increase vehicle speeds and efficiencies.

Broadband can serve to counteract these 'lost hours' commuting by enabling people to live and work in smaller towns, cities or suburbs (with much lower commuting requirements), while continuing to work for city-based national and international employers. This may involve the use of multi-occupant business centres, or regional offices for larger businesses. In other cases, whole departments can be moved to regional centres.

All of these changes hinge on the ability to move large volumes of data, voice and video between regional centres, suburbs and cities. The richness of the experiences will increasingly be enhanced by higher-end services such as 'in person' quality conferencing facilities. The economic opportunities to reinvigorate widely dispersed regional centres through teleworking and de-centralised workplaces are obviously linked to the quality and extent of the broadband network.

Challenges and Barriers

Some barriers to teleworking and regional relocation are non-technical. According to ATAC (2006) the main

"Empirical research suggests that teleworkers produce more work per hour than their work-based colleagues."

REAL WORLD EXAMPLES

East Midlands Electricity (EME), United Kingdom

EME is an electricity distribution firm in the East Midlands, UK. Approximately 150 of its 469 staff at the Pegasus building telework 1 to 5 days per week, resulting in considerable savings for both the employer and employees. Due to the high telework uptake, EME reduced its amount of office space, currently at a premium, saving the company approximately $A270,000[6] per year. The workers save approximately $A 40 per week and an average of 10 hours each per week in commuting time. In total, an average of 38,000 km per week was saved by the 150 teleworkers (Hopkins & James 2001).

Malta Information Technology and Training Services Ltd , Malta

In Malta, an information technology service has utilised a hybrid approach to telework to maximise the opportunities and overcome challenges associated with telework. Malta Information Technology and Training Services Ltd (MITTS) decided on a three-day-telework, two-day-office program with its staff. This way they have managed to retain skilled working mothers who could not commit to a full-time office-based working week (ETC 2007).

6 Based on 1 GBP = 2.7 AUD

barriers to telework implementation are:

- The trust-based relationship between employee and employer,
- The monitoring and supervision of employees,
- Insurance,
- ICT costs,
- Isolation, and
- Cultural resistance.

"The average commute time in Sydney is 4.7 hours per week, compared to 2.9 hours per week for the rest of NSW (MIAESR 2002)."

Carbon-Opportunity 4: Personalised Public Transport

At a Glance

Wireless-broadband can facilitate public transport on demand. Personalised Public Transport allows the user to order public transport provided by an integrated network of multi-occupant taxis, minibuses, buses and trains, which starts at the front door (multi-modal transport). The personal efficiency of Personalised Public Transport can exceed that of using the private car, with faster speeds door-to-door, greater flexibility and lower costs.

Status and Trends

Australia's tyranny of distance and dispersed settlement patterns have led to a reliance on motor vehicles (Alexander 2000). The transport sector accounts for approximately 14% of annual net greenhouse emissions (AGO 2007b). Further, it is anticipated that under a business-as-usual scenario, private vehicle use and emissions will continue to increase significantly, with 13% growth between 2005 and 2020 (AGO 2006a).

Private Transport: Since the 1950s, Australia has experienced considerable growth in private car ownership and kilometres travelled (ABS 2007). According to the Australian Bureau of Statistics, the majority of private transport is used for commuting to and from work, as well as personal travel such as school runs and shopping (ABS 2007). Three-quarters of Australian commuters use their car to get to work, and of these only 4% share the car with anyone else (ABS 2007).

While recent increases in the cost of fuel have made a minor impact on private vehicle kilometres travelled, there continues to be a strong positive trend in private vehicle use (Figure 15). The current greenhouse gas emissions from this sector are expected to grow from 43 $MtCO_2$–e in 2005 to 49 $MtCO_2$–e in 2020, a 39 % increase on 1990 levels (AGO 2006a). Researchers identify that a combination of demand-side management, supply-side management and behavioural change is required to significantly reduce transport emissions (Cervero 2002).

> The transport sector accounts for approximately 13.5 percent of annual net greenhouse emissions.

Public Transport: Public transport use has varied in recent history, and stabilised to a constant 12% between 2000 and 2003 (ABS 2007). Although there has been a recent spike in public transport use from increased fuel price (ABS 2007), Australia's dispersed settlement pattern has limited the viable public transport services to hub-and-spoke options, i.e. in and out of the city with poor intra- and inter-suburb services. In order to improve public transport use, there needs to be an improvement in the 'personal efficiency' of public transport options, such as increased frequency of services and across-town options (suburb-to-suburb, rather than suburb-to-city: Mees 2000).

Transit Orientated Design: Throughout Australia there is an increasing trend towards regional transport planning that incorporates Transit Oriented

Design (TOD), in which dense mixed-use activity centres are connected by frequent transport services (OUM & SEQROC 2005; V.DSE 2005). Low-density sprawling Australian neighbourhoods do not encourage the provision of such services to areas outside the TOD catchment without incurring significant running costs.

The Carbon-Business Confluence

A range of potential ICT-based solutions exists to reduce private transport use and improve vehicle energy efficiencies. These include facilitating telework options discussed earlier.

The carbon-business case presented below is based on the opportunity to facilitate new or changed services that improve the personal efficiency of public transport to the consumer, exceeding the relative value of personal car use.

There are other opportunities that include web-based intelligence to increase car pooling and therefore the net efficiency of car use and smart traffic-flow monitoring (GoLoco 2007). There is a strong business case for an existing internet company or council to create a web-based clearing house for car pooling. This report has not pursued traffic flow alternatives which could be improved by network applications, because improved traffic flow and efficiency lead to increased levels of traffic with little or no net greenhouse emission benefit (Jevon's Paradox).

The Telecommunications/IT Industry Opportunity

The opportunity identified here is the application of ICT-facilitated Personalised Public Transport in high and medium density urban areas to allow a reduction in car use in favour of lower emission travel options.

Personalised Public Transport is the provision of on-call public transport vehicles which act as feeders to Transit Oriented Developments (TODs), using integrated modes of local mini-buses, suburb-to-suburb links, high-speed express buses, trains and multi-occupant taxi services. The integration reduces travel and wait-times and increases the economies of scale for specialised services such as express commuter trains and buses, as well as suburb-to-suburb inter-connection.

The net effect of PPT is:

- Increased flexibility for the customer,
- Reduced waiting times for the customer,
- Increasing the use of public transport within the catchment,
- More frequent services,
- Higher speed arterial services,
- Increased commercial viability of all transport suppliers.

Challenges and Barriers

The barriers to the uptake of public transport in general would also be a barrier to network enabled PPT and include imbalances in tax and corporate incentives, traffic access and prioritisation as well as funding for major public transport infrastructure.

The premise is that the barriers to non-car travel are based on personal efficiency. Currently, even though a bus trip may be significantly less costly than car-based commuting and personal travel, the net time spent waiting and travelling and the value of that time to the person reverses the overall cost-benefit balance in favour of the car.

REAL WORLD EXAMPLES

Brisbane City Council

Brisbane City Council is currently trialling a limited PPT system which operates outside the Translink network. Through an agreement with Black and White Cabs Pty Ltd, maxi cabs travel along a fixed route every 15-30 minutes in five subburbs to provide commuters easy acces to and from their local train stations, bus interchanges and shopping centre. The service only runs during peak hour and the costs the commuter $1 for each trip (Brisbane City Council 2007).

MobiSoft

Technology already exists for the facilitation of personalised public transport. MobiSoft, a Finnish software company, has developed software for transport providers which:

“enables total management of incoming requests, offers real-time map-based route design as well as scheduling and capacity management, such as making sure the proper vehicle is sent to the customer. Mobile phone networks are used for fast and reliable data transfer, meaning that the system can be immediately deployed, eliminating the need for expensive equipment investments and lengthy delivery and deployment times.” (MobiSoft 2007)

Research is also currently underway to provide personalised public transport using automated, driverless vehicles. Capoco (2007) have developed the Mobilicity project. Mobilicity is a demand-responsive driverless personalised public transport system which uses hybrid electric vehicles to act as transport feeders to main trunk public transport lines and is beginning trials at the Shanghai Expo in 2010 and London Olympic Games in 2012.

Carbon-Opportunity 5: Real-time Freight Management

At a Glance

Currently one-third of the billions of kilometres travelled by Australian freight vehicles are without loads. Network-enabled vehicles and load monitoring can create systems that reduce unladen and under-laden trips.

Status and Trends

Currently the road freight sector is responsible for 36% of the transport sector's emissions and nearly 5% of Australia's total emissions (AGO 2006a). In 2004 light commercial vehicles, rigid trucks and articulated trucks travelled more than 35 billion kilometres moving goods throughout Australia (ABS 2007).

The greenhouse gas emissions from light commercial vehicles and articulated trucks is projected to increase from 13 $MtCO_2$-e in 1990 to 23 $MtCO_2$-e in 2010 (AGO 2006).

Almost a third (28%) of the 9 billion kilometres travelled involves empty freight vehicles (Figure 16). During these times, larger freight vehicles may be emitting between 1.2 and 1.4 kilograms of CO_2 on average for each kilometre travelled.

The Carbon-Business Confluence

The opportunity considered here is to target unladen vehicle use in Australia. Initiatives in overseas markets have shown that integrated high-speed communications can be used to create new freight management systems and markets that can significantly increase the average load factor on freight vehicle.

An increase in the load factor of freight vehicle use is effectively an energy efficiency measure which has direct carbon benefits from the reduced fuel use. It also represents dollar savings

> "Currently the road freight sector is responsible for 36 % of the transport sector's emissions and nearly 5% of Australia's total emissions."

Figure 16: Annual distances travelled by Australian freight vehicles

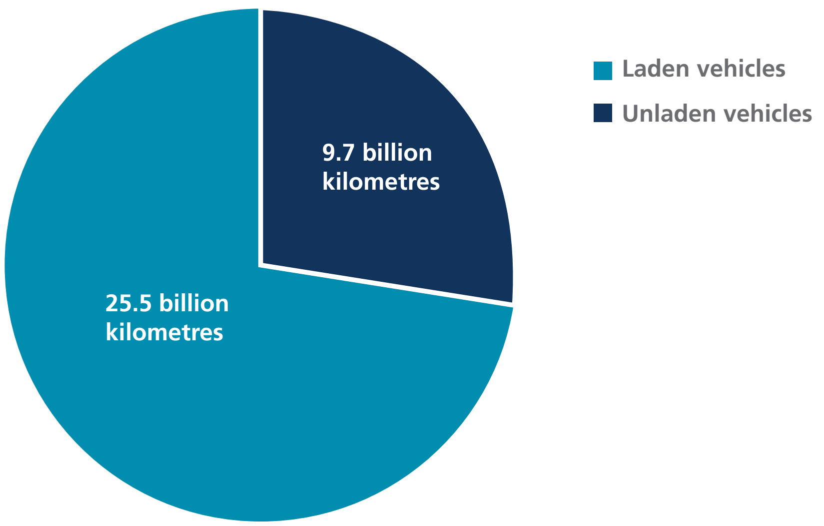


Figure 16. Fraction of freight vehicle kilometres which are laden and unladen (ABS 2007, p. 533).

which could accrue between freight handlers, third-party freight managers and the freight customer. Such a large percentage (28%) of current and projected unladen kilometres travelled presents an opportunity for telecommunications providers and the freight industry to facilitate considerable greenhouse gas emission reductions.

There are also non-carbon financial benefits due to the reduced capital stock required, reduced vehicle wear, and reduced on-road costs (such as taxation).

The Telecommunications/ICT Industry Opportunity

The opportunity we identify here is the application of ICT-facilitated Real-time Freight Management, which goes beyond typical in-house options undertaken by conventional freight businesses.

Use of mobile data networks to facilitate real-time solutions would allow freight brokers to identify loads, vehicle locations, destinations and load status in order to offer freight to empty or partially laden vehicles. Furthermore, it is also possible to provide best route options using GPS technology, providing the carrier with the shortest routes for the load pick-up and delivery.

The anticipated cost savings for the freight carrier would allow freight brokers (or third-party network providers) to capture a price for the service. The service would be particularly useful for owner-operator carriers who do not have the capacity or resources for an integrated management system.

Many businesses throughout the world have recognised that unladen freight vehicles kilometres reduce profitability and have attempted to manage this cost in a variety of ways using ICT platforms. Moreover, as Radio Frequency Identification (RFID) tagging of goods increases, it is possible that more precise savings can be utilised.

Challenges and Barriers

The major barriers to the deployment of such a solution would be the necessary tagging, monitoring and clearing-house infrastructure. The system lends itself to collaboration with a third-party logistics partner.

“Almost a third of the kilometres travelled by Australian freight fleets is wasted on empty trips.”

REAL WORLD EXAMPLE

Mercedes-Benz FleetBoard, working with Software AG, has recently developed an internet-based fleet management system whereby information between forwarders and carriers can be shared in real-time 24 hours a day, seven days a week.

The system allows the freight forwarder to enter information on to a web-based platform which assigns orders to individual vehicles. The information is sent via SMS to the vehicle’s in-cab screen, allowing the driver to accept or reject the assignment based on timing or congestion issues. The end result is that there are less unladen vehicle trips, saving considerable time and money for both the forwarder and carrier. Furthermore, all of the information can be stored for future analysis of route planning (Software AG 2007).

Carbon-Opportunity 6 : Increased Renewable Energy

At a Glance

Deep cuts in Australian emissions will require a transition to low and zero emission sources of power supply. Though plentiful, low-cost renewable energy sources like wind power are hampered by intermittency, the minute-by-minute short-term variability of the supply. Extensive broadband networks, combined with intelligent active load management of heating and cooling appliances in many buildings, can be used to effectively neutralise this variability, turning such renewables into 'stable and predictable generation' and allowing them to contribute a greater emission-free component of the electricity supply.

> Total fossil-fuel use in power generation accounts for approximately 35% of the country's greenhouse gas emissions.

Status and Trends

Australia is endowed with large volumes of fossil fuels, from oil and gas off the North-West Shelf, to the vast brown and black coal reserves in the eastern

Figure 17: Telecommunications network can reach energy generators, electricity users and grid managers.

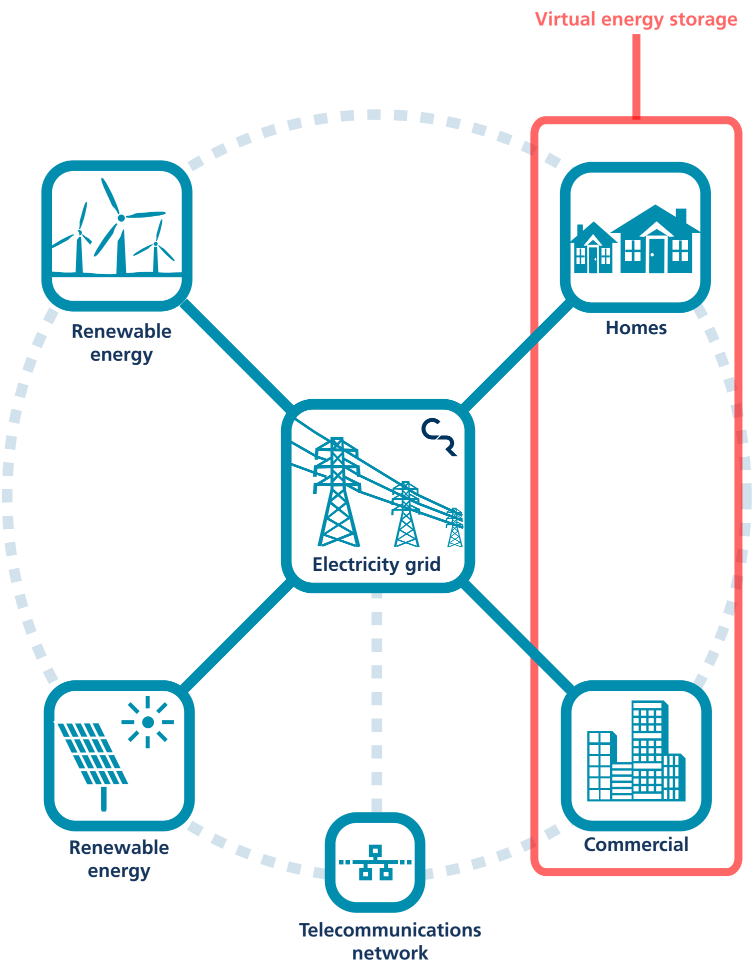


Figure 17. The ability of telecommunication networks to provide real-time communication across the whole electricity system allows many appliances in millions of homes and offices to be used to balance the short-term variations from renewable energy plants. This is equivalent to creating a very large, very widely distributed, virtual energy storage battery.

states. In a carbon-constrained world, these assets may become a liability. Already large institutional investors are seeking disclosure of the carbon liabilities of Australian companies (CDP 2007). Some energy companies are already responding by reducing the carbon intensity of their generation portfolio and divesting coal and purchasing gas and renewable energy assets (AGL 2007). This situation may become more onerous if some Kyoto-signatory countries (including those within the EU, Australia's largest trading partner) successfully call for the impost of carbon-based import tariffs against non-signatory countries. Approximately 86% of Australia's electricity is supplied by coal (AGO 2007b), with total fossil-fuel use in power generation accounting for approximately 35% of the country's greenhouse gas emissions (ABS 2007).

Australia also has large sources of renewable energy including wind power, biomass energy from agricultural wastes, solar radiation, geothermal power and ocean-based generation. Hydro-electricity can supply energy on demand. Sources like biomass or geothermal can supply relatively constant energy. However, the most rapidly growing renewable energy technologies - wind and solar - harness energy sources which have some temporal variability. Wind farms are placed in sites where there are usually strong and consistent winds, but there is always intermittency; weather forecasting technologies are now applied to predict these variations (White 2005) and multiple wind farms reduce the overall variations (Figure 18).

Although there are over 6,000 megawatts of wind energy projects proposed for Australia (enough to power 3 million homes), their implementation may be constrained by the management of the variability in output from these

Figure 18: Wind energy output from three states and in aggregate

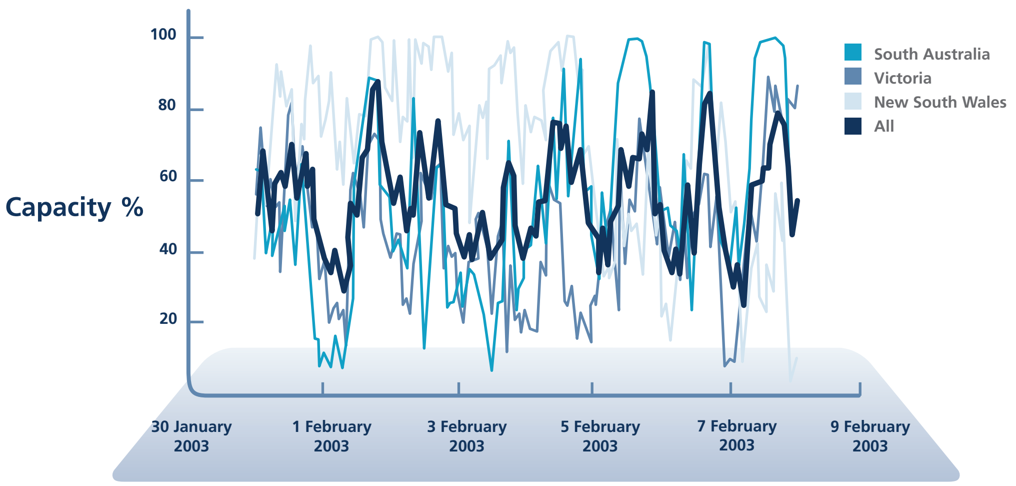


Figure 18. The variability of wind farm energy output in aggregate decreases as more wind farms are added. The multi-hourly and daily variations shown here can be predicted using weather forecasting techniques, whereas the short-term variations must be accommodated by other supply sources on the network (Coates 2004).

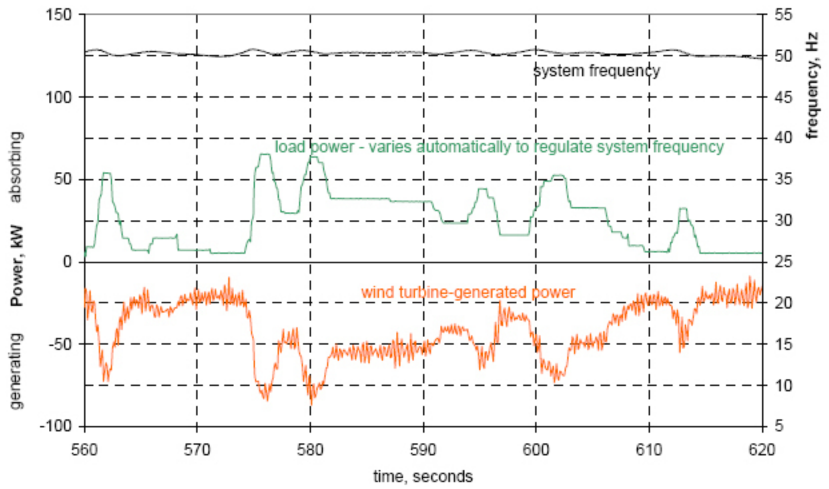
ECONNECT (UK) AND DISTRIBUTED INTELLIGENT LOAD CONTROLLERS

Automatic Load Controller

"Many domestic loads can be controlled effectively by our Automatic Load Controller. This product sheds non-essential loads when the system is in danger of becoming overloaded. Electrical appliances which can be switched off for short periods (user selectable between 8 seconds and 16 minutes) without affecting their function are most suitable - for example, washing machines, dishwashers, fridges, freezers, electric kettles, microwave ovens, irons, electric cookers, water and space heaters".

Governing Load Controller

"At times of high availability of renewable energy resource and low demand, the energy can be usefully deployed instead of being dumped to a central dump load. Suitable loads, such as water and space heating can be added".



Windmaster operation

wind farms. For example, although South Australia already has approvals for 21 wind farms with a total capacity of nearly 2000 megawatts (Auswind 2007), there have been ongoing pressures to limit wind power development partly citing this variability:

"South Australia is rapidly heading towards being, proportionally, the second largest producer of wind energy in the world. ...While wind energy has been, and will continue to be, a welcome contributor to the State's electricity supply, the sheer scale of the proposals has prompted concerns regarding the impact that such high levels of wind generation might have on the reliability, security and price of electricity in South Australia... more than 500 MW of wind generation will result in unacceptable risks to reliability in the State and create uncertainty over long term price trends. These impacts are the result of two particular characteristics of wind generation, namely the inherent variability and inherent uncertainty associated with wind energy; and the way it participates in the national electricity market." (ESIPC 2004)

Failing to harness low-cost clean-energy sources like wind power because of concerns about intermittency represents a barrier to achieving deep cuts in national greenhouse gas emissions. Wind and biomass were identified as amongst the lowest-cost energy options by the CSIRO-led Energy Future Forum, which placed a 20% limit on the penetration into the grid of each of the intermittent renewables in its future scenarios (CSIRO 2006).

The Carbon-Business Confluence

The commercial viability of this carbon-opportunity is based on the ability to manage significant electrical loads across a large customer base that can be used to effectively neutralise the short-term (up to about one hour) variability of intermittent renewable energy sources. This would allow more clean energy into the grid network and also increase the value of that energy.

Since the grid is not a battery, the demand for electricity and the supply of power must be kept in constant balance by the grid operator. Australia's largest grid is managed by the National Electricity Market Management Company (NEMMCO). The grid operator cannot control how people use energy in their homes, businesses or industries, and as such, the state grid companies and energy retailers regulate the system to achieve the balance. The electricity market is based on information about expected demand (e.g. in 5 minute intervals) at various nodes. This information is provided for bids from all potential suppliers. Supply is dispatched according to least–cost and environmental constraints. On the eastern seaboard this is called the National Electricity Market (NEM).

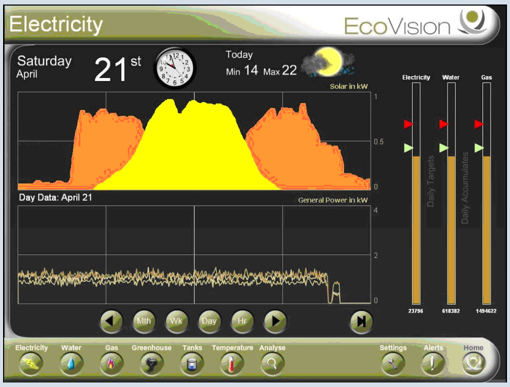
In some of the more extreme cases, such as power station units shutting down, the grid operator may regulate customer energy supply by cutting supply to a large industrial loads to avoid residential blackouts.

An alternative to balancing the energy

CURRUMBIN ECO-VILLAGE, GOLD COAST

EcoVision Solutions, a Gold Coast based technology development company, uses an integrated control and management system which will facilitate cooperative management of resources in the energy and water supply chain.

As a component of the cooperative framework, EcoVision has produced a home touchscreen interface which provides consumers with real time feedback of electricity, potable water, recycled water and gas usage. Greenhouse gases relating to resource consumption are displayed in graphical form as well as photovoltaic solar power or other forms of renewable energy generation. Energy use can be monitored at circuit level (eg lighting separate from general power) or at discrete appliance level. In conjunction with various in home sensors and timers, an in home EcoVision controller provides automation features to reduce energy consumption and phantom loads as well as shed loads in times of network constraint.



All of the data gathered by EcoVision is sent to a central server (usually via the community network) for use by the Body Corporate, enabling comparison of performance in different households and benchmarks to be set.

The important aspect of EcoVision is its architecture which facilitates aggregation of end use data far beyond the local community level. EcoVision enables occupants to offer demand side capacity back to the utility via the web at times of network constraint. This would typically include switching of major loads such as air conditioners, pool pumps and refrigerators which can contribute unnecessarily to coincident peak demand. As result distribution utilities can derive significant benefits via reduced outages and extended asset life.

EcoVision is now installing its first 144 systems at the award winning Ecovillage at Currumbin, a residential subdivision on the Gold Coast.

supply on an ongoing basis is to manage the loads (demand-side management). In this way, a spike in demand of one megawatt can be matched by either a corresponding increase in supply of one megawatt, or a corresponding dip in demand of one megawatt somewhere else in the grid - sometimes referred to as 'negawatt' (Lovins 1989). There are many electrical appliances in homes, offices and other buildings – especially heating and cooling applications - which are only mildly time-critical and can be managed to control loads with no loss of amenity to the customer. The conventional means to make these loads assist with grid management has focused on providing a price signal to customers using a 'smart meter' that can show the price of electricity varying though the day, but this is a slow and blunt instrument. A faster response could assist in the management of the short-term dynamics of renewable energy. Broadband unlocks the speeds of response required for such tasks.

The target loads that can be readily accessed by broadband are the 'discretionary loads'. These are energy-consuming devices where the timing of energy use is less important. For example, it may be important that the temperature of a fridge stays between 2 and 4°C, but whether the fridge is on for one block of 10 minutes or two blocks of 5 minutes will make no difference to the fridge owner, but can play an important part in power management in the electricity network. The ability to control when discretionary loads operate creates a large, distributed load management tool. It is important to note that the net energy use will be the same, but it is the 'dynamic' or 'time shifting' which is being harnessed.

The ability to manage discretionary consumer loads on a large scale with rapid speed unlocks the ability to actively manage variability in the grid in general, but particularly in the management of the intermittency in renewable energy supplies.

The Telecommunication Networks Application

The opportunity we identify here is the application of broadband to the home and workplace, with broadband-enabled appliances, switches and sockets which can be easily installed in buildings.

Typical 'discretionary loads' in the home and workplace include:

- Air conditioning,
- Electric Heating,
- Electric hot water systems or electric boosted solar hot water,
- Refrigerators and freezers,
- Devices on charge such as tools, laptop computers, wireless phones etc.

Most of these appliances work within user-defined ranges, such as the room temperature setting for an air conditioner. Third-party management of how the outcome is achieved is essentially invisible to the resident or

DYNAMIC LOAD MANAGEMENT

Some utilities use signals over the electrical network to turn domestic hot water systems on and off. This assists with their grid management.

worker and causes no loss of amenity.

The permission to exercise control could be assigned as part of the broadband supply contract and perhaps coupled with the promotion of third-party supply of externally controllable appliances (though this would lend itself to national standards legislation).

The NEM also has an 'ancillary services' market designed to maintain the supply availability and quality, and the load management system presented here may be suitable to bidding into these markets.

Challenges and Barriers

Critical elements of success include:

- The volume of customers with devices and appliances under external management,

- Customer trust in the management company to cause no loss of amenity,

- External control of appliances – some, like hot water systems, can be controlled at the power outlet; others, like a fridge, need to be able to have the cooling turned on and off separately from internal lighting or timers,

- The uptake of renewable energy is subject to carbon pricing and industry development mechanisms.

Carbon-Opportunity 7 : 'On-Live' High Definition Video Conferencing

At a Glance

Long-distance, short-duration travel can be effectively replaced with 'in-person' quality, online conferencing facilities that are significantly more efficient in cost, time, energy and emissions.

Status and Trends

Growth in air travel is increasing markedly with ongoing cost reductions, leading to negative environmental and social impacts. Aeroplanes are slowly becoming more efficient, but this is outweighed by increased demand, and as a result, aviation greenhouse emissions are rapidly increasing.

Aviation emissions which occur at altitude are some 2.7 times more harmful in greenhouse terms than if they were released at ground level (Tyndall 2006).

According to the Australian Greenhouse Office, domestic aviation has become the fastest growing transport sub-sector. It is projected that its share of transport sector emissions will increase from 4.7 % (2.9 $MtCO_2$–e) in 2005 to 6.8% (5.9$MtCO_2$–e) by 2010 (Figure 19). This is an increase from 0.5% of Australia's total emissions to 0.8% in just 5 years (Figure 19). By 2020, emissions from aviation may easily have doubled since the Kyoto Protocol baseline year of 1990. These figures may be underestimated given the plans for ultra-low cost carriers to enter the market (Tiger Airlines 2007).

International research indicates that between 36% and 63% of short-haul air travel is for short-term business, the wide range comes from the different airports considered in the study (Mason 2000).

"Aviation emissions which occur at altitude are some 2.7 times more harmful in greenhouse terms than if they were released at ground level."

Figure 19: Domestic aviation emissions since 1990

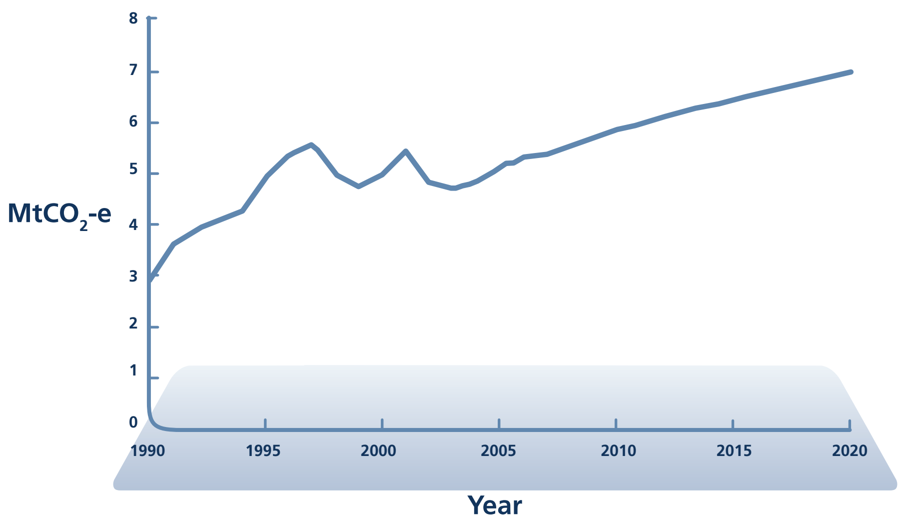


Figure 19. Trend and projected domestic aviation emissions (AGO 2006).

The Carbon-Business Confluence

In the medium to longer term, the high growth rates of 4% forecast by the aviation sector (Airservices Australia 2006) are likely to be unsustainable, given fuel supply costs and expected carbon constraints.

Currently bunker fuels are excluded from restriction under the Kyoto Protocol. This is expected to change in the next commitment period, foreshadowed by emergent regulation in the EU (Bows & Anderson 2005).

As regulatory risks increase overseas, this may impact on inbound and outbound long-haul travel as well as pricing structures in Australia.

There is a clear disharmony between the rapid growth of the aviation sector in Australia and overseas, and the pressure for carbon constraints.

There is significant potential for carbon abatement and commercial gain if telecommunication companies provide services offering equivalent contact for some aspects of business and personal aviation.

Telecommunications Network Opportunity: 'On-Live' High Definition Video-Conferencing

Business air travel can be exceedingly time inefficient. High-value executives spend valuable hours and sometimes days in transit, a significant waste of human resources with a direct dollar value to their companies.

To effectively replace business travel it is important to recognise that 60% of communication between people is non-verbal, being contained in body language, gesture and expression. These elements are often lost by conventional teleconferencing where the body is not shown, definition is too low to capture detailed expression, and latency loses critical gestures.

Technology now available to Australian businesses has been designed to address these issues. Such high-end commercial systems (from Cisco and HP) have considerable bandwidth requirements. The potential savings of time, money and greenhouse gas emissions will increase the efficiency of many Australian companies.

AEROPLANE EFFICIENCY

The aviation industry is seeing new, more efficient, aircraft enter the market. The analysis herein uses a 2005 snapshot of emissions which excludes new initiatives announced and launched since this time, as well as the sectors growth.

REAL WORLD EXAMPLE

Cisco Systems, one developer of telepresence conferencing facilities, has offices all over the world and a highly mobile workforce. Since adopting the technology internally, the company has set a worldwide target of reducing its own air travel by 20%. The Australian division of Cisco has already reduced air travel by 16% in less than one year (Ross 2007).

Consultations by Climate Risk indicate that, for some businesses, pay back periods on investments for 'on-live' high definition video conference suites costing $A250,000 can be less than six months when both travel and salary costs are evaluated.

Beyond in-house company systems, pay-for-use services by leading telcos such as Telstra would unlock a wider customer base including small and medium size enterprises (SME). These would also allow greater participation in overseas markets by SME businesses who are typically constrained by modest travel budgets and the prolonged absence of key staff.

There is also a role for 'in person' quality technology and bandwidth to offer an alternative to long-distance, short-duration travel and provide greater amenity to the customer outside the business space.

These services create possibilities to overcome the health and financial barriers to air travel, or to meet with friends and family more frequently than is feasible with air travel (e.g. someone in Perth having a catch-up with a sibling in London once a week). To some extent these are new applications that may not reduce current or future aviation use or emissions. They are therefore excluded from our carbon abatement calculations.

Challenges and Barriers

The quality of the new 'in person' conferencing is sufficiently high to make 'On-Live' High Definition Video Conferencing more personally efficient than flying. However some of the appeal of air travel is not about the travel itself, but rather secondary benefits, for example the opportunity to see friends while away. Consequently, some of these barriers may be addressed by configuring the 'on-live' alternatives to provide equivalent secondary benefits.

> "Pay back periods on investments for 'virtual-aviation' suites costing $A250,000 can be below 6 months when both travel and salary costs are evaluated."

Photograph courtesy of Cisco Systems

Part 5

Quantifying the Opportunities

The carbon-opportunities are based on using either existing ICT networks or networks that will be rolled-out in due course regardless of any greenhouse gas benefits. Therefore the energy and emissions related to increased ICT use are not included within the emissions cost-benefit equations for each carbon-opportunity, but are instead included within the overall projections of increased national emissions (Figure 24).

Remote Appliance Power Management

Data and Assumptions

The total annual net greenhouse gas emissions for Australia is 559.1 $MtCO_2$-e. (AGO 2007b).

Total residential and commercial electricity consumption was 108,000 GWh per year (ABS 2004 , ANZSIC divisions E-H and J-Q).

Estimated losses from standby power in residential and commercial sectors are 9.3 % (AGO 2007b).

Emission intensity of electricity production is 0.94 tCO_2-e per MWh (AGO 2006b, p. 13).

The national average price of electricity to residential and non-residential customers is estimated herein as 10 cents per kilowatt hour (ESAA 2004)[7] .

Assumes broadband-based Remote Appliance Power Management solutions are used to reduce standby emissions by 50% in 1/3 of Australian homes and commercial buildings.

Results

(All figures are based on 2005 data without growth)

1. The total reduction in standby emissions will be 1.8 $MtCO_2$-e per annum.
2. This emission reduction represents 0.33% of total net Australian emissions.
3. The value of the carbon abatement will be $18 million, $36 million and $92 million at carbon prices of $10, $20 and $50 per tonne CO_2-e respectively.
4. The avoided electricity purchase through application of Remote Appliance Power Management is 1,700 GWh per year.
5. The value of the avoided electricity purchases at 10 cents per KWh is $170 million per year.

BASELINE YEAR AND GROWTH

The Australian government regularly publishes a National Greenhouse Gas Inventory, the most recent of which covered emissions in 2005. The results presented herein are generally calculated based on this 2005 'snapshot'. Since national emissions are growing it has been assumed that the relative contribution of different sectors remains unchanging and therefore the abatement as a percentage of national emissions remains constant post 2005. However, several of the energy based emissions sectors to which these carbon opportunities apply are increasing their relative proportion of national emissions. Therefore, the results presented can be considered relatively conservative, and the actual abatement may be considerably higher.

7 ESAA 2004, Electricity Prices in Australia 2003/04. Electricity Supply Association of Australia

Presence-Based Power

Data and Assumptions

The total annual net greenhouse gas emissions for Australia is 559.1 $MtCO_2$-e (based on 2005 figures in AGO 2007b).

Total residential and commercial electricity consumption was 108,000 GWh per year (ABS 2004 , ANZSIC divisions E-H and J-Q).

Emission intensity of electricity production is 0.94tCO_2-e per MWh (AGO 2006b).

The national average price of electricity to residential and non-residential customers is estimated as 10 cents per kilowatt hour (ESAA 2004)[8] .

Assumes that 'orphaned' energy consumed by appliances is 15% overall for residential and commercial energy consumption .

Assumes network enabled Presence-Based Power solutions are used to reduce 'orphaned' energy emissions by 50% in 1/3 of Australian homes and commercial buildings.

Results

(All figures are based on 2005 data without growth)

1. The total reduction in standby emissions will be 2.97 $MtCO_2$-e per annum.

2. This emission reduction represents 0.53% of total net Australian emissions.

3. The value of the carbon abatement will be $29 million, $59 million and $148 million at carbon prices of $10, $20 and $50 per tonne CO_2-e respectively.

4. The avoided electricity purchase is 2,700 GWh per year.

5. The value of the avoided electricity purchases at 10 cents per KWh is $269 million per year.

8 ESAA 2004, Electricity Prices in Australia 2003/04. Electricity Supply Association of Australia

De-centralised Business District

Data and Assumptions

The total annual net greenhouse gas emissions for Australia is 559.1 $MtCO_2$-e. (based on 2005 figures in AGO 2007b).

Total emissions from private transport (passenger car) were 43.7 $MtCO_2$-e per year (AGO 2007b).

The fraction of kilometres travelled used on commuting to and from work is 32% (ABS 2007).

The fraction of jobs that are amenable to telework is about 65% (ATAC 2005c).

The emission intensity of 1 litre of liquid fuel is approximately 2.5$kGCO_2$-e per litre (AGO 2006b).

The assumed cost of 1 litre of fuel is $A1.00[9].

Assumes that emissions for commuting in non-urban areas or within a suburb, is half of those of city based commuting (based on MIAESR 2002 and assuming that for shorter distances non-car options also become more attractive).

Assumes that broadband-based telework is taken up by 50% of the employees who have telework suitable jobs and on average work one day per week from home.

Assumes that De-Centralised Workplaces are used by 10% of employees who have telework suitable jobs, and their commuting emissions are reduced by at least 50%.

Results

(All figures are based on 2005 data without growth and consider reduced travel emissions only)

1. Annual reduction in emissions from telework will be 0.91 $MtCO_2$-e.
2. This emission reduction from telework represents 0.16% of total net Australian emissions.
3. The total reduction in emissions from the De-centralised Workplace will be 2.2 $MtCO_2$-e p.a.
4. This emission reduction from De-centralised workplaces represents 0.39% of total net Australian emissions.
5. The total reduction in emissions from telework and the De-Centralised Workplace will be 3.09 $MtCO_2$-e per annum.
6. This total emission reduction from telework and the de-centralised workplace represents 0.55% of total net Australian emissions.
7. The value of the carbon abatement will be $31 million, $61 million and $154 million per year at carbon prices of $10, $20 and $50 per tonne CO_2-e respectively.
8. The avoided fuel purchase is 1.2 billion litres per year.
9. The value of the avoided fuel purchases at $A1 per litre is $1.2 billion per year.

9 This figure is high by historical values but low by current prices

Personalised Public Transport

Data and Assumptions

The total annual net greenhouse gas emissions for Australia is 559.1MtCO_2-e (based on 2005 figures in AGO 2007b).

Total emissions from private transport (cars) are 43.7 MtCO_2-e per year (AGO 2007).

The emission intensity of 1 litre of liquid fuel is approximately 2.5kGCO_2-e per litre (AGO 2006b).

The assumed cost of 1 litre of fuel is $A1.00.

The relative emission intensity of public transport is 90% lower than personal car travel in the urban environment.

Assumes that wireless broadband-facilitated Personalised Public Transport is able to capture 10% of car-based commuters[10].

Results

(All figures are based on 2005 data without growth)

1. The total reduction in transport emissions will be 3.93 MtCO_2-e per annum.

2. This emission reduction represents 0.70% of total net Australian emissions.

3. The value of the carbon abatement will be $39 million, $79 million and $200 million at carbon prices of $10, $20 and $50 per tonne CO_2-e respectively.

4. The avoided fuel purchases through application of PPT is 1.6 billion litres per year.

5. The value of the avoided fuel purchases at $A1 per litre is $1.6 billion per year.

10 Assumes that a variety of vehicle options exist in order to optimise passenger vehicle size e.g. taxi for 1-3 passengers through to a train for hundreds of passengers. Feeder bus services increase train ridership by enlarging the catchments significantly (Najafi & Nassar 1990).

Real-time Freight Management

Data and Assumptions

The total annual net greenhouse gas emissions for Australia is 559.1 $MtCO_2$-e. (based on 2005 figures in AGO 2007b).

Total emissions from freight transport are 26 $MtCO_2$-e per year (AGO 2007)[11] .

The fraction of kilometres travelled by unladen freight vehicles is 28% (ABS 2007).

The decrease in fuel use from unladen to laden is 40% (AGO 2006c).

The emission intensity of 1 litre of liquid fuel is approximately 2.7$kGCO_2$-e per litre (AGO 2006b).

The assumed cost of 1 litre of fuel is $A1.00.

Assumes that Real-time Freight Management effectively avoids 25% of unladen truck kilometres.

Results

(All figures are based on 2005 data without growth)

1. The total reduction in emissions from Real-time Freight Management will be 2.9 $MtCO_2$-e per annum.
2. This emission reduction from Real-time Freight Management represents 0.52% of total net Australian emissions.
3. The value of the carbon abatement will be $29 million, $58 million and $145 million per year at carbon prices of $10, $20 and $50 per tonne CO_2-e respectively.
4. The avoided fuel purchase is 1.1 billion litres per year.
5. The value of the avoided fuel purchases at $A1 per litre is $1.1 billion per year.

11 Freight figures include light commercial vehicles (LCVs), rigid trucks (including non-freight trucks such as fire engines) and articulated trucks.

Increased Renewable Energy

Data and Assumptions

The total annual net greenhouse gas emissions for Australia is 559.1 MtCO_2-e. (based on 2005 figures in AGO 2007b).

Total residential and commercial electricity consumption was 108,000 GWh (ABS 2004 , ANZSIC divisions E-H and J-Q).

Emission intensity of electricity production 0.94tCO_2-e per MWh (AGO 2006b, p. 13).

The Nominal capacity factor of intermittent renewable energy generation plants is 0.3 (Transition Institute 2004).

The cost of large-scale, grid connected renewable energy is $80 per MWh (Transition Institute 2004).

Assumes that one-third of homes and commercial buildings are broadband enabled and that they have agreed to have their discretionary (non-time-sensitive) loads managed by Telstra.

Assumes that on average, 15% of the total loads across residential and commercial buildings are discretionary at any one time.

Assumes that at a minimum, discretionary power is able to leverage the same average renewable energy capacity.

Assumes that the additional value of Increased Renewable Energy is 10% of the electricity production cost.

Results

1. Increased Renewable Energy would facilitate an additional 11,000 GWh of renewable energy production per year.
2. This is equivalent to 4.1GW of additional renewable energy capacity.
3. The emission abatement from avoided fossil fuel use would be 10.1 MtCO_2-e per year.
4. This emission reduction represents 1.8% of total net Australian emissions.
5. The value of the carbon abatement will be $101 million, $202 million and $304 million at carbon prices of $10, $20 and $50 per tonne CO_2-e respectively – however it is assumed that this is already included in the renewable energy pricing structure.
6. The value of renewable energy sales enabled by Increased Renewable Energy is $86 million per year.

‘On-Live’ High Definition Video Conferencing

Data and Assumptions

The total annual net greenhouse gas emissions for Australia is 559.1 $MtCO_2$-e. (based on 2005 figures in AGO 2007b).

Total emissions from domestic aviation was 5.1 $MtCO_2$-e per year in 2005 (AGO 2007b).

Emissions from international aviation are approximately double that of domestic emissions (May 2004).

The CO_2 emission per litre of aviation fuel is 3.2kg /litre (Aviation Environment Federation 2007).

The nominal fuel efficiency of air travel is 0.035 litres per person per kilometre (IATA 2007).

The estimated fraction of short haul travel due to business use is 45% (Mason 2000).

The assumed cost per kilometre of business air travel in Australia is 10c per kilometre[12].

Assumes one third of business travellers could replace a trip with an ‘On-Live’ meeting with high speed, high definition links.

Results

(All figures are based on 2005 data without growth)

1. The total reduction in domestic aviation emissions will be 0.8 $MtCO_2$-e per annum.
2. The total reduction in domestic and international aviation emissions will be 2.4 $MtCO_2$ per annum.
3. This direct emission reduction is equivalent to 0.43% of total net Australian emissions.
4. The equivalent emissions reduction including ‘up-lift’ is 6.5 $MtCO_2$-e per annum.
5. The value of the carbon abatement will be $24 million, $48 million and $120 million at carbon prices of $10, $20 and $50 per tonne CO_2-e respectively.
6. The avoided fuel consumption is 960 million litres of aviation fuel per year.
7. The avoided spending on air travel through use of ‘On-Live’ High Definition Video Conferencing is $2.2 billion.

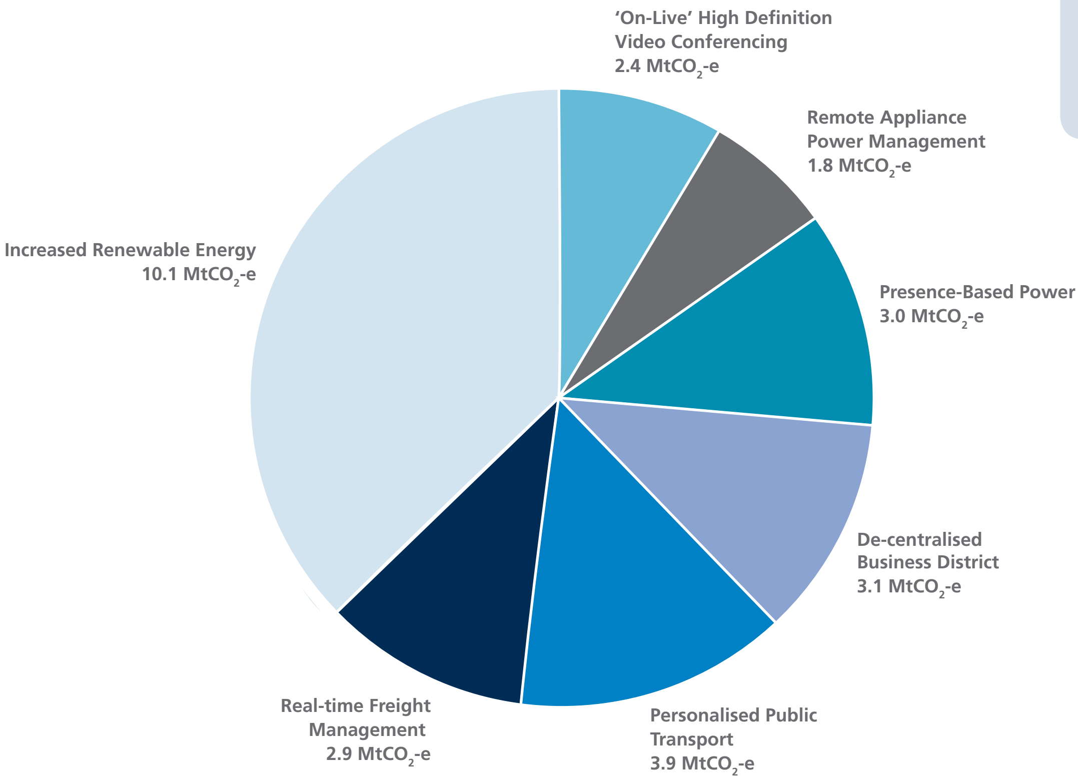
12 By way of illustration this would be equivalent to a Melbourne-Sydney trip of about 1000km costing $100 including taxes.

Total Impacts of Abatement Opportunities

The total emissions abatement potential across all seven initiatives and assuming no double counting is 27.3 $MtCO_2$-e per year. This represents 0.49% of total national emissions based on the latest National Greenhouse Gas Inventory for 2005 (AGO 2007b).

Figure 20: Breakdown of contribution from seven Carbon-Opportunities

Figure 20. Annual avoided emissions from each of the identified carbon-opportunities ($MtCO_2$-e).



Value of Avoided Carbon

The value of the avoided carbon will be depend on the future price of carbon. Should Australia adopt a carbon tax such a price would be fixed. If it adopts a market based approach to carbon abatement, as has been announced, then the value of carbon may vary according to the depth and timing of the cuts and the success or otherwise of various competing abatement technologies.

Figure 21: The value range of avoided carbon emissions

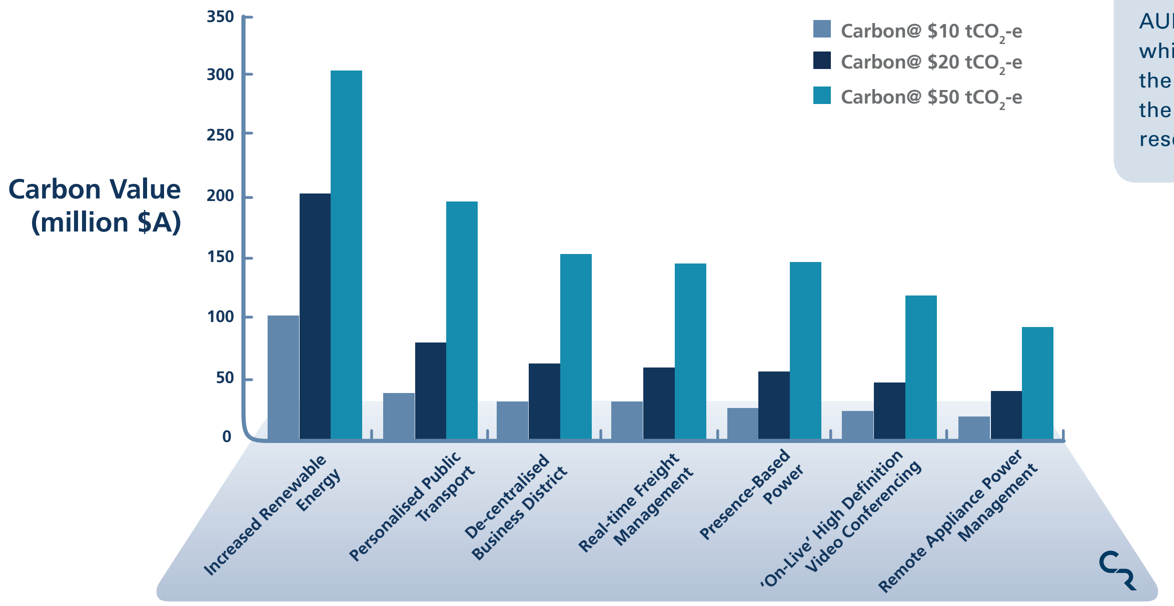


Figure 21.   The value of the carbon abatement based on carbon prices of 10, 20 and 50 dollars AUD per tonne of CO_2-e which is consistent with the range identified by the CSIRO and ABARE research (CSIRO 2006).

Total Value of the Identified Opportunities

The total value of the opportunities identified will be a combination of avoided fuel use, other avoided costs, additional value created and the value of carbon abatement. These have been estimated in Figure 22 based on the intermediate price of $A20 per tCO_2-e.

Attribution

Although we identify the value of various energy-saving or energy-creating measures which are, or can be, facilitated by telecommunication networks, it is beyond the scope of this report to develop a detailed model of attribution that would indicate with which party such value would reside.

For example for reduced aviation use, the value of avoided air travel in staff time saved, travel expenses and accommodation expenses, less the cost of using 'on-live' meeting suites, would rest with the employer. Similarly, the savings for a household from an electricity bill would rest with the householder responsible for paying the energy bills. In relation to carbon credits, in some instances it may be possible for that carbon to be assigned to a third party to be aggregated and sold on national or international carbon markets.

For this report we identify that there are precedents for companies and other organisations to undertake emission reducing activities and to trade the carbon abatement. We note that the

Figure 22: Aggregated value for each of the Carbon-Opportunites

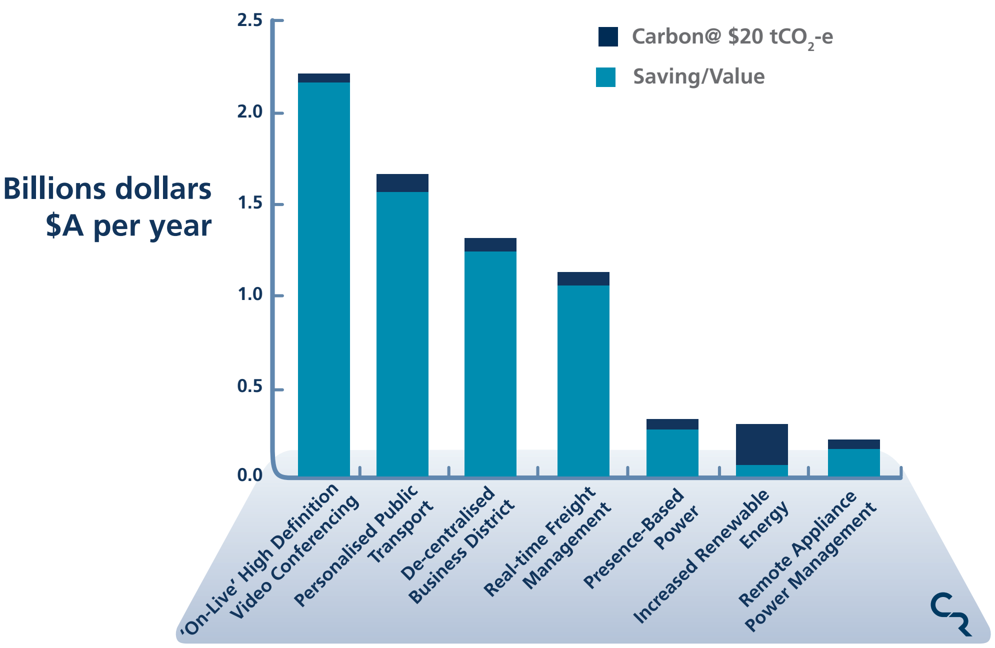


Figure 22. Each of the carbon-opportunites creates value from avoided fuel use or increased energy value, as well as revenue from carbon credits created and other ancillary services.

carbon and non-carbon value could attribute to either the conference provider, the customers, or a third party, however as we have noted above, it is beyond the scope of this report to provide analysis of the likely or possible attributions.

Regulation

In some cases the carbon-opportunities may be fully or partially constrained by regulation, though this an area of constant flux. This is particularly true of the renewable energy market which is underpinned by Federal and State based 'Renewable Energy Targets' which require retailers to procure a certain fraction of their energy from renewable sources. There are other market drivers such as private demand for Green Energy. There are also changes in the spot prices in the National Electricity Market which at time of writing are, on average, high enough to pay for wind energy without any additional assistance, in part due to shortage of adequate supply (affected by climate related water shortages in the East).

The opportunities presented in this report have not been assessed against regulatory constraints, but it is noted in each section where such systems are already being applied which indicates that they are being used in Australian or overseas jurisdictions and therefore no insurmountable regulatory constraints are anticipated.

Timing

Looking at the roll-out of the opportunities identified in this report would require the development of deployment scenarios which is beyond the scope of this study. However the ability of the various opportunities to be applied in the short term (i.e. deployed to the levels indicated over a period of about 5 years) has been considered.

In general this requires avoiding processes which require expensive retro-fitting and/or long turn-over periods. We have also noted that the deployment of new networks such as 'Fibre To The Premises' provides unique opportunities to deliver carbon abatement products and services at the same time, such as network enabled plugs or RFID systems.

As an indication only, we estimate that a plausible development and demonstration period, followed by market deployment, would provide an abatement profile as shown in Figure 23. The effect on national emissions (with measures) in shown in Figure 24).

Figure 23: Plausible emissions abatement from Carbon-Opportunities

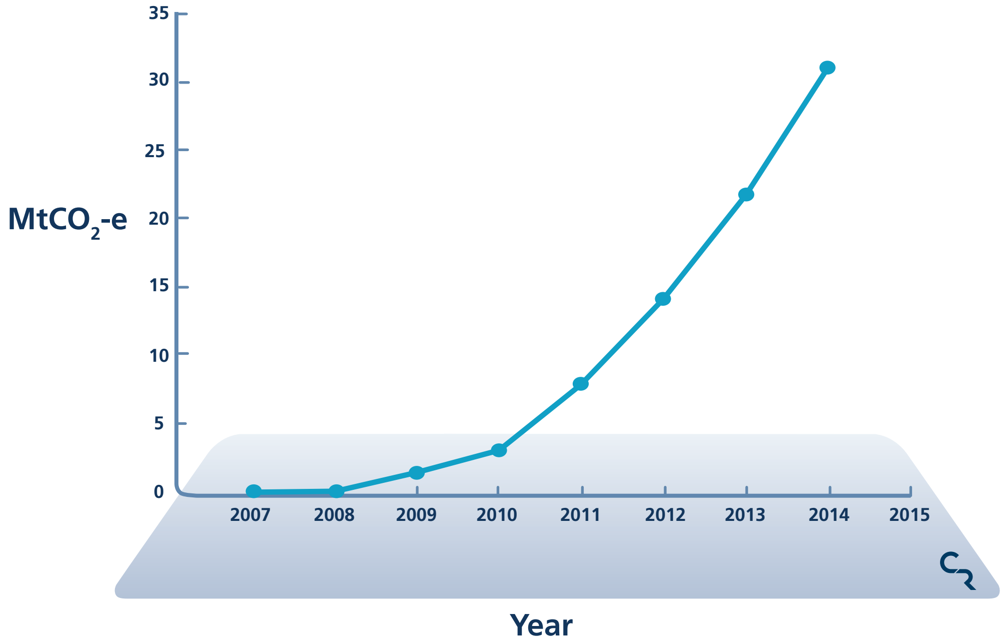


Figure 23. A plausible roll-out of the carbon-opportunities would include product development time and a gradual build up of deployment in the market.

Figure 24: Possible effect of Carbon-Opportunities on national emissions

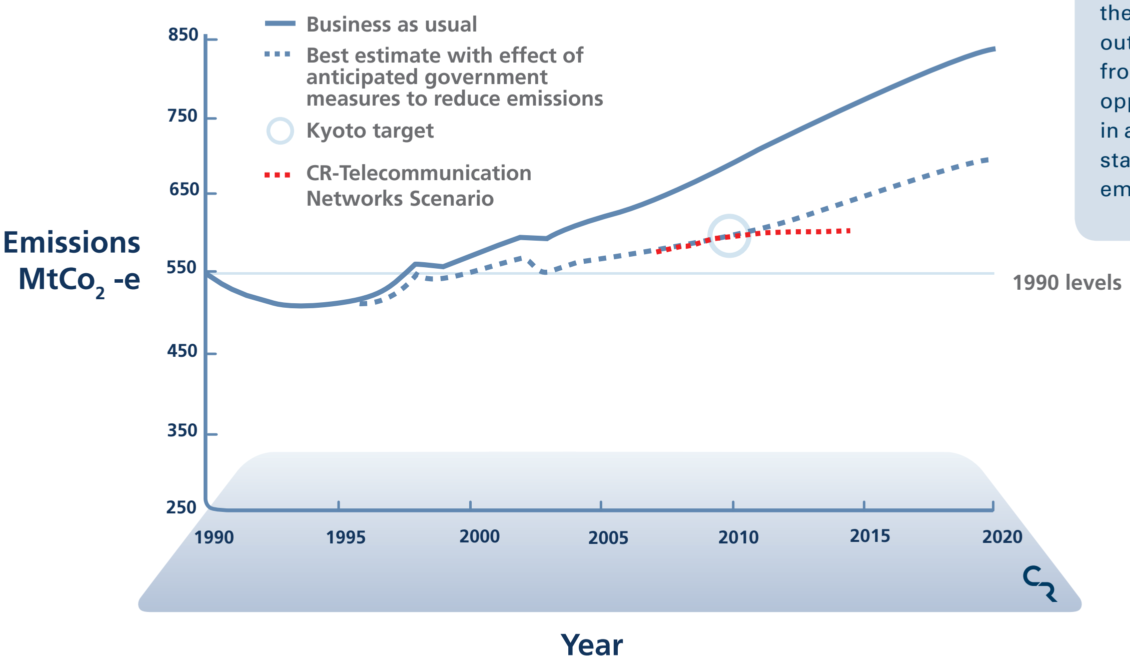


Figure 24. Applying the above roll-out of abatement from the carbon-opportunities results in an approximate stabilisation of emissions before 2015.

Part 6

Conclusions

Beyond Carbon Neutral

This report goes significantly beyond 'holding the line' goals of corporate carbon neutrality and carbon. Instead it sets out a suite of opportunities that would allow telecommunications providers to play a leadership role in decarbonising the Australian economy and equipping the nation to prosper in a carbon constrained future. All of the strategies and opportunities are based on avoiding the release of fossil carbon into the atmosphere; they are not based on off-setting emissions.

Seven options are proposed to build on existing and next-generation networks. The realisation of opportunities outlined in this report would result in telecommunications providers assisting Australian businesses and households achieving total greenhouse gas reductions equivalent to approximately 4.9% of Australia's total national emissions. Some of the opportunities identified in the consumer space can be achieved using existing network services and others are contingent on the roll-out of fibre to the node (FTTN) broadband infrastructure. Overall the initiatives identified in this report present the opportunity for one of the single largest reductions in Australia's carbon footprint by an Australian corporation.

Companies seeking to maximise their carbon emission reduction could leverage the existing and next-generation networks already built by Telstra.

The Climate Challenge

The latest statement from the Intergovernmental Panel on Climate Change (IPCC 2007) indicates the next ten years are critical in meeting the challenges posed by climate change. For the first time, scientists and governments are now agreed that global emissions must be stabilised by 2015 if climate change is to be effectively addressed. Similarly the global economic Stern Review concluded that "to stabilise at 450ppm[ii] CO_2-e, without overshooting, global emissions would need to peak in the next 10 years" (Stern 2006, p. 193). Reducing greenhouse emissions requires major commitments from both the public and private sectors as well as the government.

In 2005 Australia's net annual emissions totalled 559 mega-tonnes of CO_2 equivalent ($MtCO_2$-e) from all activities, which equates to 1.4% of the global total. In the short term, it appears that Australia will stay close to its Kyoto Protocol target of no more than an 8% increase above 1990 emission levels (AGO 2007b). However, the underlying trend is that Australian emissions will increase at about 1.3% per year.

The use of fossil-fuels in stationary-energy[iii] and transport applications is the nation's major source of emissions. The trend is not declining or stabilising, but continuing to grow significantly. If deep cuts in emissions are to be achieved, emissions from the energy sector are Australia's greatest greenhouse challenge.

Telecommunication's Significance in Climate Change Mitigation

Telecommunication operators are a major conduit for new technology and infrastructure. Australia has the only national wireless broadband network in the world.

The scale and scope of the telecommunication sector's operations unlock the ability to aggregate multiple distributed initiatives to achieve nationally significant emissions savings. The anticipated greenhouse emission constraints coincide with the government's plans for next-generation networks, which provides synergies for new emission reduction opportunities.

This report identifies seven carbon-opportunities appropriate for Australian businesses and households, which have the potential for viable carbon abatement using existing and next-generation networks. These carbon-opportunities have relevance for energy consumption in buildings, road transport, renewable energy production and aviation.

Carbon-Opportunity (in order of size)	$MtCO_2$-e saving	Percentage of national emissions
Increased Renewable Energy	10.1	1.81
Personalised Public Transport	3.9	0.70
De-centralised Business District	3.1	0.55
Presence-Based Power	3.0	0.53
Real-time Freight Management	2.9	0.52
'On-Live' High Definition Video Conferencing	2.4	0.43
Remote Appliance Power Management	1.8	0.33
Total	27.3	4.88

Table 4. Summary of emissions abatement from carbon-opportunities

Key Findings

1. This report provides an analysis of the opportunities for Australian society to achieve nationally significant greenhouse gas abatement using telecommunication networks.

2. The report identifies that the scale and scope of telecommunication network services and users provide a unique opportunity to harness economies of scale to achieve meaningful emission reductions.

3. Many of the carbon-opportunities identified lead to energy and other cost savings for commercial and residential customers, and in some cases will enable the on-selling of newly created carbon credits[i] and electricity management commodities.

4. The estimated abatement opportunity calculated herein is almost 5% (4.9) of Australia's total national emissions, making the use of telecommunication networks one of the most significant opportunities to reduce the national carbon footprint.

5. The estimated energy and travel cost savings are approximately $6.6 billion per year, and value of the carbon credits created may be between $270 million and $1.2 billion subject to the future price of carbon.

6. Some of these carbon-opportunities can be realised immediately; others are contingent on the roll-out of a national fibre optic network to residential and commercial consumers.

7. In combination with other measures being implemented by Government, a deployment of the carbon-opportunities in the period 2008 to 2014 would have the additional effect of stabilising national emissions in the period up to 2014 in keeping with the findings of the IPCC and the Stern Review, as shown in Figure 25.

Figure 25: Combined effect of telecommunication networks Carbon-Opportunities

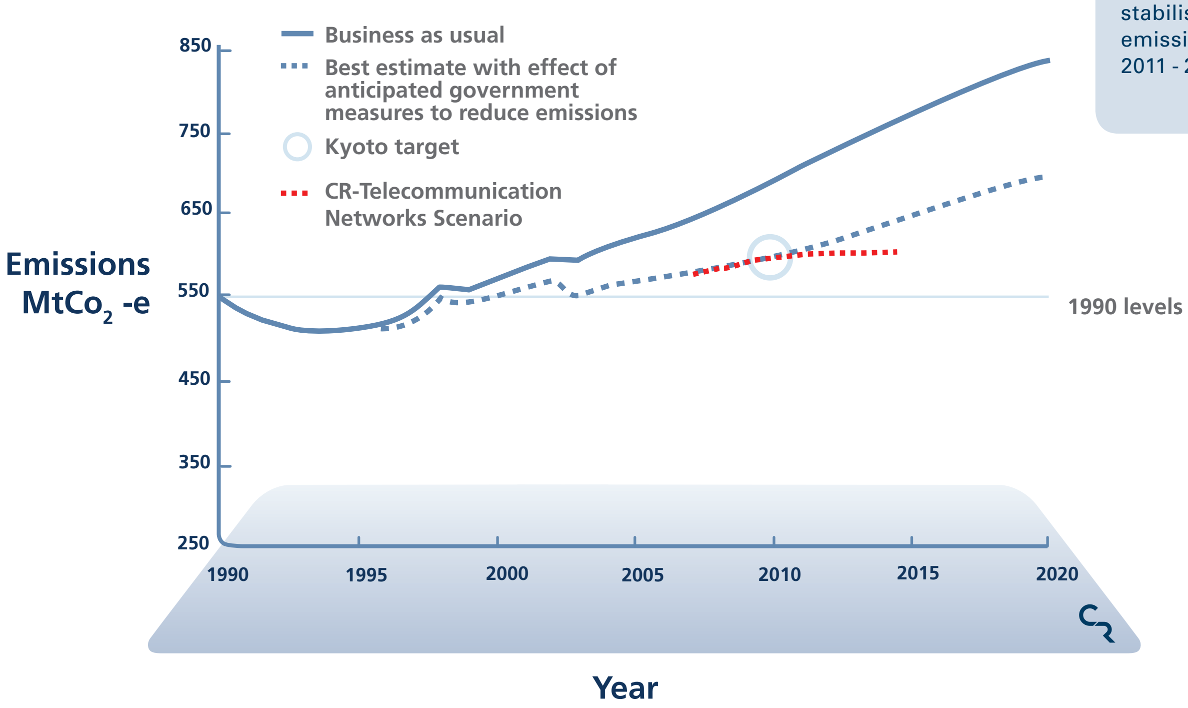


Figure 25. If the seven carbon-opportunities identified in the report were deployed, over the period 2008 - 2014, the effect would be a stabilisation of national emissions in the period 2011 - 2014.

Figure 26: Aggregated value for each of the Carbon-Opportunites

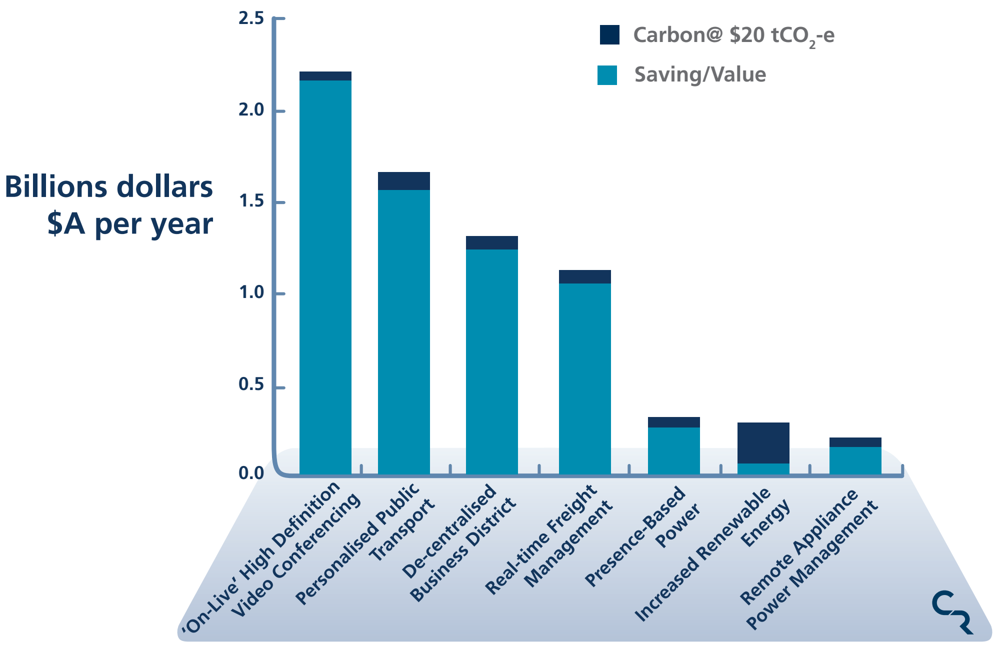


Figure 26. Each of the carbon-opportunites creates value from avoided fuel use or increased energy value, as well as revenue from carbon credits created and other ancillary services.

Part 7

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Glossary

Abatement – A reduction in greenhouse gas emissions (also see mitigation)

Adaptation -The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as an 'adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities' (Metz *et al*. 2001, p.708).

Anthropogenic – The result of human activities.

ATM – Assynchronus Transfer Mode. ANSI and CCITT communications protocol allowing different types of information e.g. voice, data, video to share the one network and interface. Based around a system of separating bytes and reassembling at delivery for optimal use of network.

Base-load – Normally refers to a power station that runs constantly (24 hours per day, 7 days per week) regardless of energy demand. Due to their slow start up and shut sown times it is more cost effective for them to remain on.

Baud – Data rate in bits per second. Falling out of use as a term.

Broadband – The term originally applied to internet networks when they were faster than 64 kbit/s and always connected. Different commentators apply different data speed thresholds for the beginning of Broadband e.g. 64, 128, 256 Kbit/s or beyond 1, 2 Mbit/s. The term Broadband has morphed into a description of wide, fast, transparent connectivity and interfacing for a variety of devices and applications.

Business as Usual – Refers to the emissions trajectory associated with undertaking activities without any measures to reduce greenhouse gas emissions. Often greenhouse gas mitigation policies are compared to "business as usual" to show the potential impact of the policy.

Capacity – Maximum rated power of a power station, usually measured in megawatts.

Capacity Factor – The percentage of yearly energy generated as a fraction of its maximum possible rated output.

Carbon Credits - When pollution levels are capped, in some schemes, it may be possible to trade greenhouse gas pollution rights referred to as 'carbon credits'. Currently NSW has a greenhouse gas emissions trading scheme, the Federal Government has announced plans to introduce a national scheme in 2012 and there are also voluntary abatement markets.

CERN - Organisation Européenne pour la Recherche Nucléaire (European Organization for Nuclear Research) particle physics laboratory based just outside of Geneva

CO_2 – Carbon dioxide, which is one of the primary anthropogenic greenhouse gases

CO_2-e - Carbon dioxide equivalent. The net effect greenhouse gas emissions is often presented as carbon dioxide equivalent which is a conversion to the global warming potential of carbon dioxide over a 100 year period. For example, the global warming potential for a tonne of methane is 21 times that of a tonne of carbon dioxide.

Dial Up – An Internet connection where the modem dials into an analog phone line using standard telephone dialing protocols.

Emissions Intensity – The emissions generated per unit of input or output.

Fibre – Refers to Optical Fibre, invented and refined in the 60's and 70's, and able to carry analog and digital data as modulated light offering extremely high bandwidths at long distances. Fibre can have a variety of optical communications interfaces applied and it comes as either Multi-mode or Single- mode with the physical advantages of being light and flexible for installation.

Fossil Fuel – A non-renewable source of energy formed from decayed organic matter millions of years ago. The most predominant fossil fuels are coal, oil and gas.

FTTx – Fibre-to-the-'x' where 'x' is a node, premises, segment e.g. FTTP, FTTN etc.

Fugitive Emissions – The emissions which come from the mining, transportation and storage of fossil fuels (but does not include the emissions from fossil fuel combustion).

GDP – Gross Domestic Product – the economic value of a country's annual production of goods and services.

Geosequestration – Refers to the capture and geological (underground) storage of CO_2 emissions.

Greenhouse Gas (GHG) – Gases in the atmosphere that adsorb and emit infrared radiation, which subsequently lead to global warming. Most common anthropogenic greenhouse gases are (CO_2), Methane (CH_4), Ozone (O_3), Nitrous Oxide (N_2O) and Sulfur Hexafluoride (SF_6).

HSDPA - High-Speed Downlink Packet Access is a mobile telephone protocol allowing high speed data transmission and is used in Telstra's Next G™ network

IP – Intelligent processing within a network. Network layer protocol in TCP/IP offering a connectionless or packetised service

ICT – Information Communications Technology

ITU – International Telecommunications Union i.e. coordinates standards for telecommunication networks and operations around the world with signatories from participating countries.

Latency – The delay through a network or process that can be caused by distance such as over satellite or through dealing with information such as reassembling bytes in an ATM network or decompressing video.

Mitigation- The Intergovernmental Panel on Climate Change (IPCC) defines as 'an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases' (Metz *et al*. 2001, p. 716).

Modem – Device for modulating data and signals over a network according to the interfacing protocols required by the devices on the network. Theer are different types of modems for different networks, whether phone or cable TV networks etc.

MPEG – (Moving Picture Experts Group) Protocol for moving compressed video and audio down data networks either as broadcast/satellite or along wires/fibre. So far there are MPEG1. 1.5, 2, and 4 referring to different rates and processing outcomes (e.g. there was an MPEG 3 specified for HDTV but it was never used).

MPLS – Multi Protocol Label Switching is a method for carrying IP over ATM. Favoured because it allows customer traffic to be less expensively introduced into backbones without needing an intermediate service.

MRET – Mandatory Renewable Energy Target

Mt- Mega-tonnes. One mega tonne is one million tonnes. Greenhouse gas emissions are often displayed in mega-tonnes carbon dioxide equivalent per annum ($MtCO_2$-e/yr) (see $MtCO_2$-e).

$MtCO_2$-e - Mega-tonnes carbon dioxide equivalent ($MtCO_2$-e) is the internationally recognised measure used to compare the emissions from the various greenhouse gases. This measure factors in differences in global warming potential and converts them to a carbon-dioxide equivalent. For example, the global warming potential for a tonne of methane over 100 years is 21 times that of a tonne of carbon dioxide.

NEM – The National Electricity Market. The NEM is a wholesale market for electricity supply which delivers electricity to market customers in all states and territories, except for Western Australia and the Northern Territory, through the interconnected transmissions and distribution network.

NEMCO - The National Electricity Market Management Company Limited administers the National Energy Market (see NEM).

Network –The term for communications systems and originally meant the physical cable of a phone network or a data network. With the growth of ATM and wireless has widened to include how signals are dealt with on a physical network but not referred to the electrical characteristics of that network plus the devices on the network. Also no longer limited to wires but includes mobile and wireless systems.

NGNs – Next Generation Networks where the physical and electrical characteristics of the network are not paramount so much as the active way in which information is processed and dealt with across the network. With NGNs this means intelligence is built into the network making it transparent to a wide range of devices and applications with application's architecture plugged into the network.

Orphaned Energy / Appliance - an appliance which is using energy even though no user is present is refered to as orphaned.

Peaking Plant – Normally refers to power stations which run at peak times to meet short term peaks in electricity demand.

Photovoltaic Cell – A renewable energy technology which converts sunlight into electrical energy.

Point-To-Point – When two sites or nodes in a telecommunications system are connected together by a physical cable or wireless system.

Power - Energy transferred per unit of time. Electrical power is usually measured in watts (W), kilowatts (kW) and megawatt (MW). An appliance drawing 1000 Watts (1 kW) for 1 hour is said to have used 1 kilowatt hour (1 kWh) of electricity.

QoS – Quality of service. Has set definitions including network availability as well as quality of usage.

Renewable Energy - Energy which comes from natural processes and which are replenished in human time frames or cannot be exhausted (sources of renewable energy include wind, biomass, solar radiation, geothermal energy, wave and tidal power).

Solar Power - (see photovoltaic cell)

SONET- Synchronous Optical Network implemented over fibre as a ring so if a fibre stops working traffic can be rerouted without interruption. Data rates from 51.84 Mbit/s through to 9.953 Gbit/s.

Switch – The large-scale device for switching phone and data from their sources to their destinations via the network.

TCP – Transmission Control Protocol ensuring data is delivered to the application layer in proper sequence without errors, missing data or duplication.

Telco – shortened version of telecommunications company or carrier.

Telepresence – Enhanced Video, audio and information conferencing with the aim of minimising the perception limitations of present electronic communication such as video conferencing compared with face-to-face meetings. As well as using better sytems such as HDTV it involves designing in 'soft' issues such as lighting, sound placement etc.

Teleworking – Using Broadband facilities to enable working away from the office whether at home or on the road.

Twisted Pair – Two wires 'twisted' together in a certain pattern to minimise electrical interference and connected as an electrical circuit for carrying phone or data as a point-to-point connection from the house to the telephone exchange.

VoIP – Voice over Internet Protocol. Makes use of Broadband to repackage voice as data routed using IP. Used for placing computer to computer calls or for entire business networks.

Wind Farms – A collection of wind turbines which connect to common substation to feed into the main electrical grid.

Wind Turbine – A renewable energy technology that converts air currents into mechanical energy which is then used to generate electrical energy.

Wireless – Refers to mobile phone networks or any public network that uses radio. Also can refer to local area networks or LANs that are distributed using inhouse wireless systems.

With Measures – Describes an emissions trajectory with greenhouse gas mitigation measures and generally shows the deviation from the business-as-usual projection.

xDSL – x Digital Subscriber Line, a family of high bandwidth telecommunications services consisting of ADSL, HDSL, SDSL, IDSL. ADSL (Asymetric) and SDSL (Symetric) have been focussed on because of the opportunity to provide broadband to the premises over existing twisted pair in addition to phone service.

Appendicies

Appendix 1

Industry Example: Broadband and Urban Development - Genesis, Coomera

Introduction

Genesis Coomera, by award winning developer, Heritage Pacific, was Telstra's first Smart Community connected with Fibre To The Premises (FTTP), providing a high-speed optical fibre cable to each of the proposed 700 residential buildings. It is located 3km from the Coomera Town Centre which is identified as a Major Activity Centre in the South East Queensland Regional Plan (Gold Coast City Council 2007). The development is occurring in one of Australia's fastest growing regions and as such measures to reduce the environmental impact are important to curbing national emissions.

The Genesis development is exploring new boundaries in urban development in several ways. This innovation has been recognised through a number of awards for its design and construction. Some of the key elements include:

- Water recycling and environmental flows which can be remotely monitored and controlled
- Genesis residents have access to shared central services for recreation, business and education, including an office suite with full high-speed broadband connectivity
- Some homes feature full automation of lighting, security and entertainment with a Voice over Internet Protocol (VoIP) phone for video conferencing
- Smart wiring and automation provide a range of monitoring and control functions in the homes. Environmental controls such as temperature and air quality, light and shade can all be regulated;
- Energy saving has been an important design consideration with much of the automation optimised to maximise energy savings with minimal user interaction.

In order to consider how broadband can facilitate reduced carbon emissions in a community like Genesis Coomera, it is relevant to consider the geographical and social context with which the community is being established.

Coomera, Gold Coast and South East Queensland

Rated as one of the world's most biodiverse areas, rapid growth is placing resource pressure on the region (Gold Coast City Council 2005). The rapid urbanisation of the Gold Coast has contributed to some suburban areas suffering social isolation and a lack of public facilities and transport (Gold Coast City Council 2005). Environmental pressure is growing with climate change and urbanisation increasing vulnerability within the region.

The region is predominantly rural with a low population. The Pacific Motorway is the major public transport route. There are two train stations in the area with less frequent services than the regional average. Currently high dependence on the private car for transport needs has heightened the economic vulnerability of residents (Dodson and Sipe 2006).

Upper Coomera is an area with high levels of disadvantage and no public transport service. The State government is planning to centre most development around Coomera in proximity to rail transport running north-south parallel to the Pacific Highway.

How Can Broadband Assist with the Carbon Footprint of Genesis?

Smart Development reduces environmental impacts

Genesis residents will have access to an epicentre for recreation, business and education. Synergy, a $3 million investment for exclusive use by Genesis residents, provides an epicentre with recreation, business and education facilities. There is an office suite and social centre including a cinema on site with full connectivity. Water recycling and environmental flows can be remotely monitored and controlled if required.

Transport

In a climate sensitive, carbon constrained world, increased fuel prices are likely to place considerable strain on the cost of living. The increase in transport costs will have repercussions for communities heavily dependent upon private cars for commuting and personal activities. Any carbon tax, cap or trade mechanism is also likely to increase costs for urbanised and rural communities whose travel is based predominately around the car.

Given that Genesis is evolving within an area with relatively high unemployment, there is strong indication that its residents will work outside the area, possibly for businesses in Brisbane. Without the provision of effective alternatives, the presence of a major motorway nearby will draw residents to car based commuting.

Home Appliance Efficiency

Genesis is a community with a high level of appliance energy consumption. This high degree of automation could lead to significant increases in energy demand above those of the less ‘smart’ home. Conversely, this automation may be used to leverage energy management and therefore reverse and reduce energy demand.

Smart Homes reduce heating and cooling demands

A proportion of homes have been automated and connected to high-speed broadband. These feature full automation of lighting, security and entertainment with a Voice over Internet Protocol (VoIP) phone for video conferencing. Smart wiring allows for a range of automation in these homes. Environmental controls such as temperature and air quality, light and shade can be regulated to allow blinds to come down during sunny periods and louvres to open to let in afternoon breezes.

Automated window opening and closing maximises energy savings with minimal user interaction.

Telstra Smart Community brought together via the web

All homes also share a domain (@ myhome.genesis.coomera.com.au). There is significant potential to develop collaborative relationships i.e. car-pooling or online purchasing, in addition to practical issues pertaining to the site. Local universities offer online courses and delivery of education via the web.

Smart Technology

Telstra have connected a product called Telstra Velocity™ which is FTTP which at present offers 8 - 20 mbps, multiple phone lines and television services on one fibre cable. This delivers ultra high quality connections and the use of many applications rarely found in CBD offices. This high-speed broadband connection facilitates the uptake of full-time or partial telework. At Genesis, of the 85 % of residents connected to Telstra Velocity™ , all request that dedicated office facilities be built at their home (Harrison 2007a). Profiling provided by Genesis suggests that many residents employed in Brisbane are working from home at least one day per week. One resident has been able to move a high technology sound production business to his home. The uptake of teleworking at the development has the potential to save a considerable amount of greenhouse gas emissions.

The projected savings for residents who are employed in the Brisbane area can be estimated as follows:

Teleworking one day per week saves 96kms per week per person. This is equal to 9,200kms per year (46 weeks x 96kms per year).

Assuming a typical Australian car emits 160g CO_2-e per kilometre then 780 kg of CO_2-e per year would be saved.

If 300 of the adult residents in the planned development worked from home one day per week then 215 tonnes of CO_2-e would be saved per year (based on travel to Brisbane).

Ancillary benefits include time, cost savings, reduced traffic congestion and air pollution.

Potential for Increased Emission Reductions

Personalised Public Transport

By utilising Telstra Fibre to the Premises (FTTP) at the Genesis development there is potential for deeper greenhouse gas abatement than provided by teleworking alone. The Genesis development is located 3km from a soon to be ‘Major Activity Centre’ which includes a large public transport node on the main rail line to Brisbane.

As discussed earlier in this report, one

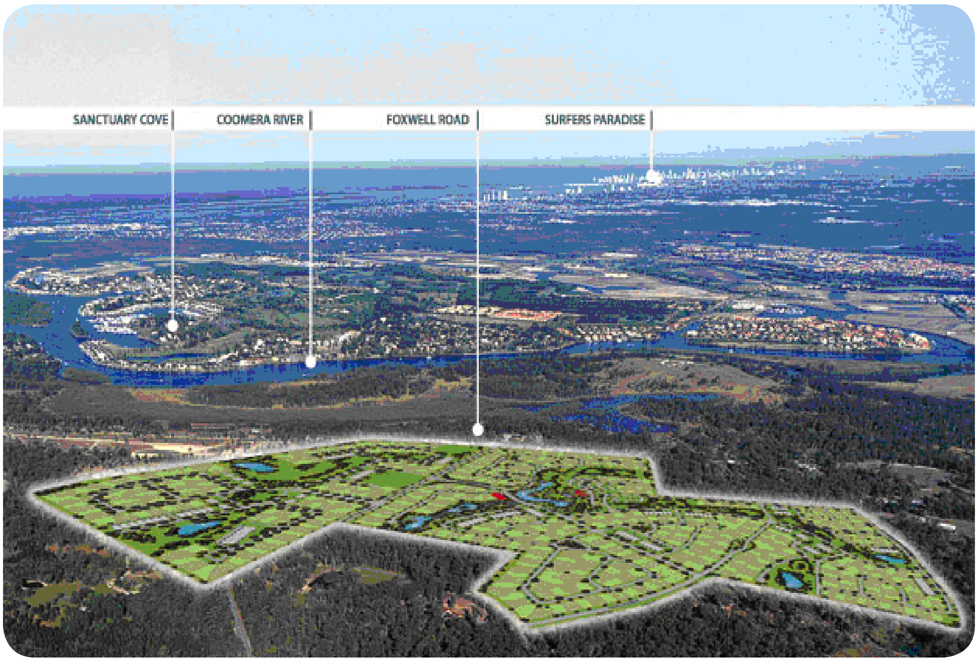

Figure 27. The Genesis Development at Coomera, Gold Coast

of the major barriers to the uptake of rail and other public transport use is the absence of feeder networks for those outside the walking catchment of the stations. Personalised Public Transport (PPT) present significant greenhouse gas reduction potential for the Genesis development. The on-call services PPT could provide would allow residents to easily access the Coomera transport node for commuting throughout South East Queensland, as well as providing access to shops and employment opportunities available in the town centre. The facilitation of feeders services such as PPT would also free up land use space in the town centre that would otherwise be used as a park-n-ride.

Remote Appliance Power Management

A high percentage of the 700 homes at the Genesis development have high-speed broadband and can be engaged in the the Remote Appliance Power Management carbon-opportunity. As each Australian home each loses more than 11% of its electricity to appliances on standby, considerable emission reductions and dollar savings could be made.

Quantifying the Savings for PPT

Assumptions:

a. 100 residents replace personal car use for PPT for commuting alone to Brisbane in a car.

b. Average distance travelled driven per day to and from work to Brisbane is 96 kilometres

c. Number of days worked a year is 200

d. CO_2-e emissions per kilometre is 163g

Emissions savings:

= (a x b x c x d)

= 312,000 kgs CO_2-e per year saved

Assume petrol is $1 per litre results in $1.7 million in combined savings (after $65 per person, per week spent on public transport is removed).

Quantifying the Savings for Remote Appliance Power Management

Assumptions:

a. 700 homes when complete

b. Average household energy use 6.26 MWh per annum (ABS 2004)

c. Standby percentage 11.6% (AGO & ICLEI 2005)

d. 900 kg of CO_2-e per MWh (CAIT 2005)

Emissions savings:

= (a x b x c x d)

= 504,000kg GHG emissions saved.

Total emissions savings potential is 312,000 kg (using PPT) plus 504,252 kg (using Remote Appliance Power Management) = 816,252 kg per annum.

Barriers to Implementation

In order to realise emissions reductions using PPT at Genesis, government support to increase the functionality of public transport in the region will be necessary. This would include high frequency rail services from Coomera to Brisbane to ensure public transport is a viable option.

Conclusion

The Genesis development is well equipped to provide best practice systems to reduce greenhouse gas emissions through the use of FTTP and consequent high quality teleworking options. Herein it is envisaged that by utilising two of the proposed options in this report (PPT and Remote Appliance Power Management) deeper greenhouse gas emission cuts are possible.

Appendix 2

Industry Example: Next generation networks, Carbon and Education - Catholic Education Parramatta

"broadband is changing the way pupils learn and construct their work, changing the ways teachers organise lessons and co-operate with colleagues, and changing the way schools administer their courses."

(Underwood *et al.* 2005, p.6)

Catholic Education Parramatta (CEP)

The Diocese of Parramatta is located in one of the fastest growing areas of New South Wales. The diocese is west of Sydney and reaches from Dundas Valley, west to Katoomba, south to Luddenham and north to Richmond.

There are 76 Catholic schools in the Parramatta diocese of which 54 are primary and 22 are secondary. Approximately 4000 staff attend to the total student population of 41,600 students. There are also six congregational (independent Catholic) schools in the diocese with the most recent, St Mark's Catholic College, opening at Stanhope Gardens in February 2007.

Carbon Emission Abatement in Schools

Using technology to save emissions in schools offers a great opportunity to expose students to new ways of managing their emission profile. They can then carry this into the workplace and home.

Significant energy and carbon emission savings could be realised via two of the opportunities identified earlier in this report; Remote Appliance Power Management and Increased Renewable Energy.

A 'Typical' School

Each of Catholic Education Parramatta's schools are different. In order to consider this industry example it is useful to create an hypothetical 'typical' school.

- Our case-study school has 1,000 pupils and just fewer than 100 members of staff.
- The class occupancy is about 25 children per class and this includes smaller classes for specialist subjects.
- The school has 40 classrooms equipped with air conditioning for cooling in the summer and heating for the winter, using an average of 3.7MWh of energy per classroom per year over the year[13]. By comparison a typical home uses about 6.2MWh per year.

"The annual energy saving of this server consolidation is 1.4 megawatt hours and a carbon reduction of approximately 140 tonnes of greenhouse gas emissions per year."

13 Assuming 50 square meters per class room, 0.125KW of power used per square metre (SEDO 2004) when in use, 3 months heating in summer, 3 months cooling in summer for 5 hours per day.

> Broadband technology has the potential to revolutionise the Australian education sector. The always-on nature of broadband connections allows school students to use the internet as an everyday research tool in the classroom more easily. High bandwidth enhances the effectiveness of existing distance learning programs by enabling video conferencing on the desktop. Access to sufficient bandwidth allows researchers in Australia's higher education institutions to participate in international collaborative research projects and broadband allows tertiary students to access high quality course materials from campuses across the country and around the world.
>
> (Broadband in Schools, NOIE Canberra August 2002)

- The school has standby loads including computers, laptops on charge and musical equipment. It also has electrical hot water heating on 24 hours a day, seven days a week. Standby power consumption is typical of that in the residential sector.

The average energy consumption in this typical school is 335KWh per person (pupils and teachers) per year (QDOE 2006) which equates to a total of 370MWh per year.

Remote Appliance Power Management in Schools

In line with commercial and residential sectors, a significant proportion of energy in Australian schools is wasted on standby power. Remote Appliance Power Management would allow all appliances to be switched off by the school caretaker at the end of the school day or during holiday periods. The intelligent networked control switch would enable the caretaker to selectively turn on areas for after hours use.

If we assume that the schools have energy wastage similar to residential standby, the opportunity exists to provide for simple standby reduction through centralised online control of either outlets or network enabled intermediate sockets (an adaptor between the socket and the device plug which can be used without the need to retro fit the outlet).

Assuming 50 square meters per class room, 0.125KW of power used per square metre (SEDO 2004) when in use, 3 months heating in summer, 3 months cooling in summer for 5 hours per day.

All standby power across the school

could be terminated from 5pm to 8am each school day and over the weekends, reducing the number of hours in which standby devices could draw power by 73%. Assuming an average 11% of energy is standby, the savings would equate to 3.2MWh of energy per school (enough to power 5 homes a year) and saving over $3,200 per year on the school electricity bill.

Increased Renewable Energy

Heating and cooling facilities in the school present an opportunity to use these loads for Increased Renewable Energy during the working hours of the school (assuming these loads are they are all off outside these hours).

The amount of power used in heating and cooling classrooms during the relevant summer and winter months would be approximately 250kW, which is enough 'discretionary' load to marry with a 750 kilowatt wind turbine with a 25% capacity factor. Across the total CEP school population of 42,000 students, this would be enough discretionary load to partner with a substantial 30 megawatt wind farm - approximately double the amount of wind energy currently operating in NSW.

Conclusion

This example illustrates a significant opportunity to reduce the emission footprint of any school through the application of several of the opportunities identified in this report to heating, cooling and energy loads.

Appendix 3

Industry Example: Telstra - Change Through Leadership

Introduction

This report identifies the opportunity for Telstra to act as a catalyst for reductions in national emissions which go beyond the direct scope of Telstra operations.

This chapter explores Telstra's environmental stewardship to date and identifies opportunities to use Next IP™ for further emission reductions.

Introduction to Telstra

Telstra's history dates back to the foundation of the Commonwealth in 1901 when the Commonwealth Government established the Postmaster-General's Department to manage all domestic telephone, telegraph and postal services.

Telstra, as Australia's largest telecommunications provider, serves Australian customers via fixed line (including data, broadband, IP and cable), wireless (2GSM, 2100MHz, CDMA and Next G™) and satellite networks. In addition, it operates a number of international services. In total Telstra provides nearly 10 million fixed line services and over 9.2 million mobile services.

Current Emissions[14]

Telstra has approximately 36,000 full-time equivalent (FTE) employees in its Australian workforce and operates Australia's largest vehicle fleet of over 17,000 vehicles (including salary sacrifice vehicles). The organisation's physical footprint covers 14,500 commercial properties with nearly 33,000 cabinet facilities.

As a builder, operator and maintainer of telecommunications infrastructure, Telstra's main emissions - 89% of the total - come from energy use in network operations including data centres and offices (Telstra 2006). Telstra is one of the largest occupiers of commercial property in Australia with over 10,000 sites nationally. The scale and scope of Telstra's operations and assets present significant energy management challenges. For example, the CDMA network when retired will reduce energy requirements while the roll-out of next generation networks is likely to increase consumption.

Other emission sources include Land Use, Land Use Change and Forestry (LULCF) which could be both negative through clearing of easements or positive through replanting. Staff travel is extensive with over 411 million road kilometres travelled in the financial year 2005/06.

Current ICT based abatement strategies

Telstra recognises and tracks its greenhouse gas emissions on a yearly basis. Telstra to date has saved 115,141

14 The data and information contained within this study is sourced from publicly available documents and from information provided by senior management. The principal source document, the Telstra Corporate Responsibility Report 2006, is written in accordance with GRI G3 standards however the information reported has not been verified by Climate Risk and no assurance is given as to its completeness or materiality.

Figure 28: Telstra's annual CO_2 emissions

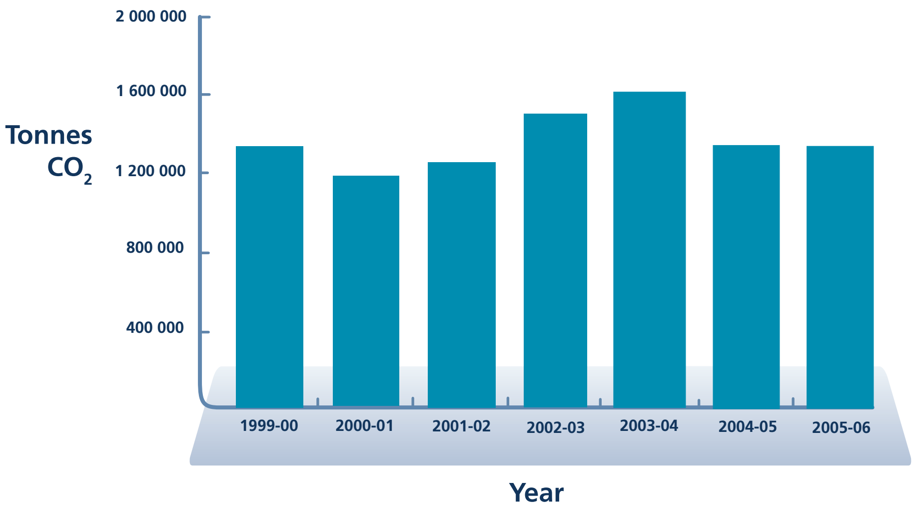

Figure 28. Telstra's annual CO_2 emissions (excluding aviation , logistics and LULUCF) (Telstra 2006).

tonnes of CO_2 equivalent emissions (Figure 29) (Telstra 2006). Telstra has a range of greenhouse gas reduction programs, some of which include ICT based strategies:

Fleet management: In addition to increasing the use of low emission fuels for its 17,000 fleet vehicles, Telstra has a partnership with Greenfleet to off-set vehicle emissions, through tree planting to absorb the equivalent emissions. It should be recognised however that the long term security of these carbon 'sinks' is the subject of some debate due to the climate impacts of increased bush fire and reduced precipitation.

Telstra is also utilising information technology to enable fuel efficient travel patterns. Telstra has installed GPS in more than 4,500 or 27% of its vehicles, and is committed to increase this to achieve a 5% reduction in fuel consumption while increasing productivity by 15% (Telstra 2006).

Decreased waste paper use: During 2005/06, 47% of waste was recycled, an increase from 32% in 2004/05. This translates to more than half a tonne per employee across Telstra. Online billing has proved popular with its customers with over 815,000 opting for this option last year. Telstra has more than 150 of its major vendors using electronic based processes for transactions.

Renewable energy: Telstra is the nation's largest solar power operator. In 2005/06 the company operated 10,450 solar powered sites including exchanges, radio terminals, small repeater stations and payphones (Harrison 2007b).

Future Opportunities

Quantifying the Savings from Telework

As Telstra employs approximately

Figure 29: Telstra's cumulative avoided emissions

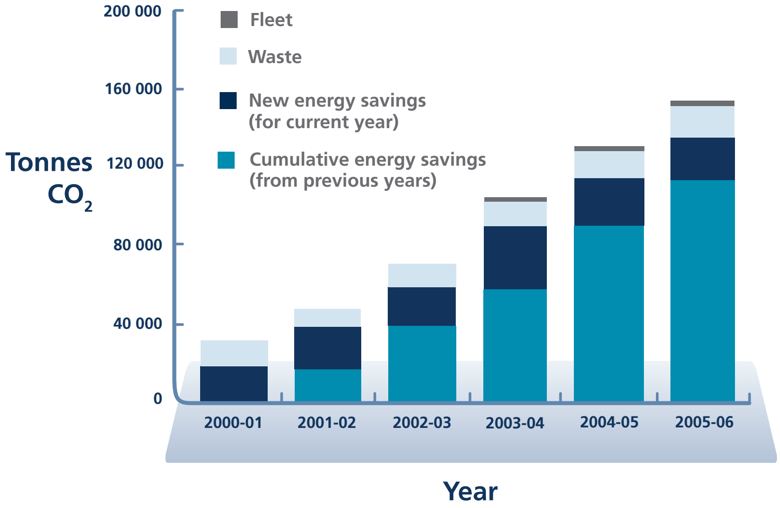

Figure 29. Telstra's cumulative avoided CO_2 emissions (Telstra 2006).

36,000 FTE people in Australia there is considerable opportunity to facilitate increased emissions abatement through actively encouraging telework, either from home or regional Telstra hubs (as shown in section 1.2).

If an additional 5% of the workforce worked from home or from a regional Telstra hub, approximately 2,000 tonnes of transport related carbon dioxide emissions could be saved per annum.

Assuming the transport patterns of Telstra workers reflect the national average, 25,000 drive alone to and from work. If 15% converted to using public transport, approximately 4,000 tonnes of CO_2 emissions could be saved per annum.

Quantifying Savings in Building Emissions

Telstra has a large number of staff and a large number of buildings throughout the country providing considerable scope to reduce the waste of 'standby' and 'orphaned' energy in the workplace.

Telstra's current building based emissions are responsible for approximately 180,000 tCO_2 per year. This could be reduced by 20% overall by deploying Remote Appliance Power Management and Presence-Based Power, delivering overall emissions abatement of about 36,000 tCO_2 per year.

Conclusion

Telstra is aware of its responsibility to the environment and has already saved over 115,000 tonnes of CO_2-e emissions through a range of initiatives. The commissioning of this report demonstrates leadership in facilitating emission reductions across the wider community. There is a significant opportunity to demonstrate in house many of the opportunities outlined in this report.

Appendix 4

Industry Example: The Health Sector, Climate Change and Telecommunication Networks

"The institutions of healthcare have enormous power to do good or harm to the natural environment and to increase or diminish carbon emissions"

(Coote 2006, p. 1344).

The Double Exposure of the Health Sector to Climate Change.

The health sector is recognised as being at the front line of climate change impacts, responding to issues including extreme weather impacts and disease migration. The World Health Organisation "estimates that the warming and precipitation trends due to anthropogenic climate change of the past 30 years already claim over 150,000 lives annually. Many prevalent human diseases are linked to climate fluctuations, from cardiovascular mortality and respiratory illnesses due to heatwaves, to altered transmission of infectious diseases and malnutrition from crop failures." (Patz *et al.* 2005)

Direct health impacts are only one component of the health sector. Indirect impacts of climate change may include the effects on the integrity of energy and water infrastructure supporting health and productivity of the wider economy. Further, it has been suggested that these secondary and tertiary impacts will be of the most significance to the health sector, "In the longer term, and with considerable variation between populations because of geography and vulnerability, the indirect impacts may well have greater magnitude than the more direct impacts" (Epstein 1999; McMichael *et al.* 1996).

There is a proven relationship between climate and health as more impacts mean more health sector activity which in turn leads to more emissions. For example, the southerly spread of tropical disease carriers in Australia increases the number of patients, some of whom will need air transfers, with consequent increases in greenhouse gas emissions. This interdependency illustrates that health care provision is both a source of greenhouse gas emissions and bears the brunt of impacts from climate change. Nevertheless, there are opportunities for the sector to decarbonise its footprint and to increase its resilience to climate change impacts.

Using Networks to Address 21st Century Health Challenges

Despite the direct and indirect consequences of climate change for human health becoming better researched and understood, there is relatively little planning within the health sector to consider the infrastructure requirements needed for adaptation to climate change.

Healthcare comprises a complex mix of institutions, structures and individuals. These structures generate varying temporal and spatial challenges that ICT networks can help address. From medical professionals and administrators to patients and insurance companies, this sector has wide-ranging information and communication needs.

Existing or emergent applications enabled by ICT networks which are relevant to the health sector include:

- The exchange of patient records and data;
- Monitoring of patients in aftercare and vital care situations;
- Transfer of images radiographs, ultrasound, CAT/MRI scans;
- Teleconsultation;
- Online health information and clinical support;
- High quality interactive video for remote care;
- E-Learning, training and testing;
- Medical Research and collaborative team working; and
- Retention and recruitment of staff in rural practices.

All of these examples reduce travel requirements and therefore emissions.

The following examples highlight several emerging eHealth solutions enabled by ICT network technologies in regional and remote areas.

e-Health

"e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies…commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology."

(Eysenbach 2003)

Strong technological leadership and good infrastructure has led to the emergence of a global e-Health industry. In Europe the industry is estimated to be worth 20 billion Euro. Telstra has pioneered a number of e-Health applications in Australia and is further developing the use of internationally significant applications in critical care using ICT networks.

The Virtual Critical Care Unit (ViCCU™) developed by the CSIRO, is a specialist teleconferencing and remote diagnostic facility. Combined with the Telstra's Next IP™ services, it enables specialists in metropolitan hospitals diagnose and treat patients in remote hospitals, improving the standard of patient care in regional areas. This obviates the risk and transport costs, and allows patients to be cared for in their own community.

According to the CSIRO the key benefits of ViCCU™ include:

- Regional delivery of expert advice often faster than via helicopter transport;
- Improved patient recovery, in their own community environment, supported by specialists;
- Recruitment and retention benefits for rural health professionals;
- Addressing health equity challenges in rural or regional areas;
- Multi-disciplinary intervention; and
- Reduced costs and risk to the medical system through avoided movement of patients.

Within the context of climate change mitigation, such applications are reducing the need for long distance road and air travel by practitioners, patients and carers, and the associated greenhouse gas emissions.

Within the context of adapting to the physical impacts of climate change, this type of initiative increases the resilience of rural communities to events that may require critical care and provides a model for other services which can be moved online.

Regional Health Care

"Only 4.9% of University of Queensland medical graduates from 1990 to 2004 are currently working in rural and remote Queensland."

(White 2006)

In many of Australia's rural areas, there is a dire lack of specialist care. Recruitment of rural practitioners is difficult due to isolation of staff, reduced revenues due to patient numbers and a lack of general resources. Rural patients may require round trips of many hundreds of kilometres for specialist diagnosis. There are considerable travel costs and subsequent emissions created by patients and family for treatment and aftercare support.

Transfer of patient care accountability back to GPs can reduce travel, but this requires providing specialist support to doctors, support which may only be available at a state or national level.

A successful example of how broadband networks are being applied to bring need and expertise together and avoid long distance, high emission travel by patients and/or medical staff is in the field of dermatology.

Tele-Derm is an online diagnosis tool available to doctors throughout Australia. Using Tele-Derm, GPs are able to access online dermatological case studies, education opportunities, recommended links and discussion forums.

Tele-Derm also allows rural doctors anywhere in Australia to electronically submit specific cases for assessment. These cases are available as case studies for all GPs enrolled in Tele-Derm.

Since it began, Tele-Derm has been used extensively by the medical community:

- It currently has over 450 people enrolled;
- In a typical month, Tele-Derm has over 1000 hits from over 170 individual doctors;
- Approximately 200 interactive, self-paced cases are now available for doctors to work through; and
- Tele-Derm has assisted with over 100 individual cases.

Rural and remote communities benefit from rapid access to expert advice through initiatives such as Tele-Derm. Currently based on ISDN, next generation networks will provide better visual definition and faster communication services. As such they can form the basis for expansion to other types of diagnostics and treatment. The reduced travel by patients and doctors will directly equate to reduced emissions.

Remote Health

"We desperately want IT training on-site for nurses, in plain English, which covers problem solving, confidence, problems of isolation", says one bush nurse.

Grampians Health Region eLearning Feasibility Study 2006

Loddon Mallee Health Alliance

Loddon Mallee Health Alliance (LMHA) is a governance entity that represents the ICT interests of 16 hospitals and 65 health agencies located at 160 sites throughout the Loddon Mallee Region (LMHA 2007).

The Loddon Mallee region covers 25% of Victoria's land mass over which LMHA has implemented high-speed broadband services. The LMHA network is a secure, high-speed Wide Area Network (WAN), utilising Telstra IP infrastructure. The network has been designed to provide fast, reliable and secure connectivity to the internet, other health agencies and government. It has also been designed to perform at a service availability of 99.8%. Unlike other networks, access to the LMHA network is 1:1 contention which means that access availability and speed is not determined by the number of users trying to connect at any particular time. It allows connectivity to centralised resources and applications, as well as advanced voice, video and data services.

The geography and dispersion of patients across a wide area mean that some nurses are driving 800km for a single patient visit. As a result of the first 3 month trial of video conferencing, the network is on target to save some 175,000kms per year equivalent to 45.5 tonnes CO_2-e.

Future Opportunities

Quantifying Savings: Reduced Air Travel Emissions

The use of 'On-Live' High Definition Video Conferencing, as identified in this report, has an application to remote diagnostics for rural and regional Australia. This is a natural extension of the static image based diagnostics used by Tele-Derm, to detailed video based diagnostics which can be undertaken in real-time.

In order to quantify the potential value of such applications, a nominal patient is considered:

- The patient requires specialist diagnosis which is only available in a major city.
- The patient is 400km from the city and chooses to use air travel (for distances of 300km or less people may prefer to drive).
- The overall efficiency of short distance air travel in smaller aircraft is significantly less than that of intercity travel and is assumed to be 0.05 litres per passenger per kilometre.
- The patient has to travel three times; once for diagnosis, once for a stay with treatment and once for a follow up consultation.
- Road transport and other emissions related to the trip are neglected.
- The person is accompanied by a family member for each of the trips.

Based on these assumptions:

1. The total air travel involved for the patient and family member is 4,800kms.
2. The total amount of fuel used is 240 litres.
3. The total amount of greenhouse pollution caused is 0.77 tonnes CO_2-e per patient.

Conclusion

Healthcare is at the front line of climate change risk and adaptation in Australia and these pressures can be expected to intensify. There is a role for ICT networks to overcome the tyranny of distance and the relative shortage of skills at a regional level by sharing limited human resources through online services. The double benefit is that overcoming the need to move people between healthcare centres will also reduce emissions associated with rural health care provision in Australia.

Appendix 5: Summary of Sectors and Applications Considered with Action

Area of interest	Possible method for GHG reductions	Characteristics	Emissions sector	Possible applications	Action
Home efficiency	Reduced energy use, and infrastructure efficiency using intelligent communicating devices and third party control.	10% of electricity in the home is wasted in standby energy. Estimated that even more is wasted in appliances that are on but not being used.	Stationary energy, fugitive	Broadband, networked appliances or switches, distributed intelligence, external controls to obviate standby consumption, systems reactive to climatic conditions or external signals. RFID tagging and telemetry.	Separate into 'remote appliance power management' and 'presence based power'. Combine household and commercial.
Renewable energy penetration	Increased uptake of intermittent renewable energy sources (e.g. wind) through dynamic load management of multiple devices in multiple homes, offices, buildings and communities.	Over 90% of electricity comes from coal fired power stations at high emission intensity. Various research limits renewables at 20-30% of mix due to intermittency (eg CSIRO Energy Futures Forum).	Stationary energy, fugitive	Requires that loads are dynamically adjusted to match renewable energy output over appropriate period. Therefore requires applications that allow real time load management without affecting customer. Could include wired or unwired appliances which have automated control already eg fridges, aircon, hot water, charging.	Develop as specific carbon opportunity, 'increased renewable energy'.
Workplace/building efficiency	Reduced energy consumption using intelligent communicating devices and third party control.	Up to 4-6% of electricity in the office is wasted in standby energy. Also appliances that are on but not being used, though this will tend to be desk based rather than room based.	Stationary energy, fugitive	Broadband, networked appliances or switches, distributed intelligence, external controls to obviate standby consumption, systems reactive to climatic conditions or external signals. RFID tagging and telemetry.	Separate into 'remote appliance power management' and 'presence based power'. Combine household and commercial.
Productivity	Increased productive output per person for the same or reduced resource use. Ability to work while in motion or without returning to hub.	If human productivity is increased, then less people required for given job, and therefore less associated consumption, emissions and waste. However, must recognise that economy will expand to use the additional (human) resource created and therefore consumption may expand with increased productivity.	Stationary energy, transport, fugitive, waste	High speed (fibre) broadband in home and workplace. On line storage solutions. Virtual networks with compatible devices (phone, laptop, desktop, network, storage). Monitoring and evaluation tools for users to overcome trust barriers.	Not taken forward for several reasons. 1. There is good reason to suggest that released resource is reallocated elsewhere in the economy 2. It involves behavioural changes which are hard to measure accurately.
Office Utilisation	Reduced embedded and operational energy through increased load factor of floor space.	Commercial buildings use about 10% of national emissions. Reducing growth or even absolute demand through greater efficiency therefore has pro rata effect on emissions provided they are not simply relocated.	Stationary energy, fugitive, waste	Looking at optimised use of space through management that may be facilitated by networks, e.g. hotdesks, shared meeting rooms, office equipment volumes which take up space. However, much of the research overlaps with telework which implies that the reduced office space has been shifted to peoples homes or cars, so the emissions savings have only been transferred.	Not taken forward because of risk of transfer of emissions and also office space costs will tend to determine use of space efficiency.
Load factors	Reducing multiplicity of devices and energy/resource use through increasing the utilisation of any given device or service e.g. servers in many company offices replaced by single servers hosting multiple company data sets.	Where there are multiple devices running at less than capacity there is the opportunity to consolidate and reduce the number of devices, their energy use and the end waste.	Stationary energy, Waste	No additional devices being used, but more network movement of say data to increase load factor of devices and allow redundant devices to be closed down. Probably housed with same companies or locations. Wider application would be to move material online into fewer data centres, essentially reverting PCs back to terminal function.	Taken forward in the case studies only (education example). Looks at major change in data management and device usage trends, e.g. trends toward increased and mobile storage and number of devices which limits opportunities for consolidation.

Area of interest	Possible method for GHG reductions	Characteristics	Emissions sector	Possible applications	Action
Freight and Fleet Efficiency	Reduce the emission intensity of freight movements.	1/3 of all kilometres travelled by freight carriers in Australia are unladen.	Transport	Use of RFID and telemetry to track vehicles, and cargos. Also requires multiple participant companies from large trucking companies through to couriers and taxis, all with common technology platform for tracking and dispatch.	Taken forward as 'Real time freight management'
E-materialisation, De-materialisation	Reduced use of resources, energy and transport and therefore carbon for creation or movement of goods.	Upsurge in global consumption is consistent with increased wealth and numbers of people. Moving some of this consumption out of the physical into the virtual can reduce total carbon footprint of the consumption. E.g. getting software online rather than from shop or by post, downloading film rather than driving to video shop. Could fully remove the need for some consumption or increase use of existing items, e.g. eBay provides a recycling service by bringing buyers and sellers together for items that would have lower value or become redundant, and for which more new items would have to be purchased.	Stationary energy, Waste, Transport	Broad range of on-line application and services largely delivered by internet	To take this forward requires moving into area of carbon content or carbon debt of multiple items and services. i.e. life-cycle analysis. Decision made not to take life-cycle approach forward due to complexity and dominance of the other impacts.
Personal Car Travel	Reduced need for car use for personal purposes e.g. shopping or taking kids to school.	Car use uses over 10% of national emissions. Anything that reduces need for car travel reduces emissions. Trends are for increased car travel.	Transport	Opportunities are in reducing the need for car travel and/or providing better alternatives. Thus focus is on the personal and work life and movement in between rather than on vehicles or traffic as traffic tends to fill space available.	Taken forward as 'personalised public transport' where it is semi-combined with commuting.
Commuting	Decreasing the emissions associated with commuting through reduced need to commute and increased uptake of higher efficiency options.	More than 70% of people drive alone to and from work each day, often poor public transport options are cited as a significant contributing factor. Major component of transport emissions.	Transport	Opportunities are in reducing the need for car travel and/or providing better alternatives for work eg by being able to work at home or close to home. Thus focus is on the personal and work life and movement in between rather than on vehicles or traffic as traffic tends to fill space available.	Taken forward as 'Decentralised business district' and 'personalised public transport'.
Work air travel	Private sector emissions from travel, especially aviation, can be reduced through use of 'presencing' technology - especially aviation.	About 40% of air travel is for business creating 2.2million tonnes of CO_2 per year. Domestic and long haul (even though the long haul isn't part of Kyoto inventory).	Transport, bunker fuels	The long distance, short duration trips have lowest amenity where 'conferencing' or 'presencing' alternatives may be an equivalent or improvement. Current technologies are not getting cut though. Next generation can pick up weaknesses, several suppliers of tele-presence suites.	Taken forward as 'on-live high definition video conferencing' in conjunction with personal.

Area of interest	Possible method for GHG reductions	Characteristics	Emissions sector	Possible applications	Action
Personal Air travel	Reduce emissions from person long distance, short duration trips that can be replaced with 'presencing' alternatives.	Aviation in Australia produces 5.5million tonnes of CO_2 per year. 'Love miles' take people long distances for short periods because of no satisfactory alternatives.	Transport, bunker fuels	The long distance, short duration trips have lowest amenity where 'conferencing' or 'presencing' alternatives may be an equivalent or improvement. Current technologies are not getting cut though. Next generation can pick up weaknesses, several suppliers of tele-presence suites. Note that needs will be different in this case. personal long haul short duration trips tend to be for special events, which would need special application of solutions, eg telepresence wedding suites, or cafe style 'catch-up' suites.	Taken forward as 'on-live high definition video conferencing' in conjunction with work air travel
Behavioural change	Consumption reduction, examination between wants and needs, acceptance of alternative options e.g. telecommuting, awareness of impacts of activities, training of use of lower impact activities eg in schools.	Ultimately - it is human behaviour that leads to anthropogenic GHG emissions. There is a certain degree of path dependency which makes behavioural change a challenge.	All	Behavioural change training can be delivered through various platforms, eg from desk-top, phone, school computer lounge. Probably reinforced by being across all applications and devices.	Not taken forward, as very diverse, long term and hard to measure accurately. However, in principle this could be one of the larges abatement areas.
Products	Products used from suppliers who have a commitment to reducing GHG emissions, only purchase products made from recycled goods or that have a certain accreditation. Using Telco shops as conduit for low emission products.	Products contain embodied energy which are often externalities and not accounted for in the end price. These include energy used to extract resources, create, store, market and transport the product.	Stationary energy, Waste, Transport, Industrial processes	There are the direct products used for and sold by telcos. And there is the influence the telco can have on the purchasing behaviour of the customers and therefore supply chains and recycling of the products. Eg rather than selling products, these can be rented, recovered and recycled. This also provides an opportunity for increased/ controlled turn-over to capture efficiency gains.	Not taken forward as beyond the scope of this report which does not include life cycle assessments. Potentially a significant item if life-cycles are assessed in future analysis.
Recycling / re use	Increase the uptake of recycling and re use to reduce the amount of waste and resources required for new products.	Recycling rates are extremely low in Australia in part because of lack of pure streams and also because of limited processing. This of course also stems from market pull for recycled products.	Waste, Industrial processes	There are the direct products used for and sold by telcos. And there is the influence the telco can have on the purchasing behaviour of the customers and therefore supply chains and recycling of the products. Eg rather than selling products, these can be rented, recovered and recycled. This also provides an opportunity for increased/controlled turn-over to capture efficiency gains. ICT also allows companied like eBay to provide high-end recycling of products which reduce demand for primary supply.	Not taken forward as beyond the scope of this report which does not include life cycle assessments. Potentially a significant item if life-cycles are assessed in future analysis. Also interesting to look at use of ICT networks by second hand goods traders.

Area of interest	Possible method for GHG reductions	Characteristics	Emissions sector	Possible applications	Action
Education	Education sector has some services that could be supplied through ICT networks.	On-line education services are growing for delivery at home or in the class-room.	Stationary energy, waste, transport, bunker fuels	The impacts in emissions will occur if ICT based education leads to reduction in travel or energy use in general. There could be some dematerialisation too, eg though avoided production and transportation of training materials. Likely to be focused on higher education where travel is most significant.	Niche application taken forward only in the education case study.
Shopping	By reducing the number of necessary visits to shops there is the potential to reduce transport related GHG emissions.	Shopping is one example of the many personal reasons for car use.	Stationary energy, Waste, Transport	The use of ICT networks to optimise movement of personal goods seems to have abatement opportunity. Eg on-line ordering with super market undertaking local distribution, rather than lots of cars making individual visits.	'De-centralised business district' with emphasis on localisation of activities. Actual shift of distribution from the purchaser to the supplier has been wrapped into 'real time freight management' though this would be a special case which is not fully explored in that application.
Stock and Asset tracking	Real-time asset tracking allows for dynamic management or moving and fixed assets, and therefore reduced transport and stationary related GHG emissions.	Poorly managed stock can result in wasted energy, and ultimately GHG, in the transportation of goods.	Transport, Waste, stationary energy	This captures much of the monitoring based efficiency improvement discussed under various applications. Includes telemetry, RFID, remote monitoring and management, intelligent devices.	Taken forward under 'real time freight management' and also under 'presence based power'
Waste	Any application that either reduces waste or increases the recovery of products or energy from waste is likely to reduce overall emissions.	Waste in Australia causes in 17MtCO_2-e of emissions through decomposition of organic matter into methane. However this does not include the embodied energy which is lost.	Waste	Applications to reduce waste would be in general reduction of product use, see products and recycling above and on increased waste recovery. There may be some rationale for increased waste monitoring and therefore value with monitoring and tagging. Eg organic wastes need to be focused into areas where landfill gas can be harnessed. Low cost tagging or monitoring could be used to increased recovery or material intensity of waste streams for recycling.	Research shows no strong market ready applications beyond what is being used already without a major change in the waste management systems already in place. There is the ability for telecos to change their own waste levels, but this is smaller niche, not society wide. Not taken forward.
Shipping	Applications that lead to reduced demand for goods into or out of Australia would reduce requirement for freight shipping. There is also the opportunity for increases freight efficiency being applied to international shipping.	Shipping emissions are covered under bunker fuels but these are outside Kyoto accounting and also wrapped into aviation bunker fuels.	Bunker fuels	Optimised freight efficiency applications will have some relevance to shipping as per trucking above. Reduced need for freight through de-materialisation/e-materialisation will also affect shipping.	Freight efficiency applications taken forward in "real-time freight management' which can be extended to international shipping in principle.
Traffic management	Smart traffic management tracking can enable reduced idle time - and subsequent transport related GHG emissions.	Transport emissions have grown by more that 23% since 1990. Affected by efficiency and urban form.	Transport	Congestion control, lights for public transport, urban form, traffic speed controls can be facilitated by telemetry and integrated management using ICT networks and technology. There are however questions about whether more traffic comes to fill the space created. Therefore focus must be on increasing utility of public transport and avoiding need for travel.	Taken forward in 'Personalised Public Transport' and 'de-centralised Business District'. Traffic efficiency measures for cars have not been taken forward because of questionable benefits.

Area of interest	Possible method for GHG reductions	Characteristics	Emissions sector	Possible applications	Action
Fugitive emissions	Monitoring of emissions, optimising responses.	Fugitive emissions are 'side effect' emissions from extracting fossil fuels and responsible for about 5% of national emissions.	Fugitive	ICT networks can provide enhanced monitoring of fugitive emissions and pick up unknown fugitive emissions eg in gas pipeline leaks or concentration of coal seam methane levels. This information can also lead to more efficient capture and use of fugitive emissions.	Not taken forward as this is primarily a monitoring application with weak additionality in terms of reducing emissions.
Industrial	Multiplicity of activities in the industrial sector.	Mining, wood paper, chemicals and other manufacturing are responsible for over 100Mt of CO_2 emissions per year. Metals processing is dominant high emissions industrial sector.	Industrial, transport, stationary energy, fugitive	ICT can impact by reducing the demand for industrial products or increasing the efficiency of production. Former is dealt with under products and recycling above. Latter may be a new application especially in the monitoring of environmental performance for compliance or even for regulation of carbon trading products between industries.	Major role appears to be in low cost monitoring across industrial sector under emissions trading scheme or similar. Not taken forward as an abatement opportunity as the additionality is weak.
Agriculture	ICT applications would have to impact agricultural emissions from cropping to animal rearing.	Agricultural emissions come from 140,000 individual enterprises which with land use makes up 25% of national emissions. Livestock is 12% of national emissions (67Mt) and cropping is 19(Mt).	Agriculture	Telemetry technology, GPS in devices can provide detailed information about crop performance, fertilizers placement, water availability and soil content.	Not taken forward as other technologies are already available and being used in this sector to deliver efficiency gains, so added value would be uncertain.
Land Use, Land Use Change and Forestry	ICT impacts on land use change in Australia would need to focus on land clearing mainly.	Land clearing rates have dropped substantially in Australia, but still cause nearly 50Mt of emissions per year.	LULUCF	There could be an argument that de-materialisation means that materials could go on line or through ICT networks. Eg people get news through phone rather than newspapers, therefore less tree use. However much land clearing is for farming. There could be role for ICT networks for monitoring and compliance, or even in increasing the value of carbon sinks through monitoring.	The paper production industry is international and overlays with issues of old growth versus plantation, which makes carbon budgeting more difficult. Monitoring issues are very unclear. Though this is a very large emission sector globally, the additionality issues mean that it has not been taken forward, so far. However the large uncertainties in this sector could mean that these services have a very significant value.






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