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# CAN BROADBAND SUPPORT ENVIRONMENTAL SUSTAINABILITY?

## AN EXPLORATION OF CLAIMS AT THE HOUSEHOLD LEVEL

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This paper looks at the ways in which broadband networks can support sustainability, focusing on the actions of individual consumers in Australia. It centres on the arguments that broadband can be used to substitute physical products with digital ones, and to substitute physical activities (like travel) with digital ones (like videoconferencing and telework). Data on current broadband availability, uptake and usage in Australia are presented. The idea that broadband technologies are currently taken up in ways that encourage sustainable action is challenged, noting that average users are not yet sufficiently interested in, or comfortable with broadband technologies to act in ways that enable sustainability. Recognising that broadband networks do have the potential to encourage sustainability at the household level, the paper identifies current constraints and offers some suggestions on mitigating them.

## THE POTENTIAL: HOW BROADBAND NETWORKS CAN ENCOURAGE SUSTAINABILITY

The December 2007 issue of the *Telecommunications Journal of Australia* addressed the theme 'Broadband for the Sustainable Environment,' publishing four papers that considered how broadband communication technologies can be used to encourage improved environmental outcomes. Although the global financial crisis has recently drawn public attention away from environmental issues, the Garnaut report on climate change (Garnaut 2008) presents a compelling case for the need for urgent, coordinated global efforts to reduce carbon emissions, and argues that the Australian public is supportive of action to tackle climate change. Garnaut's report does not directly address the role of broadband technologies in addressing climate change in Australia and beyond, but recommends actions related to investments in energy infrastructure, transforming transport, and better management of rural lands. Implementation of these recommendations would be greatly facilitated by use of broadband technologies to support data analysis, information sharing and environmental monitoring.

For instance, as Saunders (2007) argues, by enabling sharing of information and facilitating coordinated action, broadband technologies can assist stakeholders in the Australian agricultural industry in identifying environmental challenges (e.g. water management, salinity) and encouraging collaborative actions to address them. Specifically, he explains how broadband could be used to distribute satellite imaging that would allow for closer monitoring of agricultural land conditions, allowing for the development of better farming, land and water management practices, based on accurate assessments of real-time local data. Dennis and Jones (2007) explore the use of broadband technologies to support the management of energy services, including providing electricity suppliers with the means to vary pricing based on supply and demand, enabling consumers to adjust their resource consumption based on pricing and to control devices remotely, and automating device management to maximise efficient energy consumption. In both of these cases, broadband technologies are used to distribute information that encourages more efficient resource usage, taking into account real-time information and environmental conditions.

Nairn (2007) considers the impact of urban travel on emissions, explaining how broadband technologies can be used to substitute virtual for physical presence. His focus is on commuting from home to the office, and he suggests that using broadband communications to enable reductions in travel (teleworking) would result in reductions in greenhouse and other noxious gases emissions. The scale of these reductions is larger in more congested cities, but it is noted that to date the numbers of Australians actually engaged in telecommuting and using broadband communications to reduce travel is very small, meaning minimal reductions are currently being realised.

Dodd (2007) observes that through the facilitation of social networking, broadband connectivity can help to empower communities to learn more about climate change and how to respond to it. She concurs with Nairn (2007) on the role of broadband technologies in reducing local travel (not just for telecommuting, but also for purchasing goods online rather than going out to buy them). Additionally, she argues that broadband is encouraging people to abandon physical products (e.g. newspapers, greeting cards, printed corporate reports, CDs, DVDs) in favour of digital products distributed over broadband networks.

These articles provide a good introduction to the multiple ways in which broadband communication technologies can be used to decrease the anticipated negative impacts of climate change, either through the use of broadband to enable better resource management, or by using broadband to allow substitution of a physical resource with a virtual one, reducing carbon footprints.[1] These basic arguments linking broadband and sustainability are widely accepted, repeated and supplemented by others, including the ACTU (Australian Council of Trade Unions 2008), the American Consumer Institute (Fuhr Jr. and Pociask 2007), the Commission of the European Communities (2008), the State of California (California Broadband Task Force 2008), the Information Technology and Innovation Foundation (Castro 2008), BT (2004), BuddeComm (2008), Cisco (Boorsma 2008), and Telstra (Climate Risk 2007).

As such, it appears that 'broadband for sustainability' is a good news story, and that as broadband uptake increases, ever-increasing contributions to sustainability will follow. But unfortunately, the reality is not that simple.

## TODAY'S REALITY: HOUSEHOLD BROADBAND AVAILABILITY AND USE IN AUSTRALIA

The discussion thus far in the paper has been on *sustainability*, but a closer look at the *broadband* side of the equation, in the context of individual and household usage, suggests that it is not yet such a good news story after all. It is certainly likely that broadband networks can – and will – make positive contributions to sustainability as consumers use them to reduce their carbon footprints, but this is dependent on broadband networks being widely available, fast enough to enable the applications that support sustainability, and affordable. Focusing on the contributions to sustainability that can be made by individual Australians, another simple condition applies. To achieve potential benefits, broadband networks must be used extensively and regularly by a large number of households.

The focus from this point forward is on exploring the enabling conditions that would allow individuals to use their broadband connections as a way to avoid travelling (through working from home rather than commuting to the office, connecting to others through video-conferencing

rather than travelling for face to face meetings, or shopping online), and as a way to 'dematerialise' purchasing, for example downloading digital movies or music instead of ordering the physical product online or buying it in a shop. With broadband networks in place:

> the possibilities of teleworking and using communications tools such as video conferencing and high-speed Internet access in the home are great. Significant pollution costs can be avoided, with the potential for reducing carbon emissions from commuting by car and expanding the opportunities for video-conferencing to reduce the need for air travel. The extent to which businesses and consumers will be able to realise these opportunities is directly related to the cost of products and services. (Australian Council of Trade Unions 2008, 16.)

This section considers the following questions: Is Australia's broadband infrastructure sufficient to support sustainable activities outlined above? In other words, does the infrastructure have the necessary *capacity*? What is the *potential* for usage of this infrastructure? How many people who could have broadband access actually do have a connection in their homes? Is a broadband connection affordable? Finally, of those who are connected, what are their *actual* usage behaviours? Do Australians engage in online activities that will result in *sustainable contributions?*

## BROADBAND INFRASTRUCTURE: CAPACITY, POTENTIAL USERS AND AFFORDABILITY

Australia's broadband infrastructure is not as well developed as that in many other countries (Barr 2008a; Given 2008; Middleton and Chang 2008). Although increased competition among Internet Service Providers (ISPs) is beginning to have a very positive impact (Lynch 2009; Value Partners 2008), average broadband speeds are slow, prices remain high, and download caps (bitcaps) are restrictive (OECD 2007). The Rudd Government's National Broadband Network (NBN) initiative (Rudd et al. 2007) aims to improve the quality and availability of broadband for all Australians, but the process has been far from smooth and its outcomes are not assured. Even if it is successful, tangible improvements to Australia's broadband infrastructure resulting from the NBN are several years away.

The Australian Communications and Media Authority (2008a) reports that 91% of the population currently has access to a DSL broadband connection. It remains prohibitively expensive to provide wired broadband connections in remote locations; and even with the NBN's promise of connectivity to 98% of the population (Department of Broadband Communications and the Digital Economy 2008), many parts of the country will remain unserved. This is a particular concern in the context of using broadband to substitute online communication and/or purchasing for physical travel. Those who need to travel the furthest to carry out household activities are also the least likely to have the broadband connection that would allow them to reduce their travel.

But also of concern is the fact that many of those who could have a broadband connection choose not to. The Australian Bureau of Statistics' (ABS)(2008a) data on household Internet adoption show that about two-thirds of Australian households have a home Internet connection (Figure 1). Broadband adoption has increased rapidly in the past few years, with broadband connections now used in 52% of homes. While this is good news in terms of household preparedness for achieving sustainable outcomes, there is still a long way to go before broadband connec-

tions are found in most homes. Additionally, household broadband penetration is limited by the penetration of computers in the home.

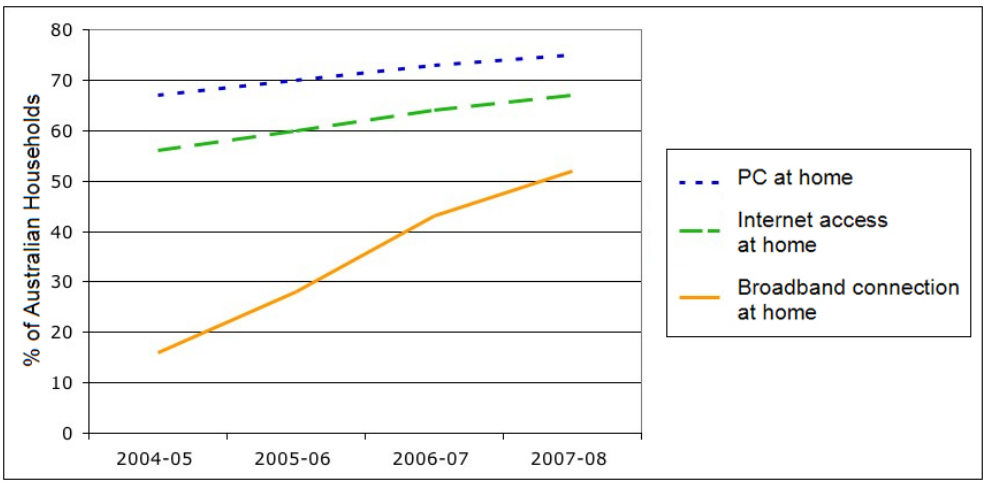
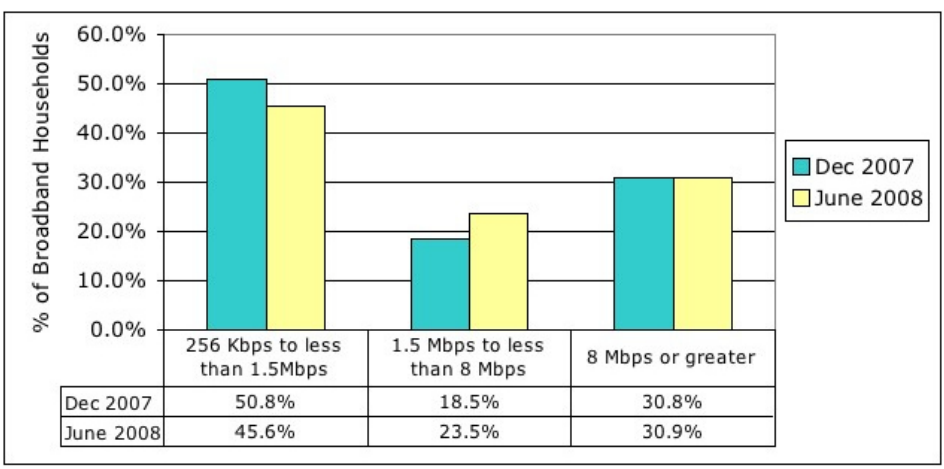



**Figure 1** Households with access to a home computer, the Internet and broadband
(ABS 2008a)

As noted above, people who live outside the metropolitan areas have fewer options for broadband service, and the usage rates are lower. In 2007–08 only 43% of non-metro households had broadband, compared to 57% of those in the cities.

The ABS (2008b) defines 'broadband' as speeds at or above 256 kilobits per second (Kbps). Connection speeds at or above 8 megabits per second (Mbps) are provided by cable or ADSL2+ networks,[2] and are now fairly widely available in metropolitan areas.[3] However, as of mid-2008, only 30% of Australian broadband households had chosen to have a connection that provides speeds of 8 Mbps or greater (see Figure 2).




| | 256 Kbps to less than 1.5Mbps | 1.5 Mbps to less than 8 Mbps | 8 Mbps or greater |
|---|---|---|---|
| Dec 2007 | 50.8% | 18.5% | 30.8% |
| June 2008 | 45.6% | 23.5% | 30.9% |

**Figure 2** Connection speeds of Australian broadband households
(ABS 2008b)

Higher speeds enable faster file downloading, but activities like online shopping, watching television shows with ABC's iView, basic videoconferencing (e.g. Skype chats), and telework are well supported with broadband connections in the 1.5 to 8 Mbps range. iView is not recommended for connections slower than 1.1 Mbps, but shopping, chatting and teleworking are possible over wired connections even at speeds of less than 1.5 Mbps. As such, the speed of broadband connections in Australia is not a limiting factor for most households looking to dematerialise various activities. The exceptions are, again, households outside metropolitan and regional population centres, which must rely on wireless or satellite connections that tend to be less reliable, more expensive and operate at lower speeds.[4]

As Internet Service Providers increase the speeds of their networks (cable networks are now offering up to 30 Mbps service in Sydney and Melbourne, with ADSL2+ offering up to 20 Mbps), the key constraint is not speed but the amount of data a household can transfer per month. Unlike in other countries, Australian broadband plans are marketed by bitcaps, rather than by speed, and it is this bitcap, or download limit that has the largest impact on affordability. Figure 3, produced by the OECD, illustrates this point by comparing average bitcaps and prices charged if the cap is exceeded in the three other OECD countries where all broadband plans are capped.

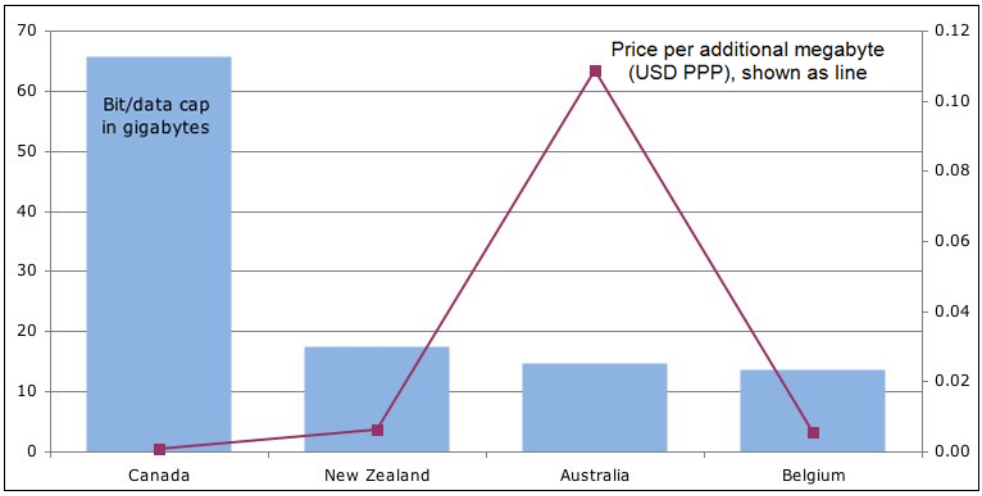



**Figure 3** Comparison of bitcaps and costs for additional downloads, October 2007 (OECD 2007)

Although the OECD data indicate that the average bitcap on Australian broadband plans is about 15 gigabytes (GB) per month, recent Internet Industry Association data show the caps are actually lower, with an average cap of 9 GB per month in late 2008 (Value Partners 2008). In the United States, bloggers splutter that Internet Service Provider Comcast's recent imposition of a 250 GB per month bitcap will destroy innovation and bring the end of the Internet,[5] but Australians must make do with a fraction of this limit, at a much higher price point. Indeed, the increase in Internet speeds combined with restrictive bit caps in Australia makes for some absurd pricing. An example is Telstra's $60 'Fastest' plan which offers ADSL2+ speed, but only a 600 megabyte (MB) download cap (Telstra BigPond 2009). The marketing for the plan boasts that

a user can "Download a full-length movie from BigPond Movies (850MB) in under six minutes," but fails to point out that with a 600 MB download cap and a 15 cent per megabyte excess charge, that single fast movie download would cost the user an extra $37.50. (A better approach for the user planning to do extensive downloads is to pay an additional $30 for a 12 GB per month bitcap.)

While many households have broadband plans that 'throttle' or 'shape' their connection speed if they exceed their bitcaps, and others choose to pay a premium to obtain a higher bitcap, the fact remains that bitcaps pose limitations to Internet usage in Australia. Users who want to download high volumes of data (e.g. transferring large files while teleworking or downloading digital products like movies or music or even educational videos) must pay for the privilege of doing so. This makes substituting digital activities for physical ones an expensive prospect.

Detailed data on bitcaps is hard to come by, but it is likely that the 9 GB per month average figure actually reflects a large number of subscribers with low bitcaps (200 or 500 MB per month) conflated with subscribers with bitcaps of 10+ GB per month. In the absence of further data, it is reasonable to assume that the users most likely to have high bitcaps are those with the highest speed connections. Extending this logic, it is suggested that it is the 30% of broadband subscribers with fast (8+ Mbps) connections who are best positioned to use their broadband connections to support teleworking or purchasing digital products.

In summary, the data presented here indicate that current wired broadband infrastructure in Australia has the technical capacity to enable various activities that would encourage sustainability. In terms of potential users of such infrastructure, with broadband connections in just over half of Australian households, there is a long way to go before broadband networks can be used to achieve sustainable outcomes across the entire population. Additionally, bitcap limits impact the affordability of using broadband networks for extensive data transfers, constraining the extent to which households will be willing to engage in sustainable activities, and further reducing the number of potential participants in such activities. Finally, while people living outside metropolitan and regional centres are most likely to benefit from using broadband networks as a substitute for travel, they are least likely to have the high quality, affordable connections that make this possible.

## BROADBAND INTERNET USAGE

What do Australian broadband Internet users do online, and how often do they do it? Having the potential to use broadband networks in ways that encourage sustainability is a good starting point, but making an impact depends on actual usage. This section looks at frequency of use data, and describes four specific activities that make use of a broadband connection to reduce travel or to dematerialise purchasing.[6]

The Australian Bureau of Statistics' 2006 time use survey (referenced by ABS 2008a) notes that the average time spent online was about one hour per day. Nielsen Online notes that by early 2008, 61% of broadband users were spending more than 10 hours a week online (as reported by the Australian Communications and Media Authority 2008c). However, as of March 2008 only 55% of total Internet users were going online once a day or more, with metropolitan users going online more frequently than non-metro users. This suggests that the Internet does not yet play an integral part in the daily lives of many Australians, as when this figure is extended to the population at large (i.e. including non-Internet users), it means than more than 60% of Australians

do *not* access the Internet daily. Even amongst the youngest sectors of the adult population, approximately a third of Internet users aged 18–34 and more than 40% of those aged 14 to 17 were not daily users (Australian Communications and Media Authority 2008c).

In terms of specific uses, the first activity of interest can be described as 'window shopping', in which an individual uses a broadband connection to browse the Internet for product information. To the extent that this is a substitute for travelling to a physical shop to get information, this activity will have a positive environmental impact. The 2008 Australian report for the World Internet Project (WIP) found that 83% of Internet users engage in some form of window shopping (Ewing et al. 2008).

A second area of interest is the substitution of online purchasing for travel – that is buying a physical product online rather than buying it in a shop. Some 59% of Internet users (about 40% of the population) have made an online purchase at some point, with non-metro users more likely to purchase in online auctions than those in metropolitan areas. While this is a good start to more sustainable purchasing practices, only 10% of Internet users say they now shop in person less often. Purchase data for January to March 2008 showed that 16% of Internet users purchased DVDs or videos online, 16% bought books, and 3% bought groceries (Australian Communications and Media Authority 2008c). These are small numbers, allowing much room for growth in online shopping. But the continued growth of online shopping will result in increased reliance on vehicles to deliver individual, often highly packaged purchases, reducing the positive environmental impact of online shopping.

The third relevant activity is the use of an Internet connection to bypass physical products entirely (eliminating the problem of packaging and delivery). Examples include online banking and bill payment (reducing paper consumption) and digital distribution of music and video files. But the World Internet Project (Ewing et al. 2008, vi) reports a strong resistance to downloading music and movies:

> Internet users are more likely to access their movies and music off-line than online. Even in terms of digital music, users are more likely to copy their own or a friend's CD than to buy online. Almost half of our Internet users would not consider downloading music or movies instead of buying hard copy at any price. Only around one in twenty users (4.7%) would be prepared to pay a price comparable to an offline version.

This resistance is likely due in part to bitcaps, as many users would exceed their monthly download limits with just a single movie download. Another reason for not choosing to access music and movies online is that the process can be complicated. At this point, most users are comfortable with the basic web surfing skills needed to purchase physical products online, or to conduct banking transactions. (The World Internet Project reports that a majority of Australian users have been online for six to ten years.) Getting downloaded music or movies into a usable format is more tricky, especially if the user wants to play the downloaded file on an MP3 player or television rather than on the computer. This is an area where user skills can limit advanced usage of the Internet.

ACMA data do show that about a quarter of Internet users are downloading audio, with about 20% downloading video (Australian Communications and Media Authority 2008c). The

ABS measures total data download volumes, allowing a rough calculation that the average household is downloading 3.4 gigabytes per month.[7] This confirms that there is some downloading taking place, but the data volumes do not suggest that most households are engaging in regular use of the Internet to obtain music or movie content. Indeed, by extrapolating the WIP data to the population overall, it is noted that 78% have never used the Internet to watch or download video, and 64% have never used it to obtain music.

The final activity to be considered is the use of the Internet for teleworking, voice and/or videoconferencing.[8] ABS data (collected in 2006, reported in ABS 2008a) indicate that 6% of employed adults engaged in some form of teleworking. Voice over Internet Protocol (VoIP) calling can substitute for 'regular' landline or mobile telephone calls, and can also be combined with a video camera to enable videoconferencing (for example using Skype software). The Australian Communications and Media Authority (2008b) reports that about 20% of Internet households are using VoIP telephone services, but notes there is a lot of confusion as to what VoIP is and how it can be used. This confusion reflects and reinforces the point that more advanced uses of the Internet require more technological expertise, limiting their accessibility in many households. Even with a fairly simple program like Skype, getting two or more parties connected for a videoconference is not a trivial endeavour. As with the other activities explored above, there is a long way to go before the average Australian household will engage in telecommuting or voice/videoconferencing at a level that will have a positive environmental impact.

## CURRENT CONSTRAINTS AND SUGGESTIONS TO ENCOURAGE MORE SUSTAINABLE BROADBAND ACTIVITIES

The key message in the statistics presented above is that although there are various ways in which households can use broadband technologies to reduce consumption of resources in activities like shopping, downloading products instead of purchasing material versions, commuting to work and travelling to meetings, Australian households have not yet embraced these practices in any substantial numbers. The majority of Australian adults do not access the Internet daily; thus it is perhaps not surprising that the number of users conducting various activities described above is low.

Despite widely acknowledged shortcomings in the broadband infrastructure in Australia, the speed of household Internet connections is not seen as a major barrier to the use of broadband to support sustainability. The more important factor is the bitcaps that limit household downloads and decrease affordability. While current usage data imply that in fact few households are actually exceeding their caps, the principle of the caps makes downloading data a much more careful, considered and expensive activity in Australia than in places with higher caps or no caps at all. This makes it more difficult to convince people to shift activities to the Internet. Another serious concern is the limited availability of high quality broadband connections outside metropolitan and regional centres, meaning that the areas that could reap the biggest benefit by substituting travel with Internet usage are least likely to have the capacity to do so.

The discussion above highlights two other constraints to achieving sustainable outcomes through household usage of broadband networks. These are:

i. apparent low user interest in using broadband technologies for the activities outlined above (as demonstrated in low uptake rates), and
ii. insufficient skill or comfort levels to carry out the more advanced activities described.

Assuming that it is in society's best interest to encourage more environmentally sustainable outcomes through the use of broadband technologies, the following points are noted.

With respect to Australia's broadband infrastructure, a rationale for bitcaps is to help mitigate demand for data transfer outside Australia. Such transfer takes place using submarine cables, and historically there have been real limits on this capacity. With new investment in cable (e.g. Pipe Networks' PPC-1 project linking Sydney and Guam), capacity limits should be less of a problem in future. It is hoped that as additional capacity comes on stream, Internet Service Provider policies around bitcaps will become more flexible. In the short term, exempting more types of content (movies, music, local file transfers) from bitcaps is likely to have an impact on encouraging more extensive network usage. Given the rationale for bitcaps, access to content that originates within Australia should not be limited, as the capacity problem is between Australia and the rest of the world. Efforts to encourage broadband usage would benefit from a coordinated approach to managing Australian content transfer among Australian ISPs.

Although wireless connections are not as reliable as wired broadband connections, having a broadband connection of some sort is better than not having one at all. Given the potential of broadband to encourage sustainable activities outside city and regional areas, it is important to improve broadband availability to these areas. Despite the National Broadband Network's stated preference to provide fibre-to-the-node connections throughout Australia, wireless connections could be deployed quickly to provide improved connectivity long before the NBN is built. (This point is made by the Senate Select Committee on the National Broadband Network 2008.)

Australia is not unique in low uptake rates of various online activities. Indeed, one of the stories of broadband deployment around the world is that of unrealised potential. As noted by the OECD in a report prepared for the Ministerial Meeting on the Future of the Internet Economy (Organisation for Economic Co-Operation and Development 2008, 10):

> the evolution towards broadband applications and use is only now gaining in speed, and many services are still in their experimentation phase. The goal of "broadband applications anywhere, anytime and on any device" has not yet been achieved, and commercial online broadband content services are only slowly emerging … there is still substantial scope for OECD governments to put more content and e-government services online. Importantly, OECD firms and governments are only just beginning to realise the full potential of broadband when it comes to advanced broadband applications. The use of broadband in education, for tele-work, for e-government services, energy, health (telemedicine), and transport (intelligent transportation systems) is still in its infancy.

It will take time for users to fully incorporate the Internet into their daily lives, and for the use of broadband networks for daily activities to become routine. The increased availability of faster networks across metropolitan Australia should encourage more usage, particularly if bitcaps

are relaxed. But with Internet penetration rates currently plateauing at around 75%, the full benefits of broadband-enabled households may not be realised for a generation or more.

As users become more interested in using their broadband connections for a wide range of activities, many will need to improve their technology skills. Younger users may not have any trouble simultaneously managing multiple music downloads, bit torrent video transfers and interactive video conferences, but for many people simple tasks like attaching a file to an email message or figuring out where a downloaded file has been stored still create challenges. It is important to encourage a 'culture of use' for broadband technologies, one that enables broadband access for those who don't have it, demystifies the often jargon-laden terminology of the Internet and helps individuals identify ways that they can use broadband technologies to meet their own needs. This is already being done through a range of social programs (e.g. computer training for seniors, access programs in public housing estates), but more support could be provided to help average users find meaningful ways to engage with broadband technologies on an everyday basis. Barr (2008b) provides some examples of ways in which users have been engaged in the development of broadband services in multiple locations around the world.

There are two other points that have not been addressed in the discussion thus far that merit brief comment.

There is a negative aspect to encouraging more widespread adoption of broadband technologies, one that is particularly important with respect to sustainability. Broadband networks and the various devices they support (personal computers, digital cameras, printers, music players, VoIP phones, wireless network routers etc.) all consume energy. As increased uptake of broadband networks is encouraged, devices will continue to proliferate (and users will upsize and 'accessorise' their equipment, e.g. adding bigger or extra monitors, external speakers etc.), increasing energy usage rather than reducing it. The UK's Energy Saving Trust (2007) estimates that by 2020 computers and consumer electronics will account for 45% of power used in the home, an argument that Climate Risk (2007), in a report produced for Telstra, refutes on the basis that individual devices are becoming more energy efficient. The infrastructure required to operate ADSL or cable or fibre optical networks also consumes power (Forum for the Future 2004), with researchers at the University of Melbourne estimating that Internet-related power consumption will double by 2020, to approximately 1% of total national power requirements (Baliga et al. 2007). But others believe that the energy costs of using broadband technologies are far outweighed by the benefits they provide, especially given the potential impact of broadband in managing the energy grid (Castro 2008). This issue is not resolved, and must be considered when taking action to encourage increased household broadband usage.

The role of mobile technologies in encouraging sustainability should also be considered. The assumption thus far has been that it is fixed home broadband connections that support applications that enable sustainability. But with the increasing availability of smart devices like the Apple iPhone or the Blackberry Bold, it will become easier to carry out various transactions on a mobile device, effectively allowing people to 'take the Internet' wherever they want to go. This does not reduce the value of fixed broadband networks in encouraging sustainability, but points to another locus of innovation. Around the world, there are many more mobile phone subscribers than fixed broadband subscribers (International Telecommunication Union 2008). With improvements in device usability and increased access to bandwidth over mobile networks, a much larger pro-

portion of the population will have more immediate access to a technology that can contribute to sustainability. Further research should consider the potential of mobile devices in this arena.

## CLOSING COMMENTS

This paper has focused on the Australian broadband market and its consumers, but many of the arguments made here would apply to other countries (especially Canada, the UK and the USA). Australia is not unique in having limited adoption of applications that can encourage sustainability at the household level. While the argument that broadband network adoption can encourage sustainability appears to be a viable one, at present there is still a large gap between the potential benefits that can be achieved by encouraging household broadband usage, and the actual benefits that are accruing from current usage.

As noted at the outset, household usage of broadband networks to encourage sustainability is not the only way that broadband usage can have a positive impact on the environment. In the short term, the gains from industrial and institutional usage (e.g. focusing on managing the energy grid, and making better use of environmental monitoring data) are likely to be larger than those at the household level. But over time, as advances in networking increase affordability, and as individuals become more confident users, many gains will be made at the household level. Until then, claims that broadband technology adoption at the household level is having immediate, positive environmental impacts should be treated with caution.

## ACKNOWLEDGEMENTS

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## ENDNOTES

1 Although not central to the arguments of this paper, an innovative approach to linking broadband networks and sustainability has been proposed by CANARIE (St. Arnaud 2007). The idea is to bundle broadband services (fibre to the home connections) with natural gas or home energy services, providing consumers with free broadband if they reduce their energy consumption. The scheme has not yet been implemented, and may ultimately prove infeasible, but it is of interest as an example of a completely different way of using broadband networks to address climate change.

2 According to Telstra, its NextG wireless network covers 99% of the population, with 'peak' speeds of 21 Mbps to be available by early in 2009 (Telstra 2008). However, its disclaimer states that "Actual customer download speeds will be less and will vary due to network configuration, congestion, distance from the cell, local conditions, hardware, software and other factors." Wireless broadband access is more expensive, offers lower download caps, and is thought to be less reliable than wired connections.

3 As of mid-2008, approximately half of the telephone exchanges equipped to provide broadband connections were able to provide ADSL2+ service (Australian Communications and Media Authority 2008a).

4 See Value Partners (2008) for details of satellite and wireless pricing.

5 See the posts and comments on http://www.geeknewscentral.com/archives/008213.html and http://gigaom.com/2008/09/30/gigaom-white-paper-the-facts-fiction-of-bandwidth-caps/ as examples.

6 The data sources used here do not always segment usage based on the type of Internet connection (broadband vs. dialup), so unless otherwise noted the statistics that follow refer to Internet users generally, not just those with broadband connections.

7 See ABS (2008b). The average figure does not differentiate between heavy and light Internet users, meaning that most users will either download substantially more, or substantially less than the 3.4 gigabyte per month average.

8 It is acknowledged that these are not always household activities. Videoconferencing is more likely to be initiated by an organisation, and full support is often provided at a corporate or institutional location. However, it is possible to engage in videoconferencing from the home, and to do so has a more positive environmental impact than travelling to the office to participate.

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