

# **A SUSTAINABLE FINANCIAL MODEL FOR KAREN**

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## Executive Summary

In 2005 the Crown formed REANNZ with the constitutional purpose of “establishing and operating an advanced network in order to promote education, research and innovation for the benefit of New Zealand”. KAREN (Kiwi Advanced Research and Education Network) went live in December 2006 and now connects nearly every researcher in New Zealand and the majority of tertiary education sector participants. By late 2010 KAREN will connect more than 200 schools.

Over this period KAREN has become essential IT infrastructure, enabling participation in highly data intensive global research endeavours, efficiency gains by concentrating key research infrastructure in fewer locations, high quality multi-site video conferencing, and the increasing use of multi-location real time delivery of education programmes.

Independent economic analysis shows KAREN delivering at least \$150 million in incremental annual returns to New Zealand by 2015, principally through increased GDP growth deriving from accelerated ICT uptake.

REANNZ was originally tasked with fulfilling a wide range of public good objectives, whilst becoming financially sustainable from Member fees and endeavouring to transfer ownership of the company to its Members.

Successive papers to Cabinet have highlighted the major challenge for REANNZ, operating in a geographically remote small country with a limited research sector, was the development of a business model that would allow financial sustainability on the basis of Member and industry Partner subscriptions alone

After four years of operation, during which revenue augmentation and cost efficiency options have been exhaustively explored, REANNZ, in conjunction with its core Members and with the input of officials from MoRST, has concluded that a purely direct Member-financed model will not work for advanced networking in New Zealand.

REANNZ has estimated annual forward costs in the order of \$12 million. Including the recently agreed increase in core Member fees of 27%<sup>1</sup>, the forecast annual revenue for REANNZ is approximately \$6 million. The current ‘gap’ between annual revenue and costs is therefore approximately \$6 million.

Most advanced networks are not sustained by Member funding alone. In countries comparable to New Zealand, sector / central contributions still account for between 50% and 70% of revenues even after 20 years or more of operation. The few global NRENs that are self funding without sector / central contributions have cost or revenue lines that cannot be replicated in New Zealand.

The proposal is that financing for KAREN be equally split between direct Member fees and a redirection of central government resources spread across the three benefiting sectors (RS&T,

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<sup>1</sup> An initial increase of 23% and a subsequent increase of 3.6% was agreed with core Members in 2009

Education and Tertiary Education). The central government contribution can be ramped up over a period of 3 years to its steady state level of \$6 million in 2013.

This report provides the evidence to support this proposal but makes no recommendation on the source of redirected funds.

In the absence of new funding, the argument for reallocating funds is based around KAREN being an enabler for greater cost efficiencies and high value outcomes across the RS&T, Education, and Tertiary Education Sectors

Putting in place a long-term sustainable financial model around KAREN is essential:

- For REANNZ: to enter into long-term supply contracts and so contain future cost pressures whilst still fulfilling its purpose.
- For Members: to provide the certainty required to invest in related long-term infrastructure and research & education programmes
- For the Crown: to be able to plan to leverage REANNZ as an expert, neutral vehicle to achieve cost efficiencies in aggregated purchasing, and KAREN as an ongoing element of national infrastructure.



## Introduction

This report outlines the path to a sustainable financial model for the Kiwi Advanced Research and Education Network (KAREN). Having read this report, the reader should understand the proposed sustainable financial model, its implications for different stakeholders, and the path that has led REANNZ and the wider KAREN community to make these recommendations.

In 2005 the Crown formed the Research and Education Advanced Network of New Zealand (REANNZ) with the constitutional purpose of “establishing and operating an advanced network in order to promote education, research and innovation for the benefit of New Zealand”. KAREN went live in December 2006 and now connects almost 90% of researchers in New Zealand and the majority of tertiary education providers<sup>2</sup>. By late 2010 it will connect more than 200 schools. The shareholder’s intent was for REANNZ to develop a self-sustaining funding model for KAREN. However, successive papers to Cabinet have highlighted the major challenge for REANNZ, operating in a geographically remote small country with a limited research sector, was to develop a business model that would allow financial sustainability on the basis of Member and industry Partner subscriptions alone.

This report proposes a sustainable model, based on internal and external research undertaken by REANNZ into cost and revenue models, input from stakeholders, experiences with international advanced networks, REANNZ’s experience over the past four years in establishing KAREN, and new analysis where gaps have been identified.

The Report is presented in two key sections, with two substantial appendices presenting background information on KAREN:

- Economics of providing an advanced network in New Zealand:

This section first looks at REANNZ sources and uses of income, and how these compare internationally. Avenues for possible cost reduction for the next ten years are then explored. Future income sources are considered, as well as the future for the New Zealand Research and Education Sector if there is no advanced network.

- Sustainable funding for an advanced network in New Zealand:

This section considers how other National Research and Education Networks (NRENs) achieve sustainability and whether REANNZ can do likewise. It recommends a sector-level contribution to funding and looks at time frames and process to achieve sustainability.

This report is focused on the financial aspects of advanced networking in New Zealand. For completeness, detailed analysis is included in appendices that set out

- Why an advanced network is critical research and education infrastructure
- How the advanced network is benefiting New Zealand.

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<sup>2</sup> Researchers are defined as CRI researchers, and University, ITP and Wananga employees who participated in the 2006 round of the Tertiary Education Commissions Performance-Based Research Fund. Those not connected is based on REANNZ estimates.

# The economics of providing an advanced network in New Zealand

## REANNZ's sources and uses of income today

**Section summary** Almost three quarters of the REANNZ \$12.7 million (2011) annual budget is network infrastructure cost. Current estimates see revenues growing at 3.5%. New Zealand has made a significant investment in KAREN.

**Three quarters of the \$12m annual budget is network infrastructure cost of which international capacity is about half** Almost three quarters of the annual REANNZ \$12.7 (2011) million budget covers infrastructure costs, that is, the direct cost of the network<sup>3</sup> (Figure 1).

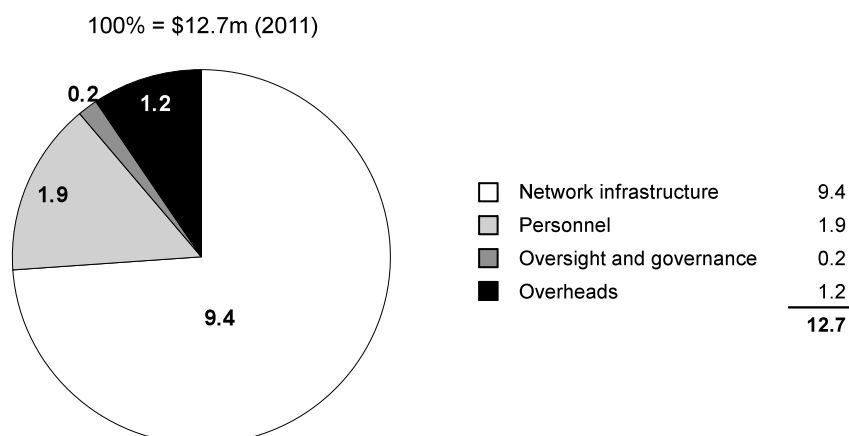
The cost of the international network is comparable to the cost of national network by spend. However this ratio underestimates the true cost of international connectivity as KAREN international capacity is approximately one tenth the size of its national capacity<sup>4</sup>. Or put another way, to buy the international KAREN network costs ten times as much as to buy the equivalent amount of national bandwidth.

As this country is small and geographically remote, networks don't come to New Zealand, New Zealand needs to connect to them. The benefits of being connected to this international network of NRENs are significant. Once on the network one can traverse all networks around the globe for no cost

Direct personnel costs make up ~60% of the remaining non-network costs with the remainder being overheads (for example office and travel expenses) and oversight and governance.

**Figure 1:**  
**Breakdown of**  
**REANNZ**  
**costs**

**REANNZ forecast annual operating costs**  
\$ million



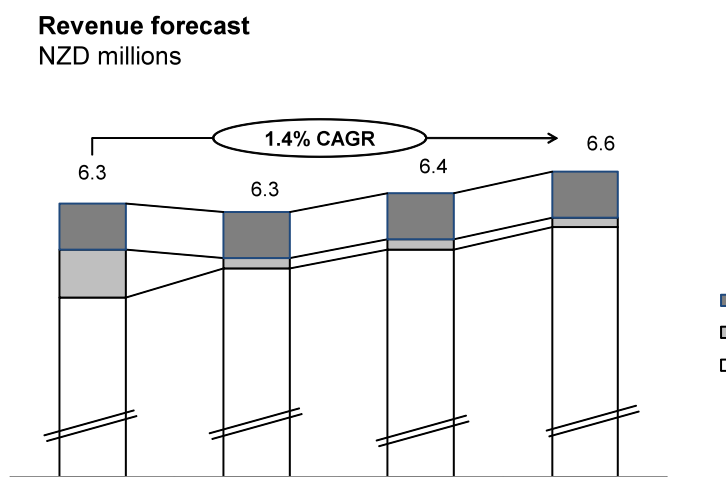
<sup>3</sup> All figures are exclusive of GST

<sup>4</sup> In this example capacity is measured by Gbps

**Member revenues are forecast to grow at 3.6% real per year**

Following a 26.5% increase in 2010 from core members REANNZ forecasts estimate that member revenue will grow at 3.6% (CAGR<sup>5</sup>) real from 2011 to 2014 inclusive. Given that other sources are expected to remain flat total growth in revenue is expected to be 1.4% CAGR real (2011-2014) (Figure 2).

**Figure 2:**  
**REANNZ**  
**revenues**  
**forecast ('11-**  
**'14))**



**New Zealand has made a significant contribution to KAREN**

Since 2006 New Zealand has made over \$100 million in capital contributions, revenues and grants to fund KAREN. Almost 60% of this funding has come directly from the Crown through capital and bulk grant commitments. The remainder has been sourced from Members. Collectively these funds have contributed to the core network, network extensions, schools access and capability building.

## How does this compare internationally?

**Section summary**

KAREN compares well to other NRENs both in terms of and in use of funds. Maintaining this position will require further efficient capacity upgrades. Member contributions compare favourably with other advanced networks.

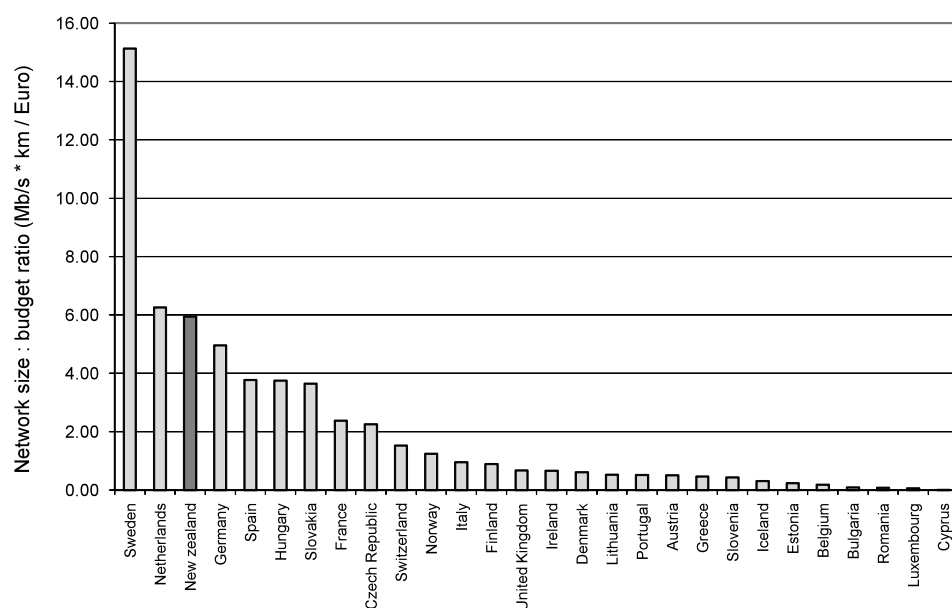
**KAREN compares well with other NRENs on efficiency and use of funds**

In 2007 REANNZ compared the cash costs of the recently purchased KAREN against those of other nations with comparable networks. This analysis considered the size of the network (defined by Mbps kilometres) purchased per Euro. Of the 28 countries examined KAREN was shown to be the third most efficient. (Figure 3: Comparison of efficiency of selected NRENs (current network)). Furthermore an assessment of the nature of REANNZ expenditure versus other NRENs shows that KAREN spends a

<sup>5</sup> Compound Annual Growth Rate

higher proportionate on transmission capacity than overheads. (3) To maintain this relative position as other NRENs shift to higher capacity networks KAREN will also need to upgrade its capacity per dollar spent.

**Figure 3:**  
**Comparison**  
**of efficiency**  
**of selected**  
**NRENs**  
**(current**  
**network)**



Source: TERENA, REANNZ analysis

**Figure 4:**  
**Comparison**  
**of spend on**  
**transmission**  
**capacity**

	<u>\$million</u>	<u>KAREN</u>	<u>NREN</u>
	<u>pa ('11)</u>		<u>average</u>
Transmission capacity	= 9.4	74%	66%
Salary, general and other	= 3.3	26%	34%
	<u>12.7</u>		

\* Latest comparable data, released by TERENA July 2009

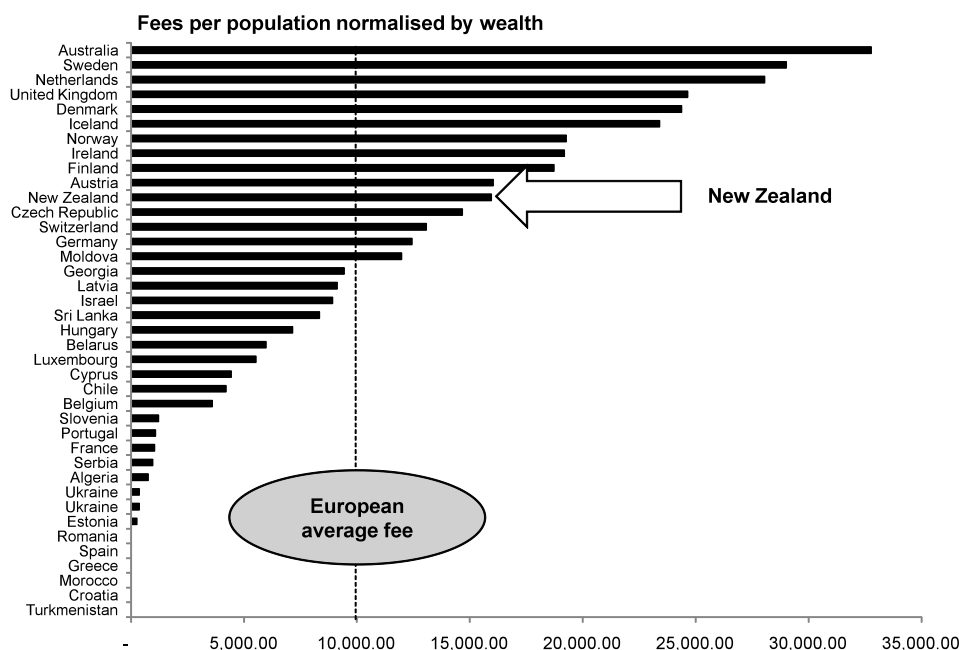
#### Member contributions

Of 40 countries where data was available it was also found that New Zealand wealth-normalised Member fees are near the 75<sup>th</sup> percentile

compare  
favourably  
with other  
advanced  
networks

(fees [Euro] per capita / GDP PPP<sup>6</sup> per capita) and approximately 50% higher than average in wealth normalised fee per capita. (Figure 5) In countries where Member fees are lower, the state or in some cases the European Union pays the remainder. There is only a weak correlation between the wealth of a nation (GDP PPP per capita) and the fees paid per capita to an advanced network<sup>7</sup>. These figures are heavily influenced by almost a third of advanced networks receiving no funding from Members.

**Figure 5:**  
**REANNZ**  
**versus**  
**average**  
**NREN fees**



Source: TERENA, IMF, Temple analysis

Once  
commodity  
internet is  
allowed for  
New  
Zealand  
NREN fees  
are even  
higher

The majority of NRENs also provide their members with commodity internet services, whereas REANNZ does not. For example GEANT provides this service to many European NRENs; NorduNet to the Scandic NRENs. If the contribution of commodity internet to total NREN fees is removed New Zealand's fees from members would be even higher on a wealth and population weighted basis.

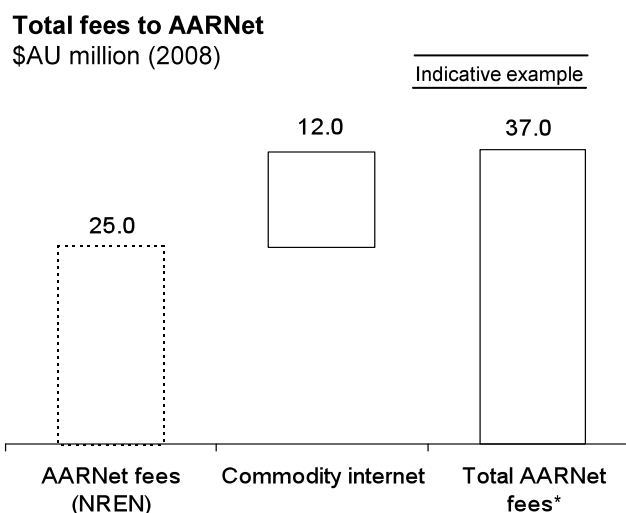
As an example approximately one third of AARNet's total fees are associated with commodity internet. (Figure 6) Once commodity fees are removed it can be seen that New Zealand ranks amongst the highest member fees in the world.

In conclusion New Zealand's members are making a significant contribution to the total cost of running an NREN when compared with their international peers.

<sup>6</sup> PPP, Purchasing Power Parity

<sup>7</sup> TERENA 2007 Compendium, World Bank, IMF, Temple analysis

**Figure 6:**  
**Example of**  
**commodity**  
**contribution**  
**to NREN**  
**fees:**  
**Australia**



\* Commodity fee Assumes 2008 3,000 TB of off-net data at \$AU4.00 per GB (price paid by members 2009), excludes infrastructure spend (assumed removed from TERENA data)  
Source: AARNet, Temple estimates

## Can the cost elements of an advanced network in New Zealand be reduced today?

### Section summary

Cost efficiency was assessed against procurement process, benchmarks, supplier costs or market forces. The cost elements considered were:

- a **national network** that connects users to each other [22% of P&L costs]
- an **international network** that connects New Zealand with the world [39% of P&L costs]
- **points of presence** (location and hardware) [13% of P&L costs]
- an **operating team** that sets up and manages all the constituent parts [15% of costs]
- overheads, oversight and governance [11% of P&L costs]

Summary findings are that there is limited current cost reduction potential at present (forward looking costs are discussed in the following section):

- International connectivity costs cannot be reduced materially unless a competitive market forms or New Zealand constrains further its ability to engage with the global community by buying less capacity
- REANNZ has recently run a competitive supply process for National capacity and this has demonstrated little additional potential to reduce costs
- Essential hardware costs are managed through a robust competitive process while most essential hardware locations (sites where network elements interconnect) are provided free.
- Member support could be reduced but technical staff costs are likely below market.
- REANNZ Overheads have limited potential for reduction

<p><b>Cost efficiency was assessed against procurement process, benchmarks, supplier costs or market forces</b></p>	<p>To determine whether KAREN is cost efficient on each cost element one needs to identify for each one or more of the following:</p> <ul style="list-style-type: none"> <li>▪ A robust procurement process e.g. open Request for Proposal (RFP)</li> <li>▪ Benchmarks (local or international)</li> <li>▪ Bottom-up economics e.g. estimate of price for \$0 economic profit for supplier</li> <li>▪ Description of market forces that drive price e.g. argue commodity market and therefore price equivalence through transparency</li> </ul> <p>The discussion below outlines the findings of each of the five cost elements against these four metrics.</p>
<p><b>REANNZ has recently run a competitive supply process for National capacity and hence there is little additional potential</b></p>	<p>National connectivity comprises two elements: Core and regional. In all cases REANNZ currently buys Ethernet services delivered over a managed wavelength.</p> <p><b>Core:</b> REANNZ has recently run a competitive market process and this showed limited cost reduction potential. The process showed that the market currently bases price more on the physical distance of a link rather than capacity. As such there is limited or no potential for cost reduction through reduction in capacity. Moreover the price for connectivity (10Gbps circuit) was the same as a similar procurement process delivered in 2006. Switches did reduce in cost by 30% on a \$/Gbps basis and these small benefits have been captured.</p> <p><b>Spurs:</b> REANNZ has recently run a competitive market process to connect several new regions by 1Gb/s spurs to the core network. This process resulted in some attractive pricing from the market for both services and fibre IRUs (Indefeasible Right of Use), and as such current spur costs can be considered to be 'bottom of market'.</p> <p>While REANNZ does have evidence of the market process it has run, prices offered by the market cannot be included here because of confidentiality requirements and the broad expected readership of this document. These processes have been subject to external verification from commercial, legal, process and probity perspectives.</p> <p>In 2011 national connectivity (excluding POPs, hardware) is forecast to be 22% of P&amp;L costs (\$2.8 million)</p>
<p><b>International connectivity costs cannot be reduced materially unless a competitive market forms</b></p>	<p>New Zealand is supplied by an effective monopoly provider, Southern Cross Cable Network (SCCN). The monopoly nature of our international connectivity market coupled with the extreme distances involved in reaching New Zealand is reflected in prices some ten times higher than comparable prices for international connectivity in a competitive market.</p> <p>Trans-Atlantic capacity prices are currently around EU90,000 to EU100,000 per year for 10Gbps wavelengths (c. USD122,000 to USD135,000). By</p>

comparison, recent 10Gbps IRU prices between NZ and US were USD49 million for 10 years, or 3.7 million Euro per year (USD4.9m per year). Even allowing for a doubling of the trans-Atlantic benchmark to account for the greater New Zealand to USA distance and then doubling it again to replicate SCCN's physical resiliency still results in a factor of approximately ten times higher costs in New Zealand. This difference seems most likely attributable to the lack of a competitive supply market.

These current international rates to reach the rest of the world from New Zealand limit KAREN's international capacity to around one tenth of that of the national network. Even KAREN's planned upgrade of the current links to 1Gbps to both Australia and the USA falls short of providing the capacity required to support some leading edge activities, hampering New Zealand's ability to participate in global programmes (as discussed further in the section "The strategic context for an advanced network?").

While reducing international data rates might reduce costs internal connectivity is already bottlenecked and inhibiting activity. For example uncompressed High Definition video and radio astronomy both require greater than 1 Gbps of capacity. Reduction of capacity, e.g. lower data rates, from the ~900Mbps currently in place (2 x 155Mbps and 1 x 622Mbps) is therefore a very unattractive solution.

AARNet gained access to a sponsored 10Gb/s from SCCN in 2003/2004 for Research & Education use due to their existing capacity purchases for commodity internet and attractive market prices due to a capacity supply glut at that time. REANNZ continues to explore, with AARNet, cost effective ways for New Zealand to gain access to this arrangement however the timing or value of any outcomes is unclear at this stage.

In 2011 international connectivity is forecast to be 39% of P&L costs (\$5.0 million)

**Essential hardware costs are managed through a robust process while most essential hardware locations are provided free**

In regard to essential hardware (transmission, switching, routing) located at PoPs (Points of Presence), REANNZ runs a robust procurement process for supply. This process, coupled with typical Request for Proposal response rates from at least five suppliers ensures that prices paid are fair and linked to current market rates usually with aggressive discounts for purchasing in bulk and / or for the education sector.

10 of 26 of KAREN's essential hardware locations are commercially hosted while the remainder are generally provided free of cash costs through Members. In the few instances where cash costs are incurred they are at a significant discount to the market. For example REANNZ has recently secured a long term arrangement as an anchor tenant in a new regional neutral co-location facility at a nominal rate.

In 2011 essential hardware costs are forecast to be 13% of P&L costs (\$1.7 million)



**Technical staff costs are likely below market and reducing other staff costs includes the risk of benefit loss to Members**

**Technical network staff:** To some extent this cost is contained by the "New Zealand good" nature of work and the current employment market. However the skills provided by competent staff in this area are in constant global demand, driven by global fibre rollouts, and are more likely to grow as demand starts to exceed capacity. Therefore there is limited if any immediate cost reduction potential.

**Other staff:** This is contained as above, but a reduction might be possible in Member engagement, between \$0.2 million and \$0.4 million if it were determined that REANNZ could step back from Member capability development and support. Reducing this cost does, however, come at significant risk of reducing the value Members are able to extract from KAREN. Overall there would be a negligible accessible net reduction in costs.

In 2011 personnel is forecast to be 15% of P&L costs (\$1.9 million)

**REANNZ overheads, oversight and governance have limited potential for reduction**

Overheads, oversight and governance have the lowest potential for reduction.

In addition to being small, REANNZ and KAREN have a tight cost culture:

- Using Government bulk outsourced arrangements where possible,
- Benefit from free deals on tools and systems
- Grade B/C office accommodation
- Board costs are benchmarked to government rates that are lower than market for comparable capabilities

Some potential may exist in seeking longer-term arrangements. This might be manifested as slightly lower cost through longer commitment e.g. rent, or lower people-related activity cost e.g. not having to run regular, short term, procurement as a requirement of the shareholder. It would of course require matching long term funding commitment from stakeholders.

In 2011 overheads, oversight and governance is forecast to be 11% of P&L costs (\$1.5 million)

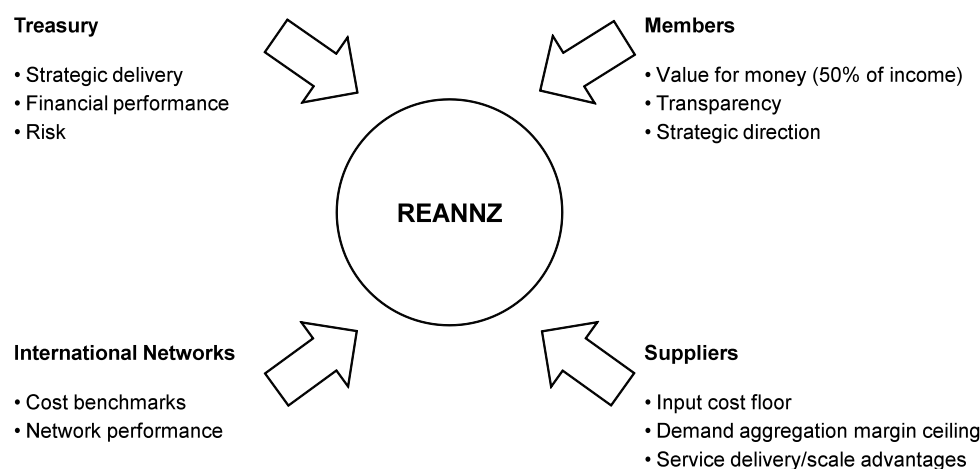
**External forces provide downward cost pressure**

Finally KAREN sits at the nexus of four different stakeholder groups that collectively act as external cost containment forces (Figure 7).

- Treasury gives independent oversight for the shareholder
- Members and broader stakeholders continually push for cost reduction, recognising this links directly to fee reduction
- Suppliers recognise KAREN is a natural supply aggregator, and as there are typically multiple suppliers a price floor can be established
- International advanced networks provide a lens against which KAREN is constantly compared.

Similar forces are at play with all advanced networks and in spite of growing capacity demand they typically manage within a flat real cost budget.

**Figure 7:**  
**External**  
**forces that**  
**drive**  
**REANNZ cost**  
**containment**



Source: KAREN 'Kiwi Advanced Research and Education Network'

## What is the likely path of cost drivers over the next five to ten years?

### Section summary

Capacity and the cost per capacity drive total cost and historically the two have remained in check, cost per capacity reducing as capacity increases, leading to flat real costs. National bandwidth costs will grow significantly so KAREN should seek dark fibre access immediately to mitigate cost growth. There will be negligible change in the staff or overheads costs. Only the arrival of a competing international cable will materially reduce international costs and REANNZ will continue to seek an anchor tenancy on a new cable.

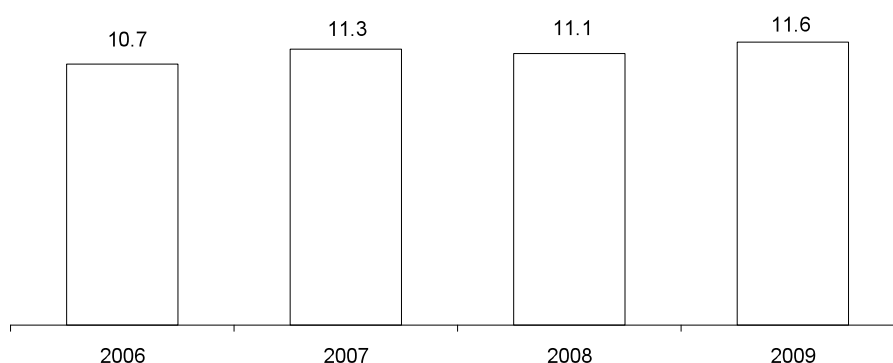
### Capacity and cost per capacity drive cost

Network costs account for three quarters of total costs. Forward looking network costs are a function of declining marginal costs for equipment and bandwidth *per capacity* countered by growing *capacity* demands.

The historical trend is for advanced network costs to remain constant as shown below for NORDUnet (Figure 8). Similar cost containment is seen across other advanced networks in spite of growth in capacity demand. This trend serves to manage cost growth for KAREN but also limits opportunities to reduce costs.

**Figure 8:**  
**NORDUnet**  
**income ('06-**  
**'09)**

**NORDUnet income**  
EUm



Source: NORDUnet

**Only a competing international cable will materially reduce international costs and REANNZ will continue to seek an anchor tenancy**

The two drivers of international capacity costs are the supply market structure and the capital deployment costs of cables.

**Market structure:** The market structure for international capacity sees Southern Cross Cable Network as the only supplier and as such until a new supplier arrives, as would be the case under the recent Pacific Fibre proposal, SCCN will continue to price higher than other competitive markets<sup>8</sup>

As an example of the market concentration found in most countries there are seventeen underfloor cables between Europe and the eastern seaboard in North America, five into Australia and fourteen into the West Coast of the USA from Asia Pacific<sup>9</sup>

The presence of competition in Australia will likely lead to a decline in the Sydney to US link even under the current market structure. Some or all of this price decline may pass to New Zealand routes if historic pricing behaviour by SCCN is maintained.

**Capital deployment costs:** Any new international capacity will need to meet its cost of capital. The biggest determinant of the revenue returns required for a link is the distance covered. In the case of New Zealand this is twice that of typical Europe-to-New York link (~5,877km from Amsterdam to New York versus ~10,478km from Los Angeles to Auckland). For New Zealand, the minimum cost of a US 10Gbps cable could be considered to be twice that paid on US to Europe links or around \$0.5 million per annum. Under a best case scenario this would take two to four years to deploy. At this point capacity demand is likely to be materially higher (40-100Gbps)

<sup>8</sup> <http://www.stuff.co.nz/business/3435625/Top-business-figures-in-bold-broadband-bid> accessed 2 April 2010

<sup>9</sup> <http://image.guardian.co.uk/sys-images/Technology/Pix/pictures/2008/02/01/SeaCableHi.jpg> accessed 4 April 2010

and therefore the net reduction in cost will be negligible.

Experience is that NRENs secure favourable price / capacity deals in supply constrained international markets by purchasing at times of supplier distress or as an anchor tenant on new cable systems. KAREN should continue to seek an anchor tenancy on a new cable.

**National bandwidth costs will grow significantly so KAREN should seek dark fibre access immediately to mitigate cost growth**

Recent estimates, commissioned by REANNZ, of the forward looking cost curves for national core connectivity suggest that if KAREN continues to buy bandwidth from suppliers the cost in 2020 will be up to four times higher than a scenario where KAREN buys access to dark fibre and installs its own network equipment (Figure 9<sup>10</sup>).

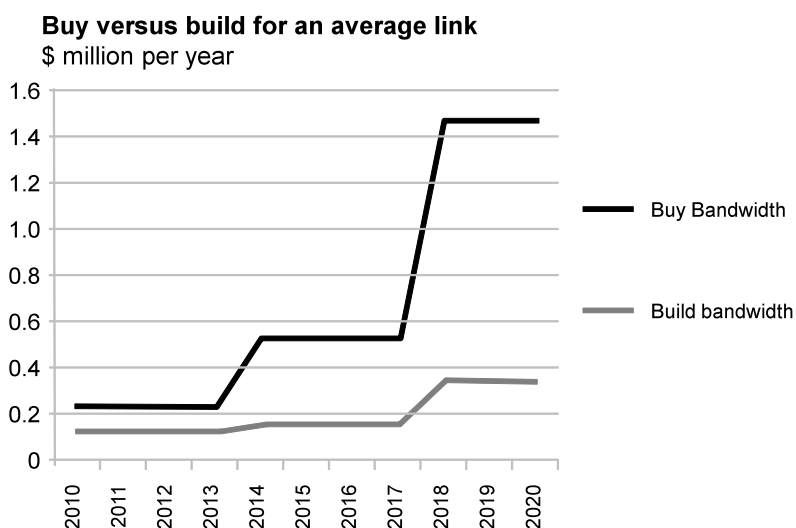
It can therefore be considered essential that REANNZ seeks to procure a national network delivering dark-fibre attributes as soon as possible, given that it could take at least two years to design and build.

There are two other benefits from this approach.

Firstly, buying access to dark fibre has the additional benefit of giving KAREN access to the lower levels of the network that are needed for cutting edge research. This type of access is rarely provided by telecommunications suppliers.

Secondly this model provides long term price certainty for those who contribute to KAREN's income.

**Figure 9:  
Cost of buying versus building a fibre link in New Zealand**



**There will be negligible**

Technical network staff is likely to be increasingly in demand as the broadband rollout accelerates globally. As a consequence, we can expect

<sup>10</sup> Gravel Road report, "Forward looking cost curve for KAREN bandwidth", February 2010

### change in staff or overheads costs

salary cost pressures to grow.

Other staff costs will be linked to the broader labour market and therefore approximately flat in real terms for the next 2-4 years.

Other corporate overheads (procurement, legal, office, admin, Board) are unlikely to change materially.

## Can REANNZ income be increased?

### Section summary

KAREN has four groups from which it may derive income using various mixes of existing and new services. These are:

- Government (existing budget and new money);
- Members (existing and New Members, current and new services);
- Partners (e.g. industry and non R&E public sector)
- Philanthropy

All have been examined in detail through trials, market research and direct stakeholder discussions and findings are summarised below (Figure 10).

The result of this investigation finds that the Government funding existing budget across the research and education sectors is the preferred source of sustainable funding in the future. Existing Members cannot internally justify material increases in fees to REANNZ and income from new Members will be too small.

New services to Members, including internet are better provided by market suppliers. Expanding the partner model will likely be NPV negative. Lastly, philanthropy is limited in New Zealand

**Figure 10:**  
**Summary of**  
**sources of**  
**revenues**

Who	Source	Details	Fit
Government	Existing Budget	<ul style="list-style-type: none"> <li>• Could come from: RS&amp;T, Tertiary, Education</li> <li>• All sectors are under budgetary pressure with significant reductions from RS&amp;T, Tertiary</li> <li>• Education is more natural sector – setting precedent for central funding model</li> </ul>	• Med
	New Budget	<ul style="list-style-type: none"> <li>• REANNZ clearly instructed not to seek new funds during last budget</li> </ul>	• Low
Members	Existing	<ul style="list-style-type: none"> <li>• Recently secured 25% increase from core Members</li> <li>• Clear statements that no further increase would be supported</li> </ul>	• Low
	New – Existing Remit	<ul style="list-style-type: none"> <li>• Most large spend users are in Membership</li> </ul>	• Low
	New – New Remit	<ul style="list-style-type: none"> <li>• Network design is not suited for non-R&amp;E activity</li> <li>• Input costs directly increased with expanded Membership</li> <li>• Internet margins are not sustainable due to 'commodity' basis</li> <li>• REANNZ is not better placed to provide other services better than the market</li> <li>• Cost and complexity increase by offering such services</li> </ul>	• Low
Partners		<ul style="list-style-type: none"> <li>• Supply market contributes through input costs not revenue</li> <li>• Expanded Partner model revenue positive, NPV negative</li> </ul>	• Low
Philanthropy		<ul style="list-style-type: none"> <li>• Limited culture of philanthropy in New Zealand</li> <li>• High risk and uncertainty as to recurrence</li> <li>• Not generally available for operating costs</li> </ul>	• Low

**Government funding:  
New sector money is the best funding candidate**

Government funding could come from 'new money' or from existing Sector budgets.

**Existing sector budgets:** Funding might come from existing budget votes. The most likely of these are RS&T, Tertiary Education and Education. While all sectors are under significant budgetary pressure, real reductions are occurring in the RS&T and Tertiary sectors. The Education sector has already adopted a central funding model for school connections to KAREN via the National Education Network and it is an extension of this approach to other sectors that is being proposed.

**'New money':** In the last budget, REANNZ was clearly instructed not to seek new budgetary funding from the government. Budget 2010 does include an allocation for Research Infrastructure.

**Existing Members cannot internally justify material increases in fees to REANNZ**

Very recently, core existing Member universities and CRIs have agreed to increase fees for REANNZ services by 23% and committed to a further 3.6% price increase for 2011/12. These members are highly unlikely to be a material source of additional funds as they cannot internally justify further material increases in fees to REANNZ.

Discussions with decision makers of these existing Member organisations have produced very clear statements that no further direct fee increases for REANNZ services will be supported in the current funding climate.

One significant reason for this is that the current funding system requires Members to provide some form of commercial justification for their investments. Commercial justification of KAREN costs is, however, complex.

An advanced network has benefits that can be defined on two dimensions:

- Recipient: Member versus non-member benefits
- Monetisable: Monetisable or non-monetisable benefits

Firstly the recipient of the benefit may not be a Member. As an example, REANNZ research has shown that communities where students are exposed to new technology drive uptake in their community. Thus, the recipient of some benefits is the community and the NZ public at large.

Where benefits are monetisable, the direct financial impact can be estimated. For example, savings might be made on shared server costs or on a wholesale migration to an external server like Gmail.

Benefits may also be non-monetisable. In this case, there may be an improvement or change, but it may not directly result in monetary impact, and so value may be estimated via an equivalent economic benefit or qualitative descriptions provided. Some examples of estimated benefit might include improvement in teaching quality or productivity, or time saved in commuting. A number of examples of where advanced network services

may not be monetisable are shown below (Figure 10).

This problem is common to all infrastructure investments. In the recent Report of the Crown Research Institute Taskforce into CRIs, one key recommendation revolved around shared infrastructure:

“Recommendation 13: The CRI Taskforce recommends that Government develop a national research infrastructure strategy to rationalise investment in RS&T infrastructure and to ensure its most effective use. CRIs should continue to finance business-as-usual infrastructure from their own resources. *Where economies of scale or scope exist and the capacity of the infrastructure exceeds the needs of any one organisation, the investment and financing decisions should take place within the context of a national strategy and recognise the need to provide appropriate access.*”<sup>11</sup> (emphasis added)

As such, these benefits of an advanced network cannot be easily or completely ‘commercially justifiable’ by the Members of REANNZ.

Approaches to try and force an increase in member fees may have the unintended consequence of splintering the core membership and weakening the current income base.

**Figure 11:**  
**Reasons that**  
**economic**  
**value cannot**  
**be monetised**

**Five reasons that economic value cannot be monetised**

<b>Benefit monetisation impediment</b>	<b>Examples</b>	<b>Path to monetise</b>
• Non commercial time lag/risk	<ul style="list-style-type: none"> <li>• Experimental research may be weakly linked outcomes or there is significant uncertainty around outcomes</li> <li>• Benefits of increasing the awareness of Vietnamese students of New Zealand as a potential study location may take 5-10 years to realise and be difficult to determine</li> </ul>	• Successful investments may reinvest at the top of the pyramid
• Quality of outcome is not recognised by recipient or funder	• The Ministry of Education has chosen not to measure teacher performance. As such there is no economic mechanism to recognise higher quality teaching	• After the fact case built to support funding. Monetisation prior to demonstration remains challenging
• Weak or multi-layer causal links	• Experimental researchers demonstrate capability of supercomputers to peers who in turn develop IP that is commercialised by Weta	• Successful investments may reinvest at the top of the pyramid
• Unrealised productivity gains	• Teacher time is saved by linking to a live class in Manchester however this time cannot be released	• Unlikely
• Structural impediments	• Operating costs could be reduced through outsourced IT however the capex budget is owned/managed elsewhere	• Change funding structure and allocation of funds

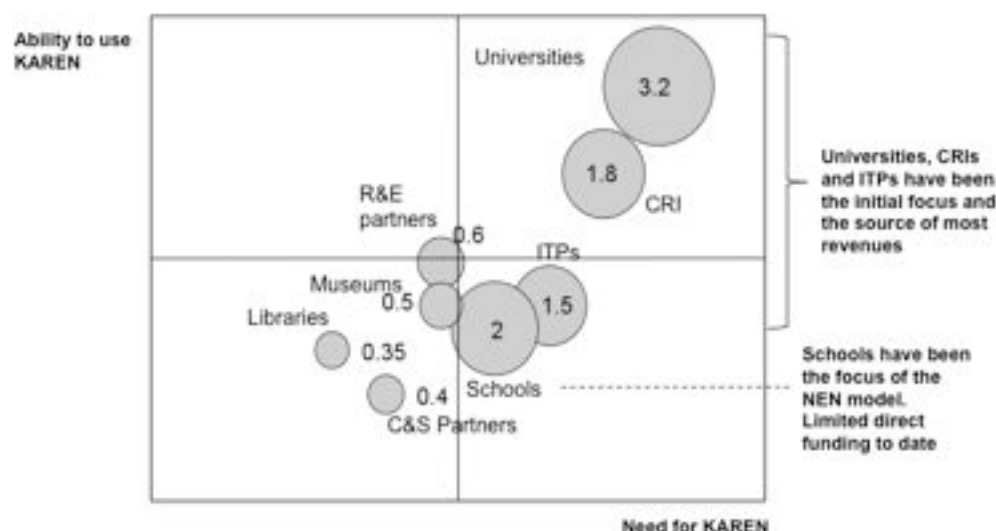
**New**  
**Members will**  
**be too small**

New Members under the existing remit of REANNZ are also an unlikely source of funds. Most naturally large users of an advanced network are already Members of KAREN (Figure 12).

<sup>11</sup> Report of the Crown Research Institute Taskforce, Recommendation 13, released 4 March 2010, p 34

**Figure 12:**  
**Revenue**  
**potential by**  
**source**

**Estimated revenue potential**  
NZD millions (2010 dollars)



**New services,**  
**including**  
**internet are**  
**better**  
**provided by**  
**market**  
**suppliers**

Another source of potential revenue is the provision of new services. However, analysis suggests they are best provided by market suppliers.

The most apparently compelling new service is 'commodity internet' services, as supplied in the broader market for bandwidth. Analysis commissioned by REANNZ shows that the provision of commodity internet services to existing Members will provide a net annual benefit of \$0.2 - 0.4 million based on current margins (Figure 13). However, as the service provided is *commodity* based, the margins are not sustainable and this revenue stream will likely decrease over time<sup>12</sup>.

REANNZ might also charge for the provision of 'Other' services such as Voice Over IP (VOIP) or shared services. Currently one service, an advanced video conferencing bridge, additional to the advanced network is provided on a neutral cost basis with a view to recovering cost. The purpose for the provision of these services is to increase the efficiency of the sector.

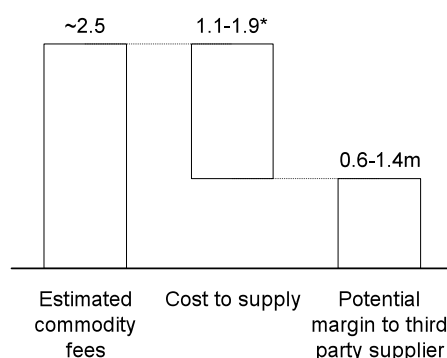
A basic criterion for REANNZ to provide a service is that it be better placed than others in the market and that such services are directly related to KAREN. No such opportunities have been identified. Moreover there is a risk that by engaging in an increased number of services the complexity of REANNZ's business, its cost base, and the inherent risk in its operations may increase with negligible net benefits.

<sup>12</sup> Recent confidential discussions with large members reinforce the belief that any margin created initially through commodity internet would not be retained by REANNZ



**Figure 13:**  
**REANNZ fees and costs for member internet and costs for commodity internet**

**REANNZ fees and costs for member internet**  
\$m per annum



- The total addressable revenue stream for members is estimated at \$2.5m per annum
- Available margin lies between \$0.6 and \$1.4m
- We have estimated members might allow REANNZ to keep ~25% of this margin

**Sustainable margin: \$0.2-0.4m per annum**

\* Assumes both a build or buy scenario, domestic costs are zero through KAREN, 600mbps capacity delivered from Sydney and West Coast USA  
See Appendix for working  
\*\* Source: REANNZ

**Expanding the partner model will likely be NPV negative**

A study by REANNZ showed that while there is revenue potential in new Partners it is likely to be NPV negative<sup>13</sup>.

In this study 226 potential partners were identified. Once a number of filters are applied, there are only 46 potential new partners available in the New Zealand market (Figure 14).

The analysis further shows these remaining potential Partners are likely to yield very limited value, particularly once the cost of acquiring the Partner and cost to serve are included. In fact, on one view, the net present value of these new Partners is likely to be negative.

However new Partners, under the existing remit might be valuable for alternative, non-revenue generative, reasons. For example, including such organisations might provide indirect value through industry connections. Involvement by such groups is currently being explored and pursued.

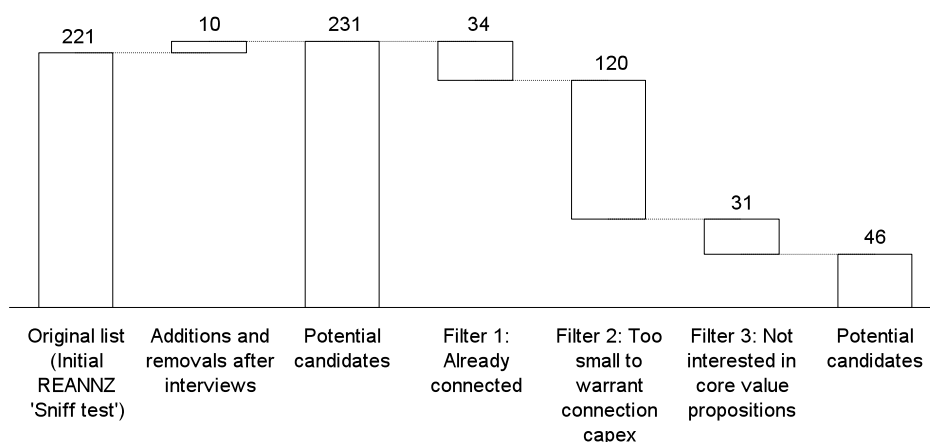
New Partners under an expanded remit for an advanced network is also unlikely to bear real value as a source of funding. Functionally the network is not suited for non-research and education type activities and operationally there would be a direct increase in input costs which would off-set any real benefit gained.

The conclusion is that new Partners under an existing or expanded remit will not be a material viable source of funding for an advanced network.

<sup>13</sup> Internal REANNZ study, "REANNZ: Evaluation of options for development of the Partner Segment" presented to the REANNZ Board 14 October 2009

**Figure 14:**  
**Partner**  
**candidates**  
**for KAREN**

**Potential partner candidates for KAREN**  
Number of organisations



**Philanthropy**  
**is limited in**  
**New Zealand**

New Zealand has a limited market for this type of philanthropy. If such a practice were to develop, this could not be a permanent source of funding as it is generally discretionary and is unlikely to be annually predictable. While such funding could be an additional source of 'bonus' funds e.g. for special projects, it is not something which could fund the core of an advanced network service. Philanthropic grants are also frequently constrained to capital items and cannot be used to support ongoing operating costs.

## "Mind the gap" - The future sources and uses of cash?

**A \$6m**  
**funding gap**  
**remains**

REANNZ has estimated forward costs in the order of \$12 million (2011-2013). Including the recently agreed increase in core Member fees of c.26.6%<sup>14</sup>, the total annual revenue for REANNZ is approximately \$6 million. The current annual P&L 'gap' between revenue and costs for 2011-2013 and beyond is therefore approximately \$6 million (Figure 15).

<sup>14</sup> Members agreed to a 23% increase in 2010 and a further 3.6% increase in 2011.

**Figure 15:**  
**Forecast**  
**financials**  
**(P&L)**

	2011	2012	2013
	\$000	\$000	\$000
Revenues	6,184	6,213	6,425
Network	9,423	8,394	8,880
Personnel and overheads	3,320	3,440	3,908
Annual Profit (Loss)	-6,559	-5,621	-6,363

Source: REANNZ forecast

## What happens to New Zealand if we have no advanced network?

### Section summary

Without KAREN there would be a loss of national access to investment in shared, fixed infrastructure supported by KAREN and a loss of our place in the global scientific community. There would be a high future cost of re-engaging services for the research sector. There would also be loss of the leading demand driver when the Crown is investing in broadband infrastructure through its stake in Crown Fibre Holdings and direct subsidies.

### Without KAREN there would be a loss of national access to investment in shared, fixed infrastructure supported by KAREN

KAREN Members and the Crown are currently investing significantly in fixed research infrastructure whose business cases and ongoing viability depend on an advanced network. For example, national scale investments in high performance computing, radio astronomy, climate science and genomics would be unlikely to proceed if there were any doubt of the ongoing existence of an advanced network. Certainty of supply of this capability is essential if we are to see ongoing investment in modern research.

*“Sustainable access to a range of specialist eScience Infrastructure services [...] and access to high bandwidth telecommunications, such as KAREN, were identified as critical requirements.”<sup>15</sup>*

Similar experience has been provided by leading astronomy researcher Dr Tasso Tzioumis of CSIRO's Australia Telescope National Facility;

*“Australia's participation [in the e VLBI project] needed fast networks to Europe which traversed the American continent. Again, the NRENs in*

<sup>15</sup> National eScience Infrastructure Investment Case, MoRST

*the USA and Canada were key to the success. At its peak there were 3 x1 Gbps circuits from Australia to the Netherlands, and a 1 Gbps lightpath is still functional, courtesy primarily of the Canadian NREN (CANARIE). The commercial price for such connections is potentially millions of dollars and not supportable. The key has been the symbiotic relationship between astronomy researchers and the NREN community. The pay-back is progress in both the next generation networks and in research.”<sup>16</sup>*

**Loss of KAREN would lead to loss of place in the global scientific community**

In many cases research work is simply not possible or is cost prohibitive or less effective without KAREN.

Examples of such research included in Earthquake research in the Department of Civil Engineering at the University of Auckland where prior to KAREN the team was able to participate but only through limited data feeds.

Similarly Dr. John McEwan of AgResearch, a Crown Research Institute, has explained that New Zealand has been able to play a leading role in sheep genome research. Prior to KAREN, genome sequencing data would have been retained in separate databases – a wasteful process as each database required updates by massive data set transfers and synchronisation. Instead, KAREN has enabled AgResearch in New Zealand to play a leading role in this research by playing host to the single sequencing database which assembles, processes and annotates the genomic data collected. Data is accessible to international researchers engaged in the project through KARENs high speed connectivity.<sup>17</sup>

Lastly, the University of Canterbury Supercomputing Facility which operates at near 100% uptime would not be possible without KAREN,

*“KAREN is a necessary part of our infrastructure giving us the ability to make high performance computing resources available throughout New Zealand,” Ian Town, Deputy Vice-Chancellor, University of Canterbury.*

**There would be a high future cost of re-engaging services in research**

For much of the last two decades New Zealand did not have an advanced network. When there has been an advanced network in place, New Zealand has played catch up in capability development. For example universities need to relearn the current state-of-the-art in connectivity, devices and applications. A REANNZ commissioned study found that the lag time for New Zealand to catch up with high-speed capabilities was estimated at about four years for universities and three to six years for consumers. However, without an advanced network, the lag time between bleeding edge and university and consumer catch-up has been far longer i.e. about seven years for universities and around nine years for consumers<sup>18</sup>.

<sup>16</sup> Personal communication (Dr Tasso Tzioumis to Donald Clark, CEO of REANNZ)

<sup>17</sup> KAREN case study

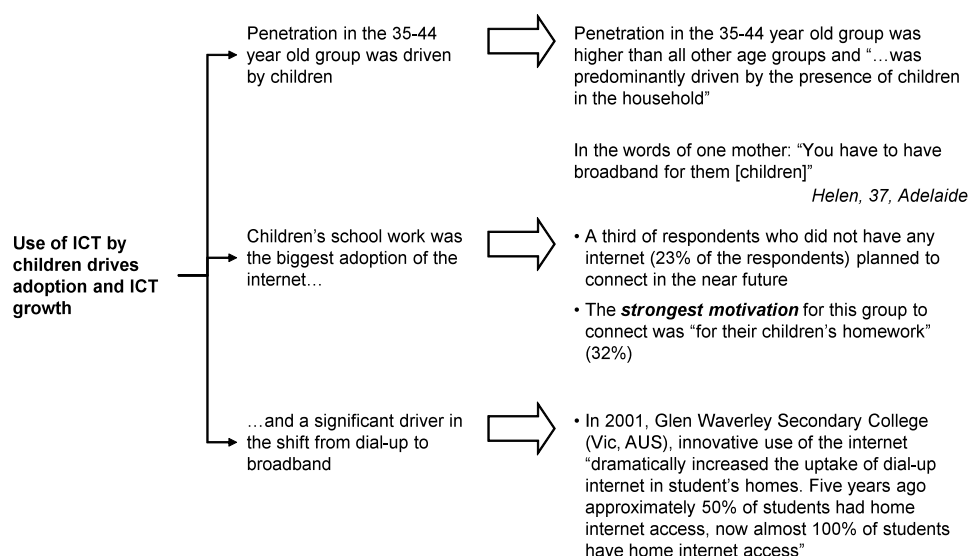
<sup>18</sup> [www.reannz.co.nz/assets/.../REANNZ-Economic-Value-Report-Full.pdf](http://www.reannz.co.nz/assets/.../REANNZ-Economic-Value-Report-Full.pdf) accessed 24/03/2010

**Loss of leading demand driver when the Crown is investing in broadband infrastructure**

One of the leading benefits of high capacity connectivity is the impact it has on adjacent communities. More specifically, students in universities and schools who use ICT drive up the uptake and use of ICT within their families and broader communities. At the school level, exposure drives both adoption in the home (e.g. the strongest motivation for parents was 'for their children's homework') and also upgrades to ICT in the home (e.g. exposure drove upgrades from dial-up to broadband) (Figure 16). In total, each year KAREN should touch ~1.2 million 'ICT ambassadors' through primary, secondary and tertiary institutions who will further drive the uptake of broadband and network connecting devices (Figure 17).

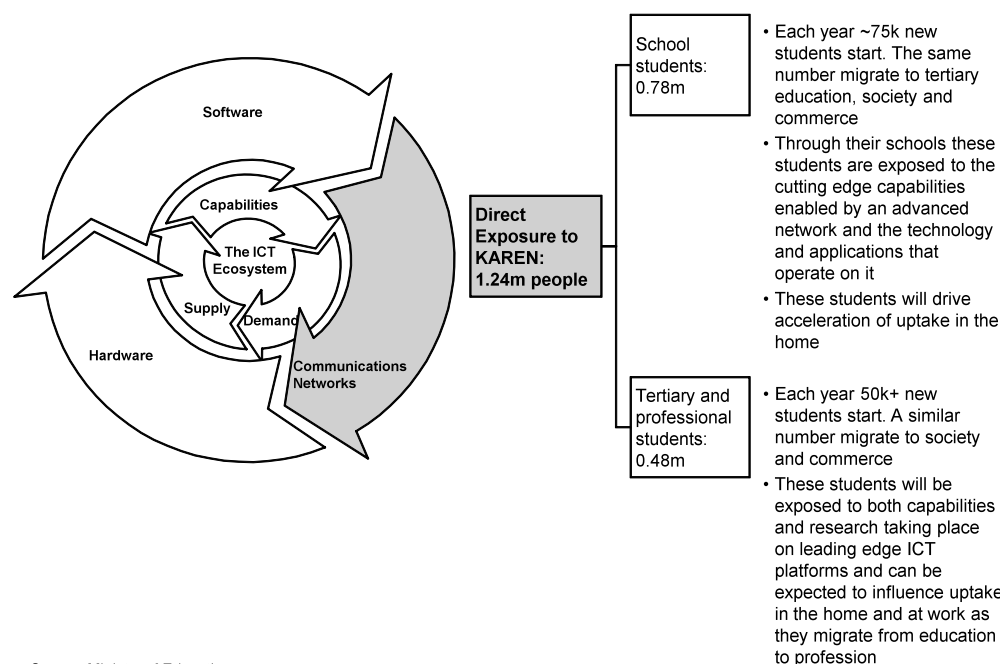
This demand driver is of critical importance in New Zealand given the \$1.5 billion investment being undertaken by the Crown on ultrafast fibre broadband.

**Figure 16: Examples of ICT in schools driving community uptake**



\*Source: "Telecommunications Today: consumer attitudes take-up and use" (Sept 2007) Australian Communications and Media Authority, 'Broadband in Education: Availability, Initiatives & Issues' (2002) NOIE

**Figure 17:**  
**Impact of**  
**KAREN use**  
**by students**



Source: Ministry of Education

## Sustainable funding for an advanced network in New Zealand

### How do others achieve sustainability and can REANNZ do likewise?

#### Section summary

Most advanced networks are sustainable but not self funding with, on average, 52% of funds coming from government. In countries comparable to New Zealand, sector / central contributions still account for between 50% and 70% of revenues even after 20 years or more of operation. Those NRENs that are self funding without sector / central contributions have cost or revenue lines that cannot be replicated in New Zealand.

#### Most advanced networks are sustainable but not self funding with 62% of funds coming from government

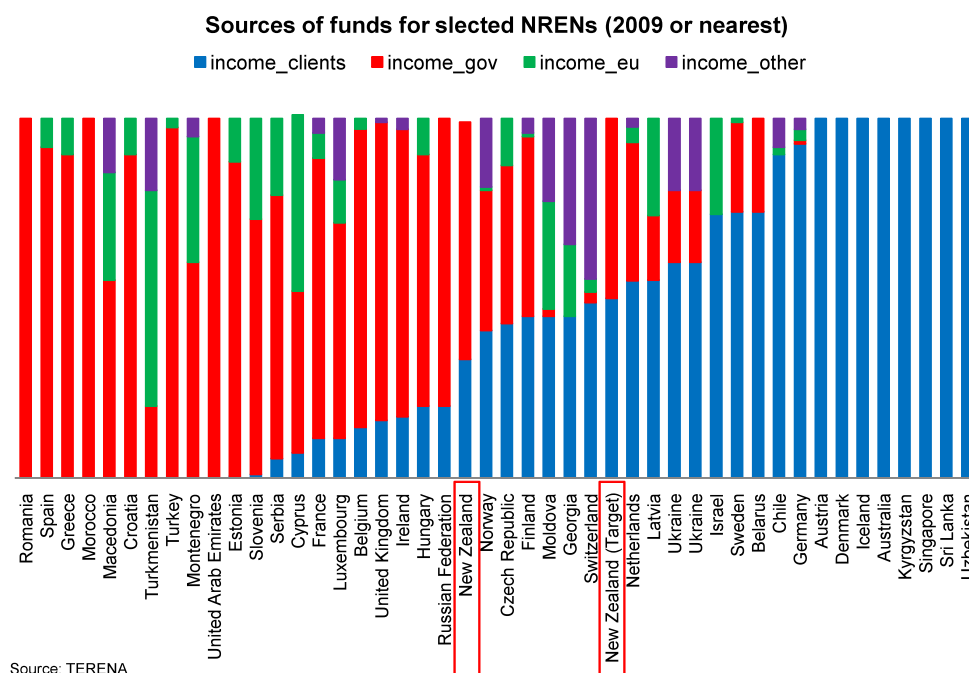
In discussing sustainable models, it is also important to differentiate sustainable from self funding. For the purpose of this discussion sustainable refers to continued surety of supply while self-funding implies no ongoing direct financial support from government.

In KAREN's case, as with many advanced networks, the Crown sought to create a self-funding model but, as the findings of this report argue, achieving this goal is now seen to be extremely unlikely.

Very few NRENs survive without sector/central funding. Internationally, the norm is for ongoing commitment from central government or in Europe's case the European union. On average only 43% of funding is sourced from members and users while 52% is sourced from government or the European Union<sup>19</sup>. (Figure 18)

<sup>19</sup> TERENA 2009 Compendium, JANET estimate based on discussions with JANET management

**Figure 18:**  
**Sources of**  
**funding**



**Those NRENs that are self funding without sector / central contributions have cost or revenue lines that cannot be replicated in New Zealand**

Those NRENs that appear sustainable without sector / central contributions have cost or revenue lines that cannot be replicated in New Zealand.

Iceland is 100% user funded, but critically pays a very small portion of its very long international circuits back to Europe and the USA. Its level of user funding therefore omits a significant network cost.

Denmark has a very small (physically only 7 PoPs) national core network - only 2% of its budget is spent on this. Another 33% is spent on external connectivity (to GEANT2). Essentially it is a physically smaller, lower cost, more compact network serving a larger and richer population base. This leads to substantially different economics from KAREN and therefore makes it able to be fully funded by users/Members<sup>20</sup>.

Another self-funding advanced network without sector / central contributions is the Australian advanced network – AARNet. AARNet and REANNZ have similar revenues (on a per population basis). However, the major difference between them is AARNet’s very low cost base.

AARNet’s low cost base comes as a result of an opportunistic purchase of access rights to dark fibre during the collapse of NextGen, the owner of the rights to the dark fibre<sup>21</sup>. In addition, at the time, international telecommunications markets had also collapsed, and AARNet took the opportunity to acquire 2 x 10 Gbps links to the USA. For REANNZ to access a similar, significantly lower-than-market cost structure requires another unpredictable event such as a market crash.

<sup>20</sup> REANNZ Business Plan Update FINAL Dec 2007

<sup>21</sup> Internal REANNZ study, “An assessment of the AARNet model and replication in New Zealand”, presented to the REANNZ Board February 2010

## The Recommended Sector Level approach to a sustainable NREN

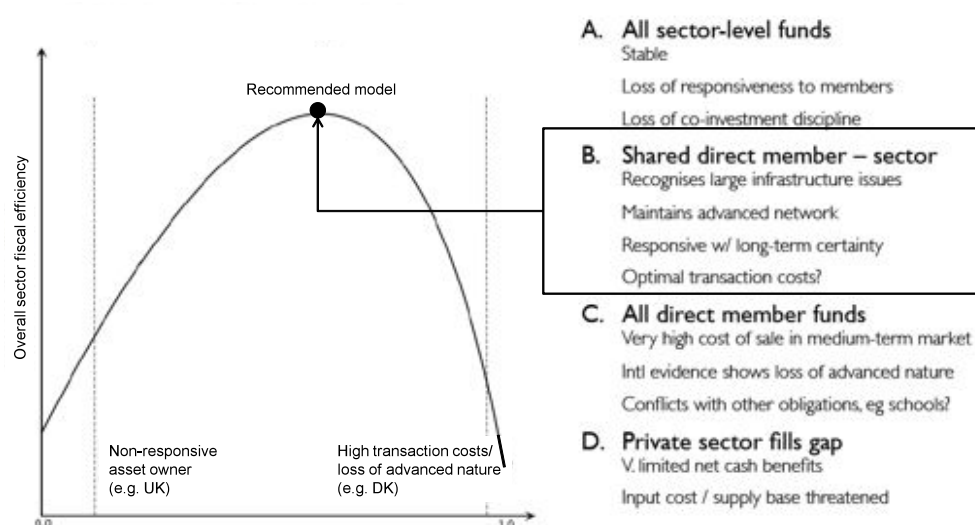
<b>Section summary</b>	Sector-level funding is the optimal model for New Zealand. Members would prefer new Crown funding. MoRST officials will need to begin the process of getting support for partial central funding from Treasury, Ministry of Education and Tertiary Education Commission.
<b>Sector level funding is the optimal model for New Zealand</b>	<p>REANNZ research and experience show that the only remaining option for a sustainable funding model is therefore the combination of direct member fees and sector-level funding (Figure 19).</p> <p>Finding the right mix of Member and non-Member fees is a challenge for all advanced networks. One way to determine the balance is to consider fiscal efficiency – the balance between benefits and costs to members. Four different funding models were considered against these criteria:</p> <p><b>All sector-level funds (0:100):</b> While this model is stable it has lower responsiveness to member needs and lacks the operating rigour that is provided by co-investment or co-funding by members.</p> <p><b>Shared direct Member – sector (x: 100-x):</b> This model recognises that the infrastructure nature of KAREN requires a shared funding model. It also allows the network to stay more, if not completely, advanced, constrained only by sector cash availability. Because of the certainty of funding members can co-invest with comfort and transactions costs are minimised.</p> <p><b>All direct Member fees (100:0):</b> The cost of sales under this model is expected to be very high given the need to continually articulate the value provided. There is also some evidence internationally that this model leads to a loss of the advanced nature of the network<sup>22</sup>. Lastly schools are not well prepared to fund under this model and hence one of the key benefactors of KAREN might be excluded.</p> <p><b>Private sector fills the gap (x:0):</b> This model has limited appeal as there is no evidence of products or services of sufficient scale not provided by the market, and were KAREN to participate in these markets there is a risk the cost base might be impact by suppliers who would come to see KAREN as a competitor</p>

<sup>22</sup> Plotting 'Core capacity' versus '% of funding from users' [TERENA 2007] shows a negative relationship i.e. higher % of users implies lower core capacity.



**Figure 19:**  
**Optimisation**  
**curve for**  
**financing**  
**mechanisms**

### Optimisation curve for financing mechanisms



### Members recommend new Crown funding

Members are most comfortable with new Sector money but would support the use of existing sector funding if no other options were available.

Large Members also reveal a strong view that KAREN is basic infrastructure and the Crown has some role in its ongoing financing.

### Three potential sources of Crown funding have been identified however funding source has not been agreed

REANNZ analysis has identified three potential sources of funds: Research, Science and Technology, Tertiary Education, and Education each with a slightly different requirement tailored to the current policies and issues within that sector.

- Research, Science and Technology (R,S&T): R,S&T requires alignment with the Resarch Infrastructure Plan currently under development.
- Tertiary: Reallocation of existing funds from low value spend to a higher value investment in KAREN
- Education: Education already has a central arrangement in place for the National Education Network trial. This should be made enduring and the final amount should be committed rather than providing funding on a block by block basis as schools join. The need for upfront funding comes from the infrastructure nature of KAREN and the fact that once established marginal costs for new users are negligible.

This approach to trans-sector funding from R,S&T, Tertiary or the broader Education Vote or other Votes has not been agreed.

It is worth noting that the magnitude of funding required is small in the context of the total expenditure (Budget 2009):

- Research, Science, and Technology: \$745 million<sup>23</sup>

<sup>23</sup> Treasury Budget data, <http://www.treasury.govt.nz/budget/2009/data/b09-expense-data.xls> accessed 1 April 2010

- Tertiary: \$2,000 million (as part of Vote Education)<sup>24</sup>
- Education: \$9,500 million (net of Tertiary above)

**A ramp-up to a sustainable funding level from the Crown is proposed**

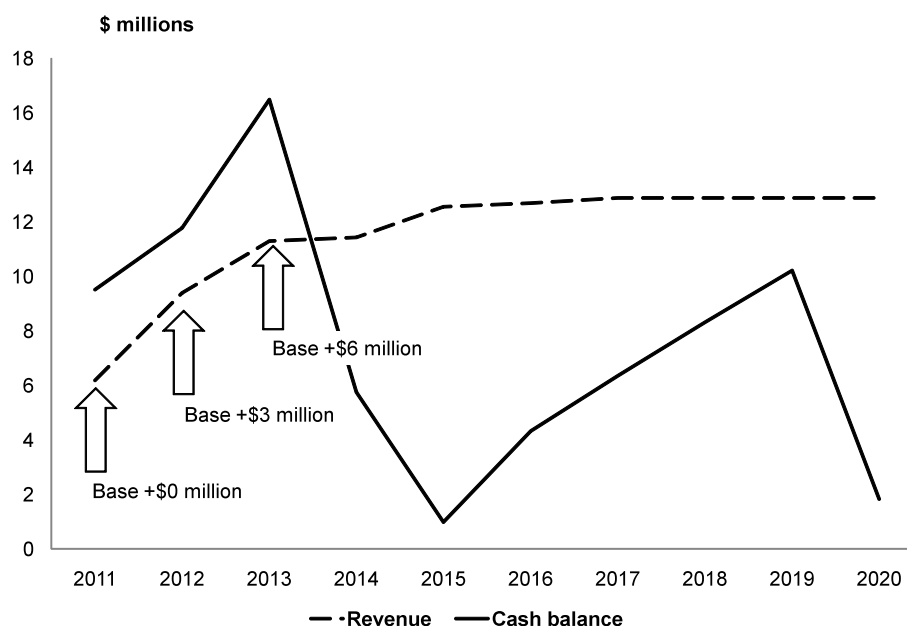
Forecast P&L costs are approximately flat over the period 2011 to 2014, however the REANNZ cash balance is expected to grow (from ~\$10 million to ~\$17 million in 2013 and from ~\$1 million to \$10 million in 2019) as REANNZ has a positive operating cash flow (excluding investments). This cash balance serves as a contribution for future network investment.

Delay on implementing a sustainable funding model must be avoided as it introduces risk into member investments that depend on KAREN while also increasing the costs REANNZ must pay for shorter term commitments. Design and building a dark fibre network will take at least two years.

To overcome this it is proposed that the Crown fund source ramp up from \$0 in 2011 to \$6m in 2013 in steps of \$3m (Figure 20). This has several benefits:

- Reduces the cash commitment from the Crown over the next two years and ensures there is sufficient cash available in 2015 for the next refresh
- Allows the Crown a re-evaluation point prior to 2015 as to the level of ongoing contribution required once forward network costs are better known

**Figure 20:**  
Revenues and cash balance model for REANNZ ('11-'20)



<sup>24</sup> "Vote Education: Overview of the Vote", Treasury 2009, <http://www.treasury.govt.nz/budget/2009/estimates/est09educ.pdf> accessed 01 May 2010

**Officials are supportive of central funding and recognise sector is the best source**

The Ministry of Research, Science and Technology recognises that the Crown needs to play a role in funding research infrastructure as outlined in a recent draft paper<sup>25</sup>,

*“Internationally, large scale research infrastructure involves substantial government investments. In New Zealand’s case the need is no different, and is indeed heightened by the small scale of our science system funding in relation to the investment required.”*

Professor Sir Peter Gluckman has stated that the core elements of a knowledge-primed economy are: the flow of ideas, the transformation of ideas, venture maintenance and policy alignment. A key part of the first element of this process is infrastructure. He states,

*“Without technological infrastructure, competing in a global knowledge based system is not realistic. The public sectors need this infrastructure for student and staff capture, for training, for research”.*

In his view, this infrastructure should be funded publicly and is

*“...the key to [New Zealand’s] economic transformation”.*<sup>26</sup>

## Recommendations, timeframes and process to achieve sustainability

**Support in the 2011 Budget is required or REANNZ should plan to wind up KAREN over the next 12-24 months**

New Zealand’s advanced network is at a critical point in its development. Positive support from the government in the 2011 Budget would build upon experience from REANNZ, Members and individual users and allow them to fulfil the potential of having an advanced network.

Budgetary security would specifically provide certainty for Members and others seeking to build on and rely on the advanced network infrastructure. It would also provide the ability for REANNZ to operate with a clearer long term view, and the associated cost containment e.g. through negotiation of favourable long-term contracts.

- *Member investment*: provide certainty for Members that the advanced network would continue. This confidence would allow Members to support additional investment and resource commitment around KAREN
- *Infrastructure investment*: provides certainty to branches of government (or others) seeking to invest further in science infrastructure
- *Cost containment*: provides certainty for REANNZ to move forward with negotiation of favourable long-term contracts as early as possible to limit cost base.
- *Aggregated procurement*: provides the Crown with the capability to do aggregated procurement beyond KAREN e.g. schools, health and Crown Fibre Holdings

<sup>25</sup> Draft paper from The Ministry of Research, Science and Technology, “Large Scale Research Infrastructure Investment Strategy” February 2010

<sup>26</sup> Gluckman, Peter “People and Capability: The Key Elements in a Knowledge Primed Society” Paper presented to the “Catching the Knowledge Wave Conference, Auckland, 1-3 August 2001.

This report proposes the Crown commit to ongoing operational funding to REANNZ to ensure the financial sustainability of KAREN. The recommended level of funding by year is:

- \$0 (2011/12)
- \$3m(2012/13)
- \$6m (2013/14)
- \$6m (ongoing)

Alternatively, should the government choose to cease support of an advanced network for New Zealand, this would allow Members, REANNZ and others involved in the advanced network to take next steps. Specifically this would involve the wind-up of the advanced network in an efficient and effective manner.

## Conclusion

This report has discussed the economic realities of providing an advanced network in New Zealand, exploring sources and uses of income, and how these compare internationally. Avenues for possible cost reduction cost drivers for the next ten years have been examined, and implications for the Research and Education sector of loss of the advanced network have been outlined.

The report has covered issues of sustainability of funding for an advanced network in New Zealand. It looked into how other countries achieve sustainability and whether REANNZ can do likewise.

On the basis of REANNZ and external research and analysis, the report recommends a sector-level contribution to funding and looks at time frames and process to achieve sustainability.

At this stage, the REANNZ Board of Directors and management seek to engage in discussion with the Shareholder on the basis on which KAREN might be funded on a mixed model sustainable basis, through a combination of Member funding and Sector level contributions at the recommended level.

# Appendix 1: An advanced network as critical research and education infrastructure

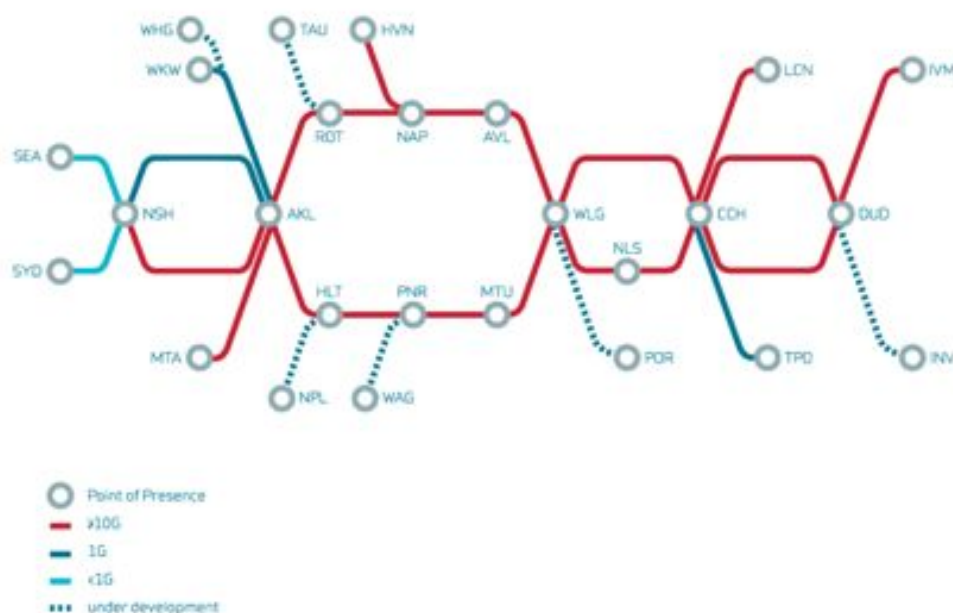
## The components that make up an advanced network

<b>Section summary</b>	There are three key elements to KAREN. The National Network allows Members to connect to one another within New Zealand. Our International Network allows us to connect to the world via connections at Sydney and Seattle. Critically, members and users are those who derive the benefits
<b>There are three key elements to KAREN</b>	<p>KAREN has three main parts.</p> <ul style="list-style-type: none"> <li>▪ A national network that connects users to each other</li> <li>▪ An international network that connects New Zealand with the world</li> <li>▪ An operating team that sets up and manages all the constituent parts</li> </ul>
<b>The National Network allows members to connect to one another within New Zealand</b>	<p>The National Network is made up of several different elements.</p> <p><b>Points-of-presence (PoPs):</b> PoPs are 26 physical locations (mid 2010 forecast) placed around New Zealand at centres of demand (from Whangarei to Invercargill) (Figure 21). A PoP is a leased space, with a number of physical network boxes that allows members to connect to KAREN. KAREN PoPs are either hosted by Members or in commercial hosting facilities. Neutrality of access is ensured at all times.</p> <p><b>Interconnection between PoPs:</b> Each of these POPs needs to be connected to the others either directly or in a physical 'daisy chain' manner. Physically these PoPs are connected by fibre links that are leased from market suppliers<sup>27</sup>. The current commercial arrangements have a combination of 1 Gb/s and 10 Gb/s links nationally<sup>28</sup>.</p> <p><b>Switches and Routers:</b> The physical fibre links are connected with devices called Switches and Routers. While the two are functionally different they both serve to connect users to one another at the PoPs. KAREN has 3 core Routers and one switch at each PoP. Additional routers are being added to better control access by content providers and schools.</p> <p><b>Service Management:</b> This management of the operational aspects of KAREN. For example; a new customer connects, a design change is made to the network, or there is a fault on one of the physical boxes or fibre links. This service includes a helpdesk, network operations centre, spares management and network configuration management and is provided to REANNZ under contract from the market.</p>

<sup>27</sup> See Section X for discussion on the types of services offered and their costs

<sup>28</sup> Gbps: (Giga bits per second) is a standard measure of the amount of data the network can move in a given period of time

**Figure 21:**  
**KAREN's**  
**topology**



**Our International Network allows us to connect to the world via connections at Sydney and Seattle**

The KAREN international network extends all the way to Sydney and Seattle. From our PoP in the North Shore we connect to Sydney via two 155 Mb/s links and to Seattle at 622 Mb/s.

At landing points at Sydney and Seattle, KAREN connects with over 50 similar research and education networks across the world, giving members seamless access to millions of people and resources without data charges.

This connection is currently provided as a single integrated service (encompassing connectivity, routers and service management) by Verizon Business (who themselves lease capacity from the Southern Cross Cable, a company partially owned by Telecom New Zealand). As this cable is the only high capacity cable connecting New Zealand internationally it acts as a monopoly and access to it represents a significant and disproportionate amount of KAREN's costs.

**The Operating Team is the glue that holds it together**

The KAREN high speed unrestricted broadband network is overseen by the operating body known as REANNZ (Research and Education Advanced Network New Zealand Ltd). REANNZ is the Crown-owned company that owns and operates KAREN for the New Zealand education, research and innovation communities. REANNZ provides three types of service: essential, highly desirable and optional, which are described below.

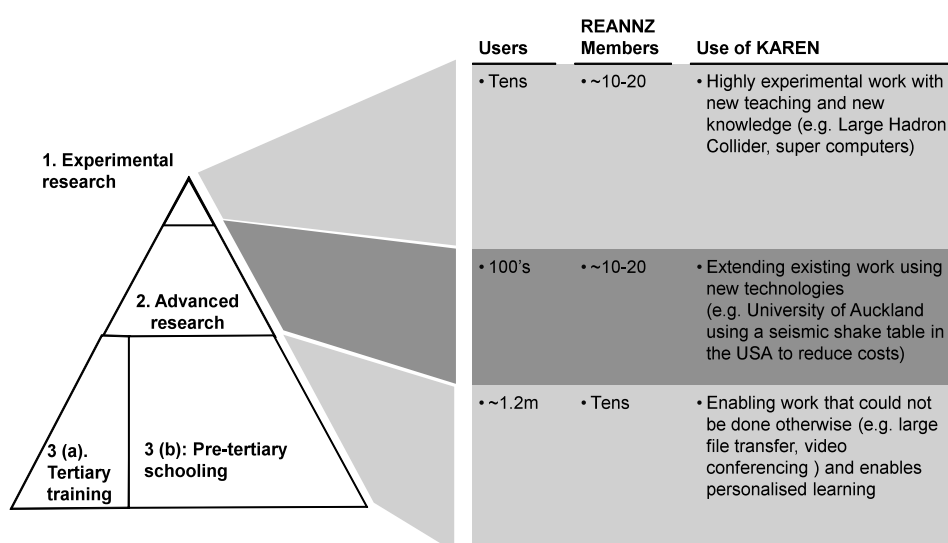
The REANNZ Ltd operating team has the design, procurement and contract management of KAREN as its central role. The team is led by the Chief Executive, Donald Clark who was previously the Prime Minister's policy advisor on telecommunications, science & innovation, economic development, amongst other portfolios, and a business consultant for the private sector in Europe. The REANNZ operating team is responsible for ensuring REANNZ is operated in a financially sustainable manner while

providing leading edge e-research capabilities and universal connectivity for New Zealand researchers and the education sector. In practice, the operating team is at the forefront of New Zealand's thought leadership on advanced networks and manages the administrative and services of KAREN.

**Members and users are those who derive the benefits**

Most important are KAREN's users, the researchers, educators and students of New Zealand. These users themselves are staff and students of KAREN's Member institutions. Importantly Members also invest in the supporting infrastructure (boxes, software, data) that sits around KAREN, as well as the in-house capability necessary to use KAREN. REANNZ Member and user groups are set out in Figure 22.

**Figure 22:**  
**KAREN's reach by user type**



\* See Appendix p.46 for a more complete view of the ICT ecosystem  
Source: Interviews

## What are its characteristics as distinct from market solutions?

### Section summary

KAREN needs to offer a high bandwidth network, even if this capacity is not used continuously. KAREN's procurement model is aligned with our suppliers needs while avoiding cannibalising their revenues: win-win for all. KAREN's massive capacity ensures low unit [cost per data] cost for members. The highest performing user sets the standard – all other users follow behind in capability

### KAREN needs to be BIG, even if this capacity is not used continuously

KAREN's National Network runs at 10 Gigabits per second – that's 2,500 times faster than standard business broadband.

Unlike standard commercial networks, KAREN (like every other research and education network worldwide) purposely over-provides for capacity to guarantee network reliability and performance. The design metric for advanced networks is to keep average peak loads below 20% of available capacity. KAREN is specifically designed for data intensive, complex

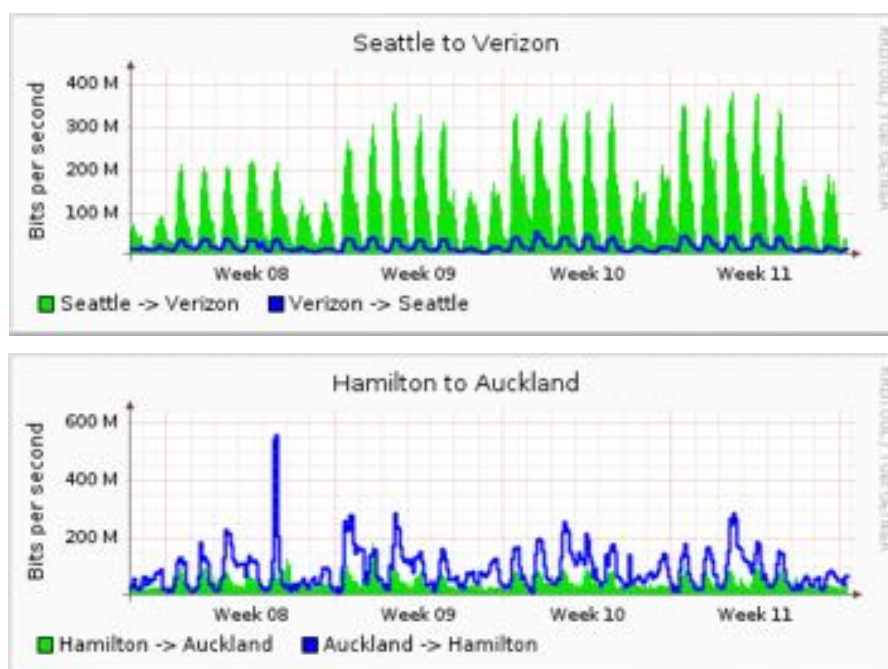


research experiments and simulation. The 10Gb/s domestic capacity ensures there is always enough capacity in the network for traffic spikes – even if there are many data-intensive applications running over the network at once. Over-provisioning is also about future-proofing. This ensures KAREN continues to be at the forefront of network evolution.

This provisioning model bears many similarities to the national grid where the energy network must be designed for peak demand rather than average use.

The high cost of international bandwidth means New Zealand's links to the rest of the global research community are much smaller than other nation's advanced networks and as a result are congested, as can be seen in Figure 23. Nationally, KAREN remains unconstrained as can be seen in Figure 23. These charts also clearly show the rate of growth in demand KAREN is experiencing. Research and education networks around the world are experiencing similar exponential traffic growth with average traffic volume doubling every two years. For example, after increasing the capacity of their core backbone from 10Gb/s to 40Gb/s in 2008, JANET the UK's advanced network, is now operating a trial of 100Gb/s in response to continued traffic growth.

**Figure 23:**  
Typical  
national and  
international  
traffic rates



**KAREN's  
unique  
procurement  
model is  
aligned with  
our suppliers  
technical  
needs while**

KAREN's procurement model differs from market providers on two dimensions: firstly it achieves performance and secondly it achieves lower price by ensuring it does not compete with its suppliers.

Firstly, traditional network services from the market come with Service Level Agreements (SLA) and financial penalty regimes to the benefit of the customer for failure to meet defined performance standards. Conversely KAREN sets target SLAs, at a slightly lower level, e.g. availability of 99.95%

**avoiding  
cannibalising  
their  
revenues**

versus 99.999% AND does not seek financial penalties if these are not met. To manage this increased risk KAREN is designed to the same build, maintain and repair regime specified by the network supplier's core engineering standards. This means KAREN get the same service levels as all the major private sector clients save several million on compliance and service level agreement management costs.

Secondly it does not seek to cannibalise the suppliers' existing revenue base as this has the potential to raise input costs. Specifically by restricting our users to a carefully defined R&E and Innovation definition [as defined in KAREN's Network Access Policy] it is possible to extract favourable "R&E" pricing from the market. Suppliers recognise they could not cost-effectively serve this market.

Recent examples include regional connections and international connections that are significantly below price book and standard market rates. These rates are however confidential and as such have not been included in this report. Access to this information will be considered on a case-by-case basis.

**KAREN's  
massive  
capacity  
ensures low  
unit cost for  
members**

Telecommunications companies often seek to provide 'value added' products or services such as Quality of Service (QoS) or capacity increases. These value added services assume that the network is constrained in some way and hence additional value can be provided by those who pay more.

Conversely KAREN capacity is always sized for the most demanding user and hence these constraints do not exist. As a result KAREN provides the lowest unit cost for users and the highest performance possible without being encumbered by complex traffic management approaches.

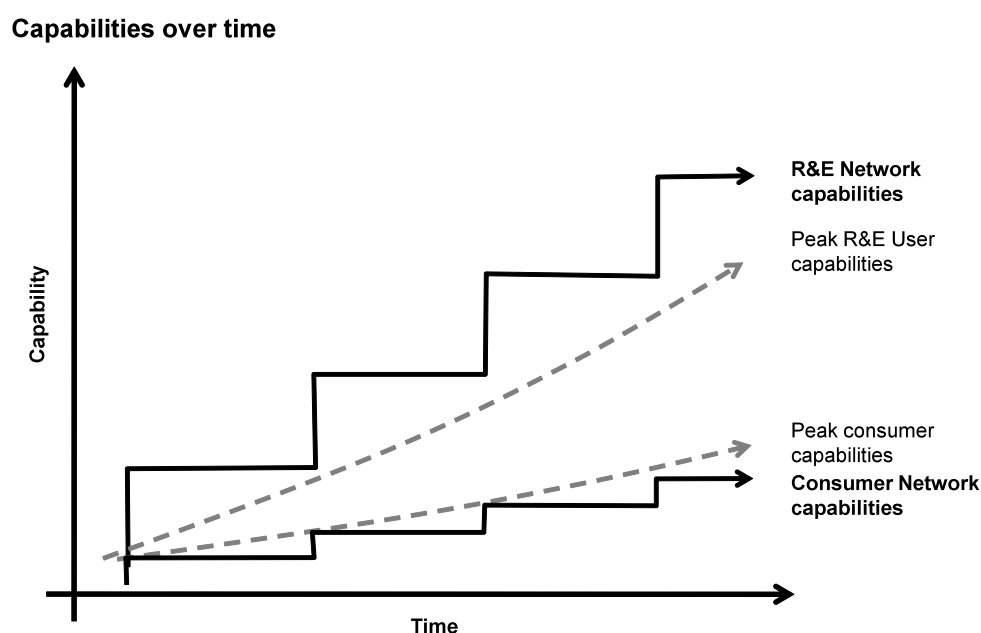
**The highest  
performing  
user sets the  
standard – all  
other users  
follow behind  
in capability**

The user with the highest demands sets the capacity requirements for the network. Therefore at any given time there may only be a handful of people who need this capacity and for all other users the network is effectively over engineered. In practice these trail blazers set the path for other users to follow.

The implication of this is that R&E users' capabilities always follow the capabilities of the network (Figure 24). Conversely in a commercial consumer network the 'masses' define the capability provided and consumer capability typically leads network capability.

An aspect that further differentiates KAREN from standard networks is that the further the demand exceeds average user demand the easier it is for suppliers to work with KAREN and provide non-standard deals. In Figure 24 below this is represented as the gap between stepped network capability curves. Unfortunately, the capability gap between the highest KAREN user demands and the bulk of KAREN user demands leads to higher costs that are rarely monetisable by researchers.

**Figure 24:**  
Evolution of  
network and  
use  
capabilities



## What functions does REANNZ provide

### Section summary

REANNZ is the operating company that oversees KAREN. REANNZ does not carry out all management functions – many are outsourced.

### REANNZ is the operating body that oversees KAREN

Since its inception, REANNZ has not only given oversight to the procurement and operation of KAREN, but has also been vested with a capability build role that involves communications, supporting members and users and fund managing the \$4.3m Capability Build Fund. Legal, financial and executive functions are necessary but kept to a minimum. REANNZ leverages outsourced arrangements for its financial and legal support.

Some people dedicated to these tasks are required, irrespective of the governance and operating model deployed for any particular advanced networks. Internationally, a discrete, neutral body is the predominant form. Even network operations and technical staff are only outsourced in 22% of advanced networks around the world (Sample of 41<sup>29</sup>)

REANNZ conducts its work through the operating team, led by the Chief Executive, Donald Clark. The operating team is primarily comprised of a group of highly qualified and specialised individuals with deep experience in telecommunications.

### Irrespective of the ongoing governance structure

Essential activities include the design, procurement and contract management of the core national and international networks and associated purchasing, for example hardware.

Highly desirable services include limited member engagement to encourage

<sup>29</sup> TERENA 2007 Compendium; NOC outsourced versus retained

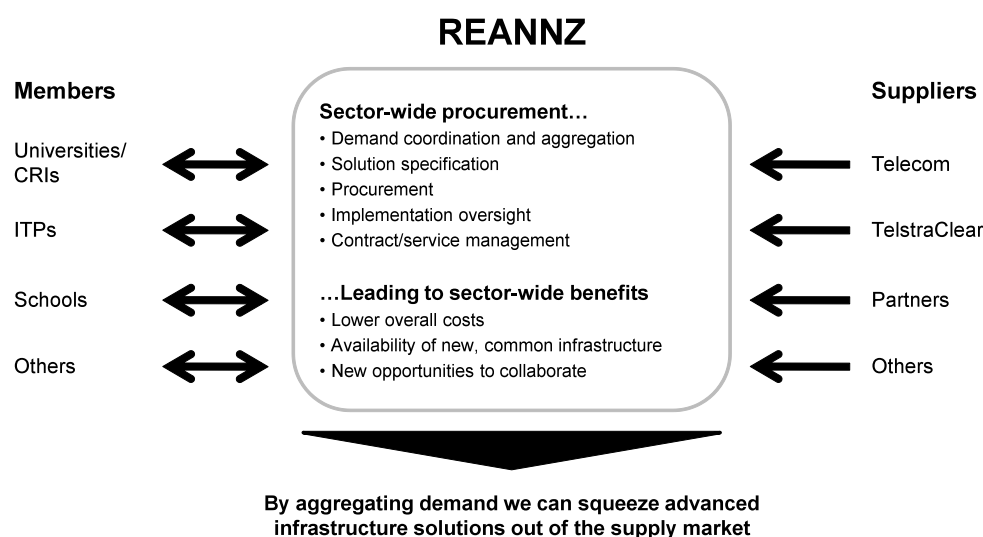
**some  
activities  
must take  
place**

uptake, formal and informal education and training, basic communications to stakeholders and engagement on wider sector issues. For example REANNZ has contributed to the NZ IPv6 taskforce, has hosted a highly successful international advanced networking conference to accelerate user adoption, and holds regular training seminars on network design.

Optional services include video conferencing, secure DNS (Domain Name Server) provision, consultancy and advocacy. For example, REANNZ has led thinking around schools connectivity, and provided expert comment on the government's various broadband plans.

REANNZ's position, as the connector between Members and infrastructure Suppliers and its role is set out in Figure 25 below.

**Figure 25:  
KAREN  
demand  
aggregation  
summary**



**REANNZ  
doesn't do it  
all – many  
functions are  
outsourced**

Importantly there are many activities that REANNZ does not do, typically left to more efficient market operators. Examples include:

- Laying of fibre (currently leased from market providers, requires distinctive capability and significant capita per link)
- Building large co-located facilities (specialist skills [construction, Resource Management Act] and requires high capital commitment)
- Staffing network operations centres, and call centres (not required for small number of members, user support is typically provided by the member organisation)
- Installing or managing user equipment (provided for well by market operators and members)

## Advanced networks as fundamental national infrastructure

**Section summary** KAREN is considered to be essential national infrastructure, analogous to motorways for vehicular traffic. This impacts the funding model and specifically the need to aggregate demand and funding in order achieve efficiency and leverage in purchasing network access.

**KAREN is considered to be essential national infrastructure** KAREN is considered to be essential national infrastructure (Table 1). The following extract from a PricewaterhouseCoopers report prepared for REANNZ notes<sup>30</sup>:

*“In considering the meaning of “infrastructure” in the New Zealand context we note that Government policy papers give some guidance as to what defines infrastructure. A 2005 paper published by the Ministry of Economic Development outlines the distinguishing features of economic infrastructure. We have summarised these in the table below together with our assessment of whether KAREN qualifies as an infrastructure asset when measured against the MED’s guidance.”*

**Table 1:  
Characteristics on  
infrastructure**

<b>Feature of infrastructure</b>	<b>Explanation</b>	<b>Does KAREN qualify?</b>	<b>How does KAREN qualify?</b>
Significant economies of scale in production	High initial fixed costs but relatively low variable costs of operation	YES	Significant capital was required for the initial build and contract term for KAREN, however as usage increases operating costs remain relatively low.
Common carrier/supplier	Economies in supplying diverse consumers jointly	YES	KAREN services all of New Zealand’s advanced networking needs.
Natural monopoly	Barriers to entry, hard to compete with incumbent supplier	YES	It is only practical to have one advanced network in New Zealand.
High level of government intervention	Direct provision or regulation of prices and supply arrangements	Partially	To date, KAREN has required significant central government funding to ensure Members are not priced out of the service.

**The infrastructure nature of KAREN impacts the funding model and** The importance of identifying KAREN as infrastructure is critical to the identification of a viable funding model. As with road, rail and energy infrastructure the investment often exceeds the ability of any one party to directly fund. Moreover in many cases the link between benefits and costs is unclear or benefits flows to the nation rather than being directly appropriable by individuals or a small number of institutions. The recent CRI Taskforce report reflects similar issues within the broader research community:

<sup>30</sup> “The Benefits and Value Attributes of KAREN”, PriceWaterhouseCoopers, 2008 (DRAFT)

**specifically  
the need to  
aggregate  
funds – like  
funding for  
roads and rail**

*“Some assets may be too large for a single CRI to buy, may have a capacity that exceeds the needs of any single user, or may be a unique database or collection. In this situation, where economies of scale or scope exist, different funding arrangements are necessary. National research infrastructure may need joint planning and shared funding. It may be necessary to support the national status of the infrastructure by developing governance arrangements or providing direct central agency funding. Such arrangements might involve universities as well as CRIs. CRIs might gain the required capital through collaborative ventures or through equity injections from government.”<sup>31</sup>*

Recognising KAREN’s role as core infrastructure therefore impacts the way the Crown should consider supporting its ongoing role.

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<sup>31</sup> Report of the Crown Research Institute Taskforce, released 4 March 2010, p34 point 4.45

## Appendix 2: How the advanced network is benefitting New Zealand

### The strategic context for an advanced network?

<b>Section summary</b>	KAREN is a fundamental requirement for modern research and enables the science that will drive NZ's future economy. Furthermore, an advanced network like KAREN has the potential to increase the nation's soft power (the ability to obtain what one wants through co-option and attraction rather than the use of coercion and payment) via participation in global programmes. Lastly, KAREN is the platform that will enable the transformation of the education sector and is already providing adding value to education quality and outcomes
<b>KAREN is a fundamental requirement for modern research</b>	<p>Dr. Jim Gray of Microsoft talks of the four paradigms in science<sup>32</sup>. In ancient times, science was <i>empirical</i>: it was concerned with describing natural phenomena. In the last few hundred years, science developed <i>theory</i>: the ability to develop models and make generalisations. A few decades ago, science branched into <i>computation</i>: the simulation of complex phenomena in computers.</p> <p>Science has entered a fourth paradigm, that of <i>data exploration</i>, where theory, experiment and simulation combine. In this new paradigm, data is captured by sensors or generated by simulators, processed by software, stored in electronic form and then analysed by scientists or by other automated processes.</p> <p>The ability to move, access, process and analyse large quantities of data on a global scale is a fundamental requisite for modern science. An advanced network, like KAREN, is the most basic and common of infrastructures.</p>
<b>KAREN enables the science that will drive NZ's future economy</b>	<p>It has been long recognised that New Zealand needs to invest more heavily in science and Research and Development (R&amp;D) in order to stay abreast of other economies. For the purpose of this paper, staying abreast means maintaining a comparable level of wealth to allow New Zealanders to support the lifestyle they have come to enjoy and expect.</p> <p>This R&amp;D capability further needs to be available in a cost effective and accessible manner. Operating and cost efficiencies will allow New Zealand to undertake research that would otherwise be inaccessible. Moreover collaboration in R&amp;D would in many cases be stifled without KAREN.</p> <p>Example of R&amp;D that could not occur without KAREN include:</p> <p><b>Life changing medical research:</b> KAREN provides a means for New Zealand's researchers to access large scale research equipment not otherwise available in New Zealand. Access to such machines facilitates</p>

<sup>32</sup> Paradigm <http://research.microsoft.com/fourthparadigm> accessed April 2010

projects such as Associate Professor Vic Arcus' lifesaving tuberculosis (TB) treatment research. Through remote control of a Stanford University (California, USA) synchrotron, Associate Professor Arcus and his team use x-ray crystallography to examine the operation of a set of targeted TB proteins. Soon researchers will also be able to use KAREN to access the Australian synchrotron via KAREN's trans-Tasman link.

**Global virtual telescope:** KAREN links New Zealand and Australian radio telescopes with others around the globe to create a giant virtual radio telescope with a diameter of many thousands of kilometres. Researchers in New Zealand now access data on astronomical events almost instantaneously (rather than in months) and more effectively and actively participate in this research. New Zealand's school children also benefit from this research as schools become linked into KAREN. Children at KAREN-connected schools can observe visualisations of astronomical events, such as supernova explosions, galaxy outbursts and colour pictures of light dating back to 3-4 billion years before earth existed.

**Groundbreaking microbiological research:** KAREN connects New Zealand infectious disease researchers to PulseNet, a group of major international research laboratories. This link provides New Zealand researchers with opportunities to conduct their research in entirely new ways, for example, researchers could undertake laboratory and computer analysis via live, interactive video microscopy without concerns of disease containment issues and consult on findings across global sites. Key achievements already include:

- Establishment of PulseNet methodology for PFGE analysis of isolates of *Campylobacter* spp., *Salmonella* spp., Shiga-like toxin producing *E. coli* (STEC) and *Listeria* spp.
- Completion of certification with PulseNet USA
- The Institute of Environmental Science and Research's (ESR) work in establishing PulseNet Aotearoa New Zealand was recognised by the US Centers for Disease Control (CDC) with an International Recognition Award.

**Understanding 'Matter':** KAREN enables New Zealand researchers to engage in international research on 'matter' conducted through the Large Hadron Collider (located in Geneva) – a particle accelerator which collides protons to expose sub-units of matter. This allows New Zealand, along with Australia, to pursue status as a Tier-2 computer centre to import and store data. Access to this data will increase the speed of research by allowing researchers to carry out analyses within hours of it being recorded in Geneva.

**Lifesaving Earthquake engineering:** KAREN makes it possible for earthquake engineers at the Universities of Auckland and Canterbury to take an active role in earthquake simulation and research being conducted by the USA-based George E Brown Jr Network of Earthquake Engineering Simulation (NEES) (Figure 26).



Prior to KAREN, researchers could only observe NEES as they lacked the bandwidth to actively participate. They could watch international experiments, but only through one or two camera feeds. Now, KAREN gives the engineers in Auckland the ability to watch experiments through multiple views while communicating in real time with researchers conducting the experiments.

*“The big aim of earthquake engineering is to minimise costs due to earthquakes and to reduce the number of lives lost and injuries. If we can use this facility to help us with research in this area, it will help us to build better and safer buildings,” says Quincy Ma, Lecturer project leader.*

**Figure 26:**  
**KAREN’s use**  
**in tsunami**  
**prediction**

**“Over KAREN we can quickly collect the global information we need to predict how tsunami will strike NZ’s coastline”**



New Zealanders are better protected from catastrophic tsunami thanks to KAREN

**An advanced network has the potential to increase the nation’s soft power via global programmes**

An advanced network allows New Zealand to participate in global research and development programmes. In doing so New Zealand maintains and grows its respected status on the global stage and therefore ensures the ‘voice’ of New Zealand remains heard in important trans-global projects as explained by Minister of Research, Science and Technology Dr. Wayne Mapp;

*“Having KAREN gives us greater inclusion and collaboration in global research, education and innovation. In turn, this has potential spinoffs by bringing in new ideas and applying them to New Zealand’s challenges. KAREN also gives us access to new markets for our own ideas...”<sup>33</sup>*

<sup>33</sup> <http://www.beehive.govt.nz/speech/keynote+speech+canterbury+software+summit>], accessed 20/03/2010

This influence model has been described as soft power<sup>34</sup>.

Two examples of such programmes are the Square Kilometre Array and the Global Alliance on Agricultural Emissions.

1. The Square Kilometre Array will involve a group of 19 countries, likely including New Zealand and Australia, and countries in Europe, Asia, Africa and the Americas which links radio telescopes around the globe to create a giant virtual radio telescope. New Zealand's participation in this research gives it status in the international arena as an equal participant in a major global research program.
2. The Global Alliance on Agricultural Emissions is a work in progress to develop a worldwide virtual network for climate change research into agriculture and food production. The New Zealand government is playing a leading role in the progress of this "virtual" Alliance, and the operation of such an alliance will rely on KAREN capabilities. Given New Zealand's role as an agricultural producer and exporter, a leadership position in this Alliance is a powerful positioning for New Zealand on the global stage<sup>35</sup>.

Respected scientist and advisor to the New Zealand Prime Minister Professor Sir Peter Gluckman added to this in a recent speech on the evolution of science in New Zealand;

*"And the priorities list goes further; it sees the importance of international strategic partnerships. A few days ago the CEO of the Ministry of Foreign Affairs & Trade, John Allen, and myself co-chaired a meeting of leaders of ministries, agencies, universities and CRIs to consider how we can use science better to leverage New Zealand's position in the world we need to ensure our relevance to others and how to protect and develop our diplomatic and trade interests<sup>36</sup>."*

**KAREN is the platform that will enable the transformation of the education sector**

Education is also undergoing a transformation. Modern teachers are expected to be 'knowledge navigators' for their students rather than the source of all knowledge. Teaching resources and student output are increasingly digital and accessed and stored in the cloud.

The Minister of Education, Anne Tolley acknowledges the strategic importance of technology for the education sector. In a recent speech to an education conference, Minister Tolley stressed the need for New Zealand's education system to "fully commit" to the digital age. Furthermore in terms of education learning outcomes she went on to state:

<sup>34</sup> Nye defines soft power as, "... the ability to get what you want through attraction rather than through coercion.", <http://www.international.ucla.edu/article.asp?parentid=34734> accessed 26 April 2010

<sup>35</sup> <http://www.mfe.govt.nz/publications/climate/nz-fifth-national-communication/page13.html>, accessed 20/03/2010

<sup>36</sup> <http://www.pmcsa.org.nz/wp-content/uploads/2009/07/PDG-Lecture-at-Maidment-Theatre-26-November-20091.pdf> accessed 10 April 2010

*“We want people to stop thinking of technology as new or a bit of an ‘add-on’, but rather as a key tool to achieving learning success<sup>37</sup>.”*

Digital literacy is no longer a novelty. It is not new and untried. For the sake of our young people all schools must embrace e-learning. Students and educators must be connected to communities of learners and to parents and experts beyond the classroom.”<sup>38</sup>

**KAREN is already providing adding value to education quality and outcomes**

New Zealand educators are in the nascent stages of utilising KAREN connectivity creatively to improve education quality and outcomes. Some recent examples of this include:

**Improving teaching quality:**

- Intra-New Zealand: Linking specialised teachers such as native language teachers or specialised music teachers to students in small or remote community schools that would otherwise be unable to fund a teacher into such a position
- International: Linking piano students in Nova Scotia for real time tutorials to world class teachers at the Royal Conservatory of Music in Toronto. Such experiences would not be possible without the speed and resolution that KAREN provides

**Increasing course availability:** Schools, polytechnics and universities can utilise staff and resources better by providing courses to students at more than one campus or institutional location. One such example of this campus and course linking is the new joint Seafood Sector qualification from Canterbury and Otago Universities. All seminars utilise KAREN to enable students to interact with lecturers and classmates via videoconferencing facilities. University representatives state that it is akin to a “mega-campus using KAREN to give students at both Canterbury and Otago the change to participate...”

## Progress and current status with KAREN

**Section summary**

KAREN serves the vast majority of researchers and tertiary institutions, usage is strong and international links are congested.

**KAREN serves the vast majority of researchers and tertiary institutions**

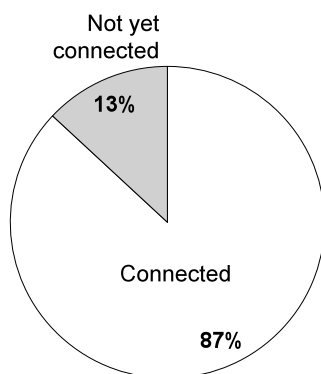
By the end of 2010, KAREN will be connected to almost 90% of New Zealand’s researchers and over three quarters of all tertiary students (Figure 27). KAREN membership also includes key content providers, such as the National Librar and Te Papa. And the National Education Network trial extension will connect another 200 schools. In the longer term, KAREN anticipates providing the national and international backbone network for all schools by 2015.

<sup>37</sup> <http://www.beehive.govt.nz/speech/ulearn+conference> accessed 10 April 2010

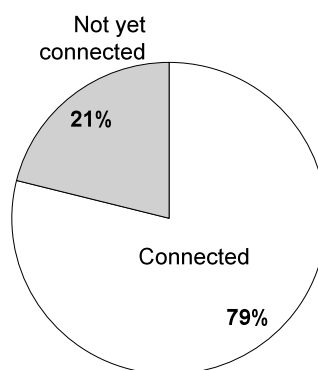
<sup>38</sup> “National Education Network is being extended and expanded” NZ Interface, [http://www.interfacemagazine.co.nz/articles.cfm?c\\_id=&id=301](http://www.interfacemagazine.co.nz/articles.cfm?c_id=&id=301)

**Figure 27:**  
**KAREN users**

**Researchers on KAREN**  
%



**Tertiary students on KAREN**  
EFTS



**Plus...**

- >200 schools
- National Library, Te Papa
- MoRST, TEC, MoE
- Royal Society, InternetNZ
- Content providers

Note: Forecast to December 2010

Source: KAREN 'Kiwi Advanced Research and Education Network'

**KAREN  
usage is  
strong and  
international  
links are  
congested**

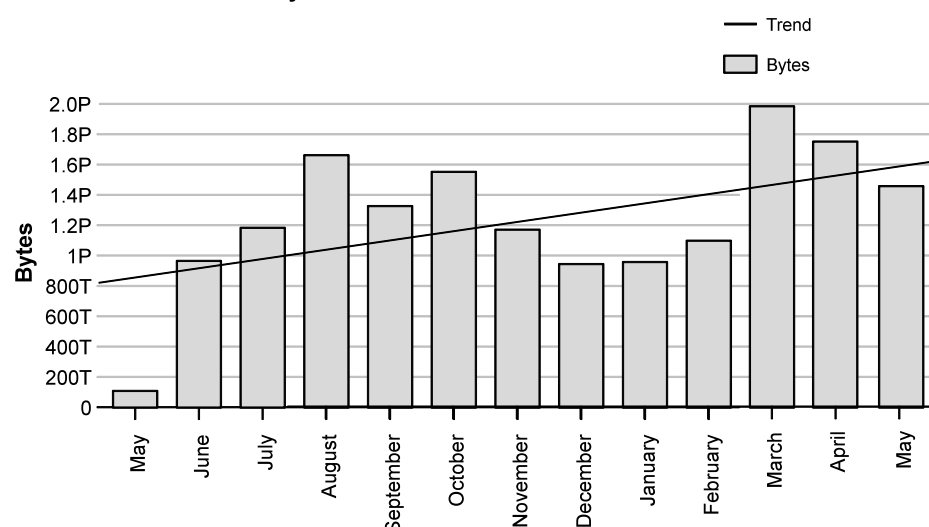
The latest traffic statistics (from February 2010) show that usage of KAREN is strong. The national network is seeing peaks of 600Mbps, or 6% of capacity (Figure 23). The international circuit to the USA is hitting 400Mb/s peaks, or 65% capacity (Figure 23).

Total network traffic over KAREN has increased to between 1 and 2 petabytes per month since go KAREN was first commissioned<sup>39</sup> (Figure 28: Network volume by monthFigure 28).

<sup>39</sup> Peak months are typically mid-year with lower utilisation over New Zealand summer months

**Figure 28:**  
**Network**  
**volume**  
**by**  
**month**

**Total network volume by month**



## What are the economic benefits of an advanced network?

### Section summary

Measuring the value of research infrastructure is difficult however independent research suggests that for every dollar spent on KAREN and KAREN related investment at least four dollars of benefits are created. KAREN does this by enabling efficiencies and cost-containment in R&E, increased research productivity and has the potential to contribute measurably to GDP growth. Lastly KAREN has stimulated telecommunications supply side innovation

### Measuring the value of research infrastructure is difficult but the qualitative understanding is clear

Like all infrastructure, value and the recipients of value are hard to estimate or measure directly. The fact that KAREN is a new infrastructure exacerbates that challenge.

A recent study by the Ministry of Research, Science and Technology did however outline a series of benefits of advanced research infrastructure to New Zealand<sup>40</sup>:

- Optimises utilisation of assets, by making sector collaboration a prerequisite for participation in government-provided infrastructure
- Increases productivity, effectiveness and/or scale of activities that use advanced facilities
- Enables shared access to international facilities through co-investment or agreements
- Improves retention and attraction of top class researchers, by creating an internationally connected, competitive and collaborative research environment
- Removes the uncertainty in relation to access to advanced research infrastructure

<sup>40</sup> "MoRST: Large Scale Research Infrastructure Investment", draft report, Ministry of Research, Science and Technology, February 2010

**Independent research suggests that for every \$1 spent on KAREN or members that use KAREN at least \$4 of benefits are created**

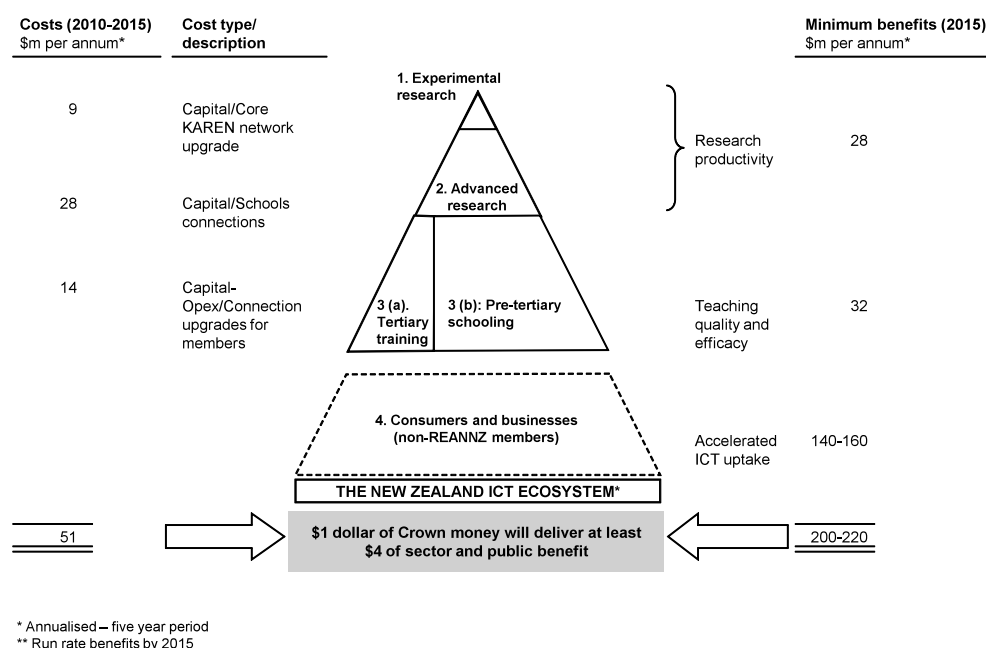
- Enables better value procurement, by coordinating buyer power

To facilitate Crown decision making, REANNZ commissioned Temple, a consultancy, to undertake an independent study to estimate the economic benefits that result from Crown investment in an advanced research network (KAREN) and the supporting organisation (REANNZ).

This study estimated that a Crown contribution of \$51m per annum [KAREN (\$9m), connecting schools so they could use KAREN (\$28m) and some member spend (\$14m)] over the period 2010 – 2015 would deliver minimum benefits of ~\$200M per annum by 2015 i.e. one dollar of Crown contribution provides a minimum of four dollars of ongoing national economic benefits that would not be delivered by the market (Figure 29). The main benefits groups identified and estimated were<sup>41</sup>:

- Experimental and advanced researchers: Ongoing benefits to research organisations through increased research productivity: \$28million / annum
- Teaching and training: A step change in benefits to schools through increased teaching productivity and quality in high schools: \$32 million / annum
- Consumers and business: Ongoing non-member, non-monetisable community benefits (measured as growth in GDP over a non-KAREN scenario): \$140-160 million per annum

**Figure 29:  
Summary of  
KAREN  
economic  
benefits to  
New Zealand**



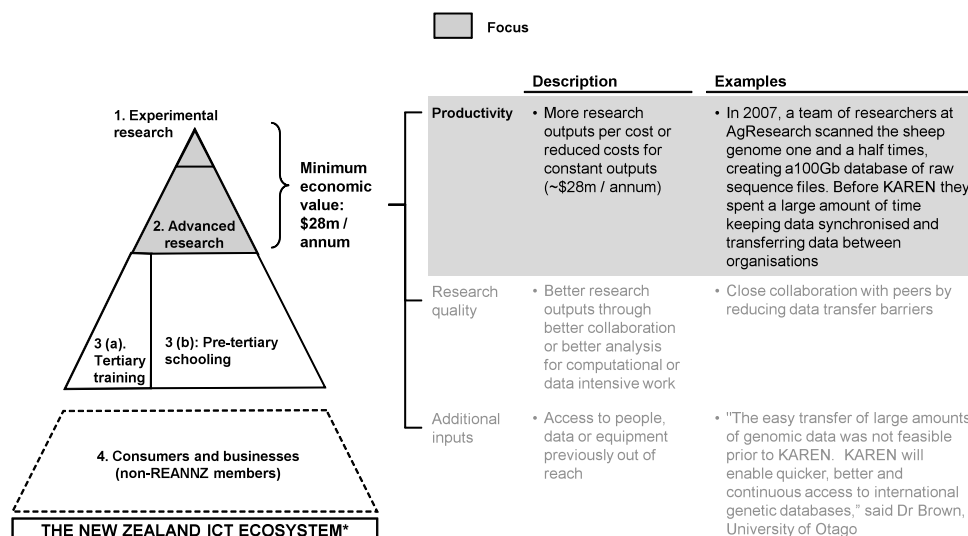
**KAREN improves research productivity**

Significantly, KAREN impacts positively on research productivity in experimental and advanced research. A detailed four year study in the United States showed a strong positive causal relationship between access to high speed connectivity and the outputs of researchers (Figure 30). This

<sup>41</sup> <http://www.reannz.co.nz/assets/Uploads/Publications/REANNZ-Economic-Value-Report-Full.pdf>

research was independently corroborated during the research into the economic value of KAREN.

**Figure 30:**  
**KAREN**  
**research**  
**benefits**  
**summary**



**KAREN**  
**enables**  
**efficiencies**  
**and cost-**  
**containment**  
**in R&E**

This research also identified benefits to education in areas such as reduced fragmentation of sub-scale classes and increases in access to quality teachers (Figure 31, Figure 32).

Additional benefits that were not quantified but are likely significant include the ability to nationally source centralised infrastructure and national connectivity versus a fragmented school-by-school approach.

Selected benefits from this research are included below (Figure 31 and Figure 32)<sup>42</sup>.

In an independent report submitted to Minister Joyce, REANNZ noted that committing to long-term, ie 5-10 year contracts for school local access connectivity will result in 30-45% discounts on standard rates. It also stated that the ability to purchase long-term demand contracts will accelerate the deployed footprint of fibre through the government's supply-side investment programmes due to decreased business risk and revenue incentives for investors.

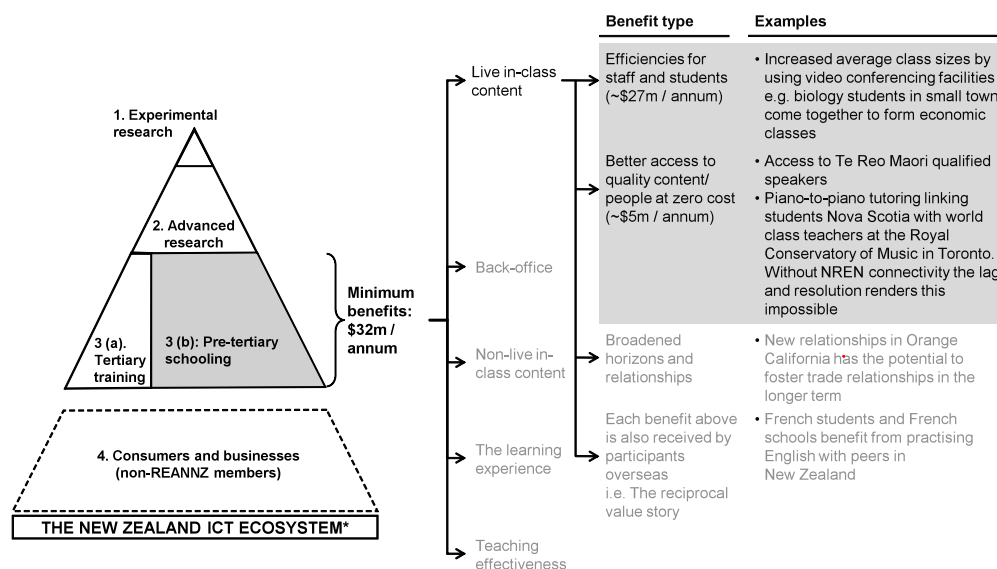
REANNZ provides the only existing way for the Crown to achieve these demand-side benefits.

Furthermore moves to concentrate high cost research infrastructure into fewer locations across New Zealand will be enabled by KAREN, for example in the case of High Performance Computing. Without KAREN the efficient concentration of high cost items research equipment into fewer

<sup>42</sup> "Benefits of long-term purchasing for schools connectivity", REANNZ to Hon Joyce, 26 March 2010.

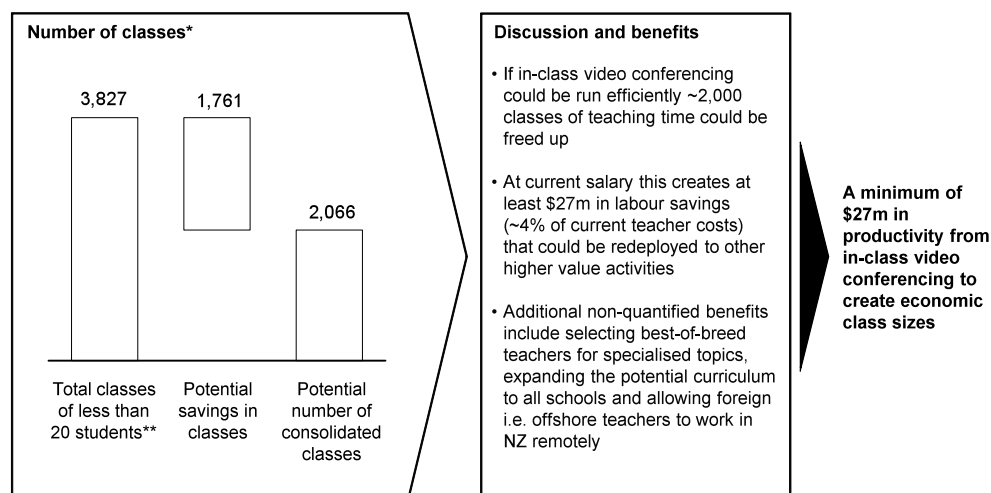
**Figure 31:**  
**KAREN pre-tertiary schooling benefits summary**

locations with shared use would not be possible.



\* Greyed text is not quantified in this study

**Figure 32:**  
**Virtual aggregation of classes using KAREN**



Source: Ministry of Education

\* Assumes a subject with less than 20 people can be taught by one person today, average salary \$65,000, 5 subjects per teacher, teacher cost is salary x 1.2

\*\* 20 students is considered to be a minimum economic class size

**Research shows that advanced networks contribute measurably to GDP growth**

**ICT drives GDP growth:** Eight studies examined suggest increased broadband uptake could grow GDP by 0.1-1.3% CAGR per annum

**Accelerated ICT uptake further drives GDP:** Even a one year acceleration on a ten year timeline can bring an additional 0.01% CAGR to GDP under conservative scenarios

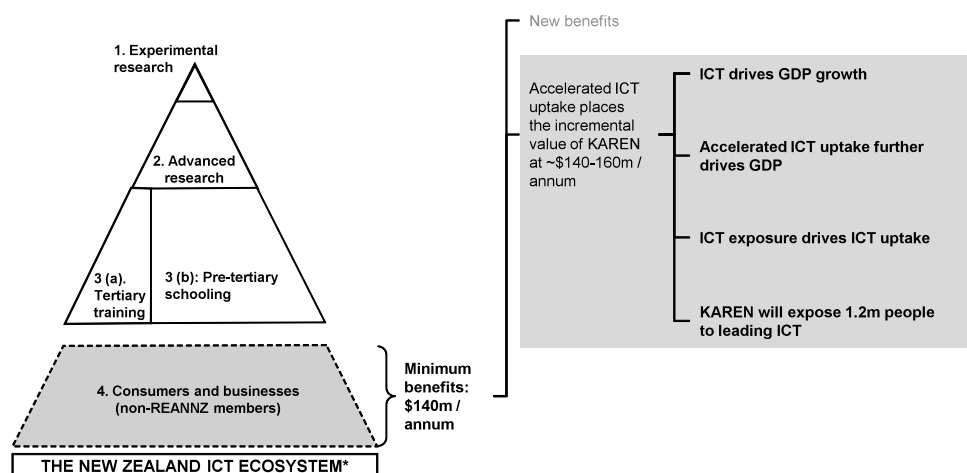
**ICT exposure drives ICT uptake:** Exposure to leading edge ICT has been shown to accelerate demand (adoption or use) and supply of consumer-available ICT. Over the last two decades the presence of an advanced



network has coincided with accelerated uptake of ICT by universities and consumers

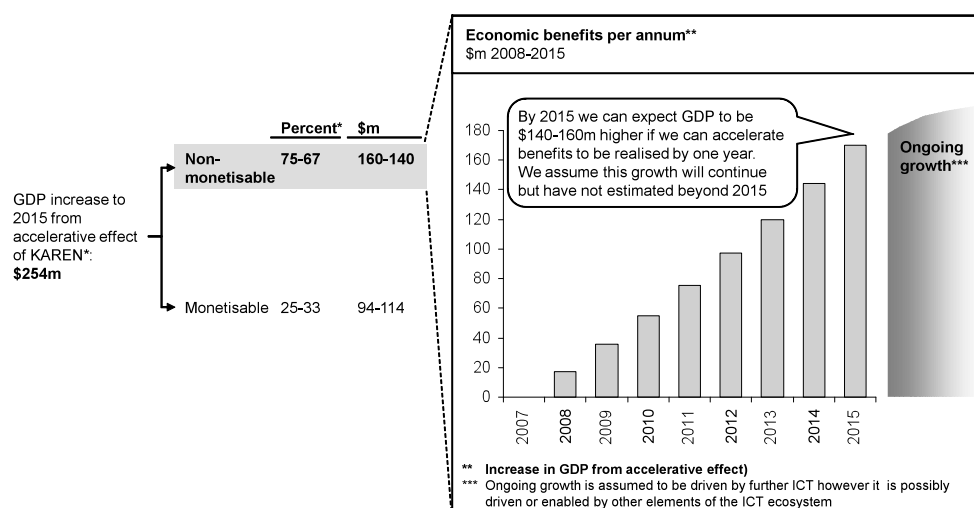
**KAREN will expose 1.2 million people to leading ICT:** KAREN is a leading edge element in the ICT ecosystem. Soon KAREN will directly 'touch' 1.2 million students and researchers and hence drive accelerated ICT uptake (Figure 33 and Figure 34).

**Figure 33:**  
**Benefits to**  
**New Zealand**  
**from KAREN**  
**(description)**



\* Greyed text is not quantified in this study

**Figure 34:**  
**Benefits to**  
**New Zealand**  
**from KAREN**  
**(estimate of value)**



\* Based on a one year acceleration of a ten year timeline, 0.1% GDP growth in addition to historical growth. An examination of underlying value drivers suggest a large proportion of the benefits are not monetisable e.g. time saved traveling to work may not be captured by the employer, health benefits cannot be captured due to funding disconnects. We have used New Zealand Institute estimates to guide this assumption. We have further assumed that there are no KAREN GDP benefits in 2007, that growth is realised by 2015 and growth is linear

**KAREN has  
stimulated  
telco supply  
side  
innovation**

REANNZ has had a positive impact on the competitiveness of broadband supply.

- In the initial procurement of KAREN, the investment enabled TelstraClear to lay new fibre to five towns, bringing them competitive broadband for the first time.
- REANNZ is procuring anchor tenancies at regional neutral internet exchanges to support these critical brokers of open access networking
- All KAREN's architecture and commercial policies have enforced open access principles since day one.
- We have released under Creative Commons license detailed technical standards for neutral co-location / internet exchange facilities.
- Our preferred standard for connection for members (including schools) is dark fibre, thus stimulating demand for this product

KAREN's need to be at the front end of the technology curve creates a slipstream for suppliers to enhance their capabilities and capacity for the nation.