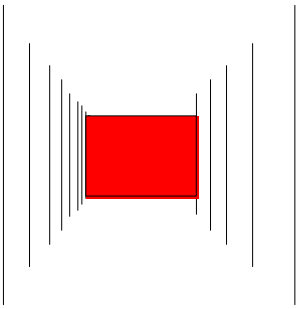

Centre for Building Performance Research

Beacon New Build Technologies

NEW1 NEW TECHNOLOGY IMPACTS

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TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

1.1 Project Brief

The deliverables from this project were to provide answers to the following questions in relation to the application of new technologies in new and existing New Zealand houses:

1. *Do all the technologies exist that are needed for 2012, and*
2. *If not, where do we source information about ways to fill the gaps, and*
3. *What barriers exist to uptake of the technologies, and how do we remove them, and*
4. *How do we assess the likely impact of yet to be identified technologies in terms of their contribution to achieving the Beacon goals?*

1.2 Context

To be meaningful these questions had to be answered in a particular sustainability context. The standard agreed was that contained in the NOW house brief. The answers were addressed under four separate subject headings: Energy, Health, Materials and Water

Preliminary answers to the questions were prepared by the project team under each of the topic headings and three NZ experts and one international expert were consulted and their comments used to inform, moderate and validate the team's report. Not all who agreed responded, but sufficient responses were gathered to obtain a reasonable and reasoned critique of the original draft.

1.3 General issues

A series of general issues are seen to affect all facets of this project.

1 Short time horizon/ high uptake.

- Seen as the most challenging and constraining aspect of the brief.
- Unlikely that new technologies could be invented, developed and deployed in the timescale.
- Need to rely on better use of existing technologies.
- Danger of unintended consequences.

2 Appropriate Technologies for New and Existing houses.

- Different technologies required for new and existing houses
- Much harder and expensive to achieve NOW house standards in existing houses.
- Greatest benefit possible from application of new technologies in existing houses

3 Replacing Inappropriate Technologies

- Some currently deployed technologies are counterproductive to achieving Beacon objectives.
- Some sustainability related technologies demonstrate premature failure characteristics or inadequate performance and create antipathy in consumers to further investment in this area.

4 Limitations of NOW House Brief Content

- The NOW house brief often focuses on a narrow field of requirements within a particular topic and subtopic area.
- The report defines the wider context and seeks to address related sustainability issues when possible.
- Outcomes like Health are an integral part of sustainability, that are largely ignored by our use of the NOW house brief as a definition of sustainability.

5 Interdependence

- Technologies should be selected which generate synergies between each other.
- Breakthroughs might be due to simplification, improved performance or affordability rather than hi-technology.
- Consideration should be given as to how the employed technologies will have benefits across several performance areas.
- Cost is a fundamental barrier/constraint to take-up.
- Consideration must be given to clusters of technologies, as many technologies depend on other technologies being in place for their effectiveness.

6 Interactions of People and Technologies

- It is necessary to distinguish between technologies that work passively and those that require active participation and control by people to be effective as the later will only work effectively if users are committed, knowledgeable and have override control.
- Design integration and installation quality are often as important as the technology itself in achieving the desired performance.

1.4 Questions

Do all the technologies exist that are needed for 2012?

The simplistic answer is no. However the full answer is much more complex and in many cases is different depending on whether we are dealing with new or existing houses and particular topic or even sub-topic areas. There appears to be more need for new technologies related to the affordable upgrading of existing building than those needed for new houses. In general terms however much of the technology required is available. There remain issues of affordability, assured performance, and a number of other issues that relate to take-up.

If not where do we source information about ways to fill the gaps?

The most effective source of online information was an electronic journal search database called Scopus. This has only just come on-line in a prototype form. The annual Greenbuild conference combines leading edge research presentations and the world's largest trade show of green (sustainable) materials and products. This would be a good source of information about ways to fill the gaps. New Zealand does not at present exploit its membership of the two International Energy Agency research Agreements focused on bringing together builders, manufacturers and researchers from 20 IEA countries to share expertise and develop leading edge building focused R&D in sustainability.

What barriers exist to the uptake of the technologies, and how do we remove them?

The main barrier identified was lack of an independent source of information to which consumers or designers might go in order to discover what technologies might suit their house; what the likely performance of that technology might be; or tools to determine whether the technology has been installed correctly.

How do we assess the likely impact of yet to be identified technologies in terms of their contribution to achieving the Beacon goals?

One of the BRANZ HEEP project goals is to develop a tool which would allow the impact of a particular energy related technology into New Zealand to be assessed in terms of its impact on NZ. This tool is about 12 months away. NZ is thought to be ahead of the rest of the world in this respect. This tool would not be suitable in its current form to make assessments beyond the energy sector. However it might be used as the basis for developing a tool which would address the Beacon objective.

Until such a tool is developed, assessment by informed expert opinion is probably the least unsatisfactory way of carrying out such a task. The expert opinion might be informed by any

technical reports and overseas user evidence if this was available and/or by requiring the manufacturer to undertake testing to validate performance claims.

1.5 Detailed Energy, Health, Materials and Water issues

The analysis of the NOW House brief produced the following list of topic areas:
The following summary lists the Sustainability Standard Target Issues identified using the NOW Home brief. They are organized into the four topic areas used in this report:

ENERGY	**HEALTH**
Weathertightness Reduction of heat loss Passive solar design Means of heating Natural lighting Technical innovation in solar technology Water heating Life cycle analysis Appliances and Energy use	External noise Internal noise Air quality (and energy efficiency) Low toxicity materials Separation of health affecting pollutants from people Limiting potential harm from EMF's Warm shade provision Hygiene Loose fit technology to fit lifestyle
WATER	**MATERIALS**
Conservation – low flow shower heads Conservation – rainwater collection and re-use	Sustainable materials Re-use and recycling Waste reduction Efficient use of structural materials

Several of the reviewers noted that this sustainability definition was limited. As well as the obvious greater number of items listed under Energy and Health compared with Materials and Water, there is a clear mix of focus – sometimes on individual technologies (low flow showerheads) – sometimes on principles (re-use and recycling). A sustainability goal is a definition of a series of outcomes not a list of technologies.

Energy

Most of the energy related technologies discovered in the internet searches had a generation rather than efficiency focus. The most important technology need is for improved insulation and air sealing materials for cost effective retrofit of existing buildings. Double glazing technology needs to be improved so that double glazing units last the lifetime of the building. There is also a need to develop a healthy, efficient, controllable heating system that fits the needs of a well insulated New Zealand home. Current systems all have significant drawbacks.

Specific examples of technologies not yet **A**vailable in New Zealand, or **N**ot yet developed are:

- (A) Coatings that cool by absorbing moisture when exposed to sun
- (N) Thin, cost effective retrofit insulation & Durable, cost effective improved glazing systems
- (N) Small (portable?) low tech thermostat controlled heating systems

In energy, the major barrier to uptake of existing technology is lack of understanding of the implications of decisions made by designer or owner on the comfort or energy performance of a home. The greatest need therefore is for better information systems to overcome these.

Health

The technology opportunity is to solve the major health problem in New Zealand houses is that they are seriously under-heated. The degree of the health effects associated with this under-heating is still being investigated.

The impact of urban intensification on health is likely to require the introduction of more sophisticated technologies many of which are available internationally. These solutions must be holistic; they cannot focus merely on a single issue. For example, the sealing of a building against noise requires careful design not to exacerbate already problematic air quality.

Specific examples of technologies not yet **A**vailable in New Zealand, or **N**ot yet developed are:

- (A) Construction practices that emphasise and encourage flushing of VOCs etc during and immediately after construction or retrofit
- (A) Catalytic coatings for removal of some VOCs from indoor air
- (N) Tools for selecting healthy technologies and practices

As with energy, the greatest barrier to uptake of healthy building practice is a general understanding of the issues and of the impact of design or operation decisions on the quality of life of the people in a house.

Water

The NOW house brief primarily focuses on aspects of the conservation issue and is very sparse. There are four main aspects when dealing with water from a sustainability viewpoint: Water conservation; Stormwater detention; Water Quality; On-site water treatment. All of these factors can be dealt with by the intelligent employment of existing technologies.

The greatest barrier to sustainable water management is that water is generally not valued as a scarce commodity by most participants in the building industry. It is still very difficult to overcome the innate conservatism of the installers and regulatory authorities, to the deployment of a new technology or new design approach to water conservation, especially in reticulated water zones. Many technologies exist for water recycling, water conservation in use and site water management, but few are used.

There are many other well tested technologies available. Specific examples of technologies not yet **A**vailable in New Zealand, or **N**ot yet developed are:

- (A) Colour coded PEX water piping systems to ensure separation of potable from other water in the house and make retrofit of waste water recycling simpler, plus remove copper contamination
- (A) Hot water return loop supply plumbing properly designed has the potential to save huge quantities of water
- (N)Low pressure, water efficient appliances and fittings

Materials

The biggest challenge we face in terms of materials is to make our buildings resource neutral. The NOW house brief has requirements relating to all four major areas of material sustainability: use of sustainable and healthy materials, use of pre-used, recycled or waste sourced materials, waste reduction; efficient use of materials. Greener materials are available and these are gradually becoming more affordable, available and able to match the performance of less sustainable materials. It is a rapidly moving area with many new materials being marketed every year.

The greatest barrier in this sector is the lack of trustworthy information and advice on the sustainability and health associated attributes and performance of materials and products in the marketplace. This applies to both specifiers and clients. A similar lack of reliable information also applies to resource recovery, waste reduction and the efficient use of materials. This lack of

certainty is allied with the natural conservatism of the home buyer and the reticence of building professionals when employing unproven technologies or techniques.

Specific examples of technologies not yet **A**vailable in New Zealand, or **N**ot yet developed are:

- (N) Design for deconstruction and waste reduction
- Use of natural healthy materials and products e.g. (N) high strength natural adhesives
- Use of non-traditional renewable materials in construction e.g. (A) flax insulation
- Use of recycled or waste sourced materials in construction e.g. (A) maize residue based plastics; (A) wood residue or recycled wood insulation and engineered composites; (N) recycled crushed concrete aggregate
- Use of innovative materials e.g. (N) fibre reinforced geo polymers; (A) phase change materials; (A) plastic composite nails

2 RECOMMENDATIONS

2.1 General

1. **Develop an information resource where consumers and designers, investors and even product importers and developers can find reliable information on the available technologies and their likely impact on sustainability outcomes.**
2. **Develop an assessment tool to assess the sustainability of new and existing houses across all sectors, to predict the improvement brought about by specific interventions and to measure the actual improvement.**

2.2 Energy

3. Develop tools to demonstrate compliance – for calculating energy use or comfort and then for balancing energy against comfort against enjoyment.
4. Develop a super-insulation wall product and IGU's with greater than 20 year lifetimes that can be retrofitted to existing houses (could be retrofit systems for existing products)
5. Develop a small cost effective distributed heating system suited to New Zealand houses and small heating loads without the negative health effects associated with some existing technologies.

2.3 Health

6. Develop a range of information systems and advice to help combat coldness in New Zealand homes – a higher priority than energy efficiency.
7. Develop one trusted source of information on the impacts of building materials, behaviours and technologies on air quality and other aspects of people's health.

2.4 Water

8. Install water meters and charge for water consumed. This is seen as a prime prerequisite to water conservation.
9. Encourage and support the setting of stringent maximum water use code limits for all water using appliances, fittings and fixtures sold in NZ.
10. Develop an information and advice programme on water efficiency and conservation.
11. Encourage and support the development of ranges of water saving fittings and appliances for use with low pressure water reticulation systems.

2.5 Materials

12. Make it easy for people to identify and access greener building materials:
13. **Beacon to fund the completion, dissemination and maintenance of VUW's NZIA Life Cycle Environmental Impact Charts, Greener Building Directory and Greener Materials and Products Reference Collection.**
14. Develop and disseminate an information pack on the merits, and benefits of waste reduction to those who commission, design and build buildings. Develop guidelines for ways to achieve this objective.
15. Commission research into ways to use existing materials more efficiently and support the development of materials, technologies and techniques that would enable greater material efficiency to be achieved.
16. Work with others to produce reliable and trusted labeling/certification schemes for greener, pre-used and recycled materials.

3 THE NEXT STEPS

1. **Develop a trusted information source on sustainable materials and products**, possibly by funding the completion and maintenance of VUW's set of three information tools:
   NZIA Environmental Impact Charts
   Greener Building Directory
   Greener Building Reference Collection

2. **Develop a sustainability assessment tool for both existing and new houses,**
   possibly based on the BRANZ **HEEP** assessment, informed by the Canadian **Energuide** assessment tool and widened in scope to include other sustainability elements in addition to energy.

3. **Fund and organize a small expert team** with a watching brief to discover, identify, assess and report on new technologies as they appear.

4. **Assess the validity of other recommendations and take-up those that fit the master strategy.**

4 INTRODUCTION

4.1 Project Team

Project Team: Michael Donn and John Storey (Centre for Building Performance Research, Victoria University)

4.2 Project Brief

The purpose of this project is to critically assess the likelihood that new technologies can be developed that will have an impact on the achievement of the Beacon strategic goal that 90%+ of the housing stock, both new and existing, will meet a sustainability standard by 2012.

The deliverables from this project were to provide a **high level overview** of the answers to the following questions in relation to the application of new technologies in new and existing New Zealand houses:

5. *Do all the technologies exist that are needed for 2012, and*
6. *If not, where do we source information about ways to fill the gaps, and*
7. *What barriers exist to uptake of the technologies, and how do we remove them, and*
8. *How do we assess the likely impact of yet to be identified technologies in terms of their contribution to achieving the Beacon goals?*

4.3 Methodology

To be meaningful, the Project Brief questions had to be answered in a particular sustainability context. The standard agreed was that contained in the NOW house brief. The project team extracted those issues from the NOW house brief connected with technology and these formed the basis of the research. In order to manage the information in this process the answers were addressed under four separate subject headings: Energy, Health, Materials and Water, which correspond with the sustainable development provision categorisation in the Building Act 2004.

The definition of technologies was agreed with Beacon to include techniques to facilitate the effective and efficient incorporation of technology into buildings by 2012.

Preliminary answers to the questions were prepared by the project team under each of the topic headings and three NZ experts and one international expert were asked to critique the project team statements. The comments of those who responded were used to inform, moderate and validate this report.

Local Experts

ENERGY	**HEALTH**
Molly Melhuish – independent consultant *Albrecht Stoecklein - BRANZ* *Dr. Gerry Carrington – Otago Uni*	*Dr Robyn Phipps – Massey Uni* *Dr Philippa Howden-Chapman – Med School* *Reinhard Kanuka-Fuchs – Independent consultant*
WATER	**MATERIALS**
Dr. Michelle Kaczor - URS	*Dr Louw van Wyk – Forest Research* *Roman Jacques – BRANZ* *Dr. Robert Vale – Landcare*

International Experts.

ENERGY	**HEALTH**
Prof. Ray Cole	*Prof. Ray Cole -*

WATER	MATERIALS
Bill Wilson – Cal Poly Pomona	*Prof Tom Woolley Dublin University*

The critique comments and suggestions of the experts were incorporated into the report.

4.4 General Issues

A number of general issues were identified as affecting all facets of this project.

1 Short time horizon/ high uptake.

There are a number of issues that arise as a result of focusing first on such a short time horizon as 2012, and second on setting the uptake standard at 90%+ of ALL houses in New Zealand.

- Seen as the most challenging and constraining aspect of the brief.
  Two contrasting experts' views illustrate this: *"… for BEACON to achieve its targets, which are totally unrealistic in my view, the minor changes in materials used in domestic construction will have no impact".* However another suggested that she would not have been interested if the question was not focused by this short time frame and high uptake onto *"what we can do NOW"*

- Unlikely that new technologies could be invented, developed and deployed in the timescale.
  The general consensus was that, *"The lead times for development, manufacturing capability and market take up of new technology would seem to eliminate these possibilities and thereby place the emphasis on readily available and accessible existing technologies."*

- Need to achieve better use of existing technologies.
  It is clear that "*... major gains can be achieved by making better use of existing materials and designing houses that capture and retain solar gains."*

- Immediate and deferred benefits.
  One expert noted that, *"It is important to distinguish between technologies and strategies that offer benefits from the outset, as distinct from those where the benefits are deferred and as such can only be seen as potential."*

- Danger of unintended consequences.
  When action is time constrained there is the danger of unintended consequences. If for instance we succeeded in convincing New Zealanders that to be comfortable was to be healthy, this could conceivably treble the space heating energy used in New Zealand houses and we would need several new power stations to meet the increased demand. Several experts commented that it would be impossible, within this project's timeframe, to systematically examine how social, cultural and economic barriers to such rapid uptake might be addressed. Similarly, the likely success of regulations that would take the question of implementation out of the realm of personal or national economics, by making some targets compulsory, was also a subject for significant comment.

2 Appropriate Technologies for New and Existing houses.

- Different technologies required for new and existing houses.
  For example, the NOW home brief requires much higher levels of insulation in walls than is currently the norm. The NOW home goal of R3.4 requires thicker walls. In new

construction new technology is not needed, 200mm studs, though rare, are hardly 'new'. In existing buildings however these R values are impossible to achieve with conventional technology. The new technology need here is for affordable, easily retrofitted, thin retrofit insulation, which does currently exist.

- Much harder and expensive to achieve NOW house standards in existing houses.
  It is relatively easy to introduce appropriate new technology into new buildings. Often this can be done in a way where the overall cost of the building is little different from conventional houses. Having to add technology into existing houses almost always carries direct cost and often the double cost of removal as well as addition. The exception would be where there is a need for end of life replacement. To replace items before they are worn out is a counterproductive strategy in terms of improving sustainability.

- Greatest benefit possible from application of new technologies in existing houses.
  There are many more existing buildings than new buildings and their sustainability performance is in most respects significantly inferior to that of new buildings. Existing houses have different needs to new houses which often cannot be easily met by technologies and techniques developed for new buildings. The existing house market is also somewhat a neglected market compared with the new house market. Therefore, both the greatest need and the greatest potential for the evolution and deployment of new technologies and techniques lie in the existing house sector.

3 Replacing Inappropriate Technologies

- Some currently deployed technologies are counterproductive to achieving Beacon objectives.
  "The emphasis is largely on adding new technologies. Perhaps a different starting point could be a review of existing technologies and practices to eliminate the most unhealthy, inefficient etc."
  A significant number of products come within this descriptor:
  Flueless, mobile, gas heaters
  Toxic timber preservative treatments
  Solvent based glues, paints and other materials
  Formaldehyde based products
  Etc.

  It is unlikely that the owners of the over 200,000 LPG portable gas heaters in New Zealand homes follow the small print instructions on the back of these appliances and leave windows open during strong, cold, storms to protect their health from gas fumes. The motivations for selecting LPG heaters over less polluting, less expensive options need to be understood in order to develop sustainable heating appliances. Finding appropriate, healthy alternatives, that match the heating need, requires the replacement of the existing technology.

- Some sustainability related technologies demonstrate premature failure characteristics or inadequate performance and create antipathy in consumers to further investment in sustainable technologies
  At present, glass in single sheets is installed for what most people expect is the lifetime of a building. In New Zealand double glazing has a nominal lifetime of only 20 years and some units require replacement well within this nominal period.

4 Limitations of NOW House Brief as a Sustainability Standard

- The NOW house brief often focuses on a narrow field of requirements within a particular topic and subtopic area.
  Several of the reviewers noted that the sustainability definition resulting from the use of the technologically related aspects of the NOW house brief was constraining, and there was a clear mix of focus in the brief issues defined, some of which were described in the widest terms while others were extremely prescribed.

- The report defines the wider context and addresses related sustainability issues when necessary.
  In order to cover the topic and enable it to answer the questions asked with a higher level of certainty and authority the project team allowed itself some latitude and went beyond the NOW house brief when it was felt necessary. It was noted that any tools for assessment of the role of technology in sustainability must include measures of impact on social and cultural sustainability and personal well-being.

5 Interdependences

- *Synergies*
  "A high performance house will be recognised as much by the interaction/synergies between technologies as it will be by the efficiency/effectiveness of the individual technologies themselves"

- *Breakthrough technologies*
  Breakthrough technologies do not necessarily mean increasingly hi-tech solutions. The breakthrough might be in the realm of simplification, affordability, availability, increased certainty or improved performance. It might be that relatively modest incremental improvements, made to a particular product, change the attitudes of buyers and tip the balance from rejection to enthusiastic acceptance. Double glazing that lasts 50+ years or could be easily repaired would perhaps fit this category.

- *Multiple Benefits*
  "Whereas technologies may be initially conceived in support of a single performance area, perhaps a more useful way of thinking might be to examine how technologies can offer multiple benefits across several performance areas."
  "Some technologies may in and of themselves seem significant; however their thoughtful deployment may trigger or enable improved performance in other areas."

- *Cost*
  While the project team was not asked to explicitly consider cost, it is one of the fundamental barriers/constraints to the take up of new technologies and must not be forgotten.
  "The cost issues needs to be explicit in the review framework since it will play out in a whole variety of ways (e.g. cost of imported technologies: cost versus performance of the various technologies individually and collectively: the possibility of ... bundling linked technologies ... as a means of reducing the overall payback of the group etc."

- *Linkages*
  "The performance goals of some technologies are invariably linked to other technologies being in place, e.g., the use of air-air heat exchangers independent on tight construction. As such it is important to identify clusters of technologies/strategies rather than see them in isolation."

6 The interaction of People and Technology

- *Acceptance*

  "It seems absolutely essential to make a clear distinction between those technologies that impact on or involve users for their success and those that do not. Improved insulation... for example, if correctly installed generally perform(s) silently and effectively from the outset. By contrast technologies that must be switched on/off or operated in specific ways to ensure their effective performance can only be considered as offering potential benefits..."

  The level of interaction between occupants and technologies is very important in terms of their actual use. Evidence suggests that people will use technologies only if they are helpful and not constraining, difficult to understand and use or intrusive. Manual override features are essential; otherwise the technology may be permanently disabled.

  Knowledge, understanding and commitment to the objectives of the technological features is essential. *"Some performance areas (such as indoor environmental quality) are linked as much to occupancy as they are to building design and construction. For example, studies have indicated that houses designed to high indoor air quality standards do not demonstrate high IAQ after occupation, due to the introduction of polluting furnishings and cleaning products."*

  "Technologies must clearly be assessed in terms of user acceptance and their performance over time. This will influence a number of factors ..., e.g. how and when is the performance to be assessed."

- *Designers and builders*

  "It is not always the technologies that are important; the way that they are integrated with the overall design and the competence with which they are installed affects overall cost and overall performance"

5 DELIVERABLES

5.1 Do all the technologies exist that are needed for 2012?

The simplistic answer is no. However the full answer is much more complex and in many cases is different depending on whether we are dealing with new or existing houses and particular topic or even sub-topic areas. There appears to be more need for new technologies related to the affordable upgrading of existing buildings, than those needed for new houses. In general terms however, much of the technology required is available. There remain issues of affordability, assured performance, and a number of other issues that relate to take-up. More detailed information on the technology and techniques that are available and needed is given in the sections of the report which deal with the four sectors investigated and the data sheets that deal with the NOW brief issues.

Even if there are technologies and techniques currently available to facilitate the accomplishment of the Beacon target, in many areas, new or improved technologies are constantly emerging. Any of these could result in breakthroughs as far as meeting the Beacon target is concerned. It is therefore vital that Beacon maintains an awareness of these new developments.

There is at least one major American initiative aimed at developing new sustainability related technologies. Information on the products that they are working on is difficult to come by, as it is quite commercially sensitive even at this very general level. There is a huge amount of interest worldwide in sustainability and this is growing every year and it is likely that many other programmes of research and product development are in place in several parts of the world. If Beacon wishes to initiate product invention and development then it is suggested that it should aim to find out as much as possible about these existing programmes and decide on that basis whether to try to join these groups or initiate its own programmes.

It is possible, from the information set down in this report, to identify several new products and techniques that are needed to expedite the realisation of the Beacon goals and which do not appear to be available. However, the cost, timescale and the lack of certainty that surrounds the development of any new technology or product makes it doubtful that they could significantly affect the Beacon outcomes by 2012. It would probably be more feasible for Beacon to identify and participate or invest in suitable, existing product development programmes. Alternatively Beacon could perhaps identify gaps in the market and develop responses to simple problems before 2012, even if they were only brought to market after this date. Complex problems requiring extensive research may well be beyond Beacon's capacity unless suitable, possibly international, partners were found and Beacon was able to cope with the extended timelines involved.

5.2 If not where do we source information about ways to fill the gaps?

What we learnt from a systematic questioning of experts is that even they have no simple listing of technologies that exist internationally and might be used here, or of technologies that they have identified or are needed. A whole series of websites were examined as possible sources of information to fill the identified gaps. All proved to be disappointing. Even the experts in particular fields had to concede that comprehensive sources of information on new technologies simply do not exist.

The most effective source of online information was found to be an electronic journal search database called **Scopus**. This has only just come on-line in a prototype form but enabled us to scan many more journals in a short timeframe for relevant information. The annual US **Greenbuild** conference combines leading edge research presentations and the world's largest trade show of green (sustainable) materials and products. Attendance at this event would be a good source of information about new and emerging technologies.

New Zealand does not at present fully exploit its membership of the two **International Energy Agency** research agreements[1] focused on bringing together builders, manufacturers and researchers from 20 IEA countries to share expertise and develop leading edge, building focused R&D in sustainability. Typically these IEA Research Agreements form teams of 20 to 50 experts from laboratories around the OECD focused on a particular topic. Participant countries leverage a small investment in one or two person research teams into a major return in learning and innovation. Both VUW and BRANZ are members and participate in some of the IEA programmes.

The electronic spreadsheet provided with this report was compiled as background to this project and to inform the answer to this question. It contains reference material identifying a list of technologies that might be worthy of continuing study. It may be a suitable starting point for Beacon to create a systematic listing of available technologies and ideas that might eventually become technologies or techniques.

5.3 What barriers exist to the uptake of the technologies, and how do we remove them?
The main barrier identified was lack of **independent, creditable, helpful and usable sources of information** to which consumers or designers might go, in order to discover:
- what technologies might suit their house
- what the likely performance of that technology might be
- tools to determine whether the technology has been installed correctly
- ways of assessing the effectiveness of the installation in terms of improved performance and payback
- authoritative assessment of performance

The New Zealand market is small and there is a current lack of demand in the sustainability market sector. Both of these factors mean that a very limited range of products is imported. To overcome this barrier the market needs to be developed and demand stimulated. Both local and imported products must be tested under NZ conditions for there suitability. This is an expensive, difficult and time consuming process. Perhaps Beacon can identify a number of key products that it could help bring to the market in NZ.

Sustainable products must perform at least as well as their less sustainable competitors and be of similar cost. They must be readily available in the quantities or sizes required and carry the same level of guaranteed performance as other materials. In many cases sustainable products do not meet one or more of these tests and consequently fail to attract sufficient specifiers or buyers. The answer to this barrier largely lies in the hands of producers but there is also a need for the big builder's merchants to have them as stocking items so that they can gain a reputation as mainstream items. There is also a need for central and local government to lead the way and specify sustainable products in their buildings.

A whole series of barriers and suggested solutions are presented in a recent paper entitled *Overcoming the Barriers to Deconstruction and Materials Reuse in New Zealand* written by John B. Storey and Maibritt Pedersen. While the focus of this paper is quite narrow many of the issues and putative solutions are applicable across the whole sector.

VUW has produced user information tools to help specifiers and buyers select and access sustainable materials and products. These are the *NZIA Life Cycle Environmental Impact Charts* and the nearly complete *Greener Building Directory*. A third element is envisaged entitled, '*The Greener Materials Reference Collection',* which would provide comparative data on all the materials and products included in the Greener Product Directory.

5 .4 How do we assess the likely impact of yet to be identified technologies in terms of their contribution to achieving the Beacon goals?

None of the experts felt able to answer this question with conviction. However one of the BRANZ HEEP project goals is to develop a tool which would allow the impact of a particular energy related technology to be assessed in terms of its impact on NZ. It is understood that this HEEP tool is due for completion within the next 12 months. NZ is thought to be ahead of the rest of the world in this respect. This tool would not be suitable in its current form to make assessments beyond the energy sector. However it might be used as the basis for developing a tool which would address the Beacon objective.

Until such a tool is developed, assessment by informed expert opinion is probably the least unsatisfactory way of carrying out such a task. A small consultative team might be established in each sector. The expert opinion might be informed by technical reports and overseas user evidence, if this was available, and/or by requiring the manufacturer to undertake testing to validate performance claims.

6 DETAILED ENERGY, HEALTH, MATERIALS and WATER ISSUES

6.1 General

Analysis of the NOW House brief produced the following list of topic areas:
The following summary lists the Sustainability Standard Target Issues identified using the NOW Home brief. They are organized into the four topic areas used in this report:

ENERGY	**HEALTH**
Weathertightness Reduction of heat loss Passive solar design Means of heating Natural lighting Technical innovation in solar technology Water heating Life cycle analysis Appliance+ Energy use	External noise Internal noise Air quality (and energy efficiency) Low toxicity materials Separation of health affecting pollutants from people Limiting potential harm from EMF's Warm shade provision Hygiene Loose fit technology to fit lifestyle
WATER	**MATERIALS**
Conservation – low flow shower heads Conservation – rainwater collection and re-use	Sustainable materials Re-use and recycling Waste reduction Efficient use of structural materials

Several of the reviewers noted that this sustainability definition was limited. As well as the obvious greater number of items listed under Energy and Health compared with Materials and Water, there is a clear mix of focus – sometimes on individual technologies (low flow showerheads) – sometimes on principles (re-use and recycling). A sustainability goal is a definition of a series of outcomes not a list of technologies.

6.2 Energy

Most of the technologies discovered in the internet searches related to energy were more about energy generation than about energy efficiency or conservation.

The most important technology need is for improved insulation and air sealing materials for cost effective retrofit of existing buildings. These priorities extend to improved glazing systems that do not fail within a 20 year lifetime.

Weathertightness and Infiltration
There is a need for the development of membranes that permit the outward migration of moisture vapour but not the inward flow of moisture in any form. There is also a need to control the inward and outward movement of air both for energy and health reasons.

Reduction of Heat Loss
The specific mechanism the NOW house uses, namely very high R values for thermal insulation, has a host of implications. The values used are well above the 'best' values established for the recent NZS Code of Practice. They require the significant redesign of the whole of the building envelope construction of light timber frame houses and it is doubtful that they can be affordably

met with solid wall construction using currently available technology. The values cannot be affordably met in existing houses using available technology. Unless the entire holistic envelope design and operation is compatible with the required insulation values, the effort and cost will be largely wasted, as heat will be lost through windows, doors, cracks, flues, inadequate weather sealing and uncontrolled ventilation.

Passive Solar Design
Tools are available but better predictive tools are required especially when dealing with complex designs. The knowledge and information is available but is underutilised.

Means of Heating
Poor heating choices are made by many New Zealanders. Replacement technology is needed for flueless gas heaters and high output wood burners. Heat distribution ducts are underutilised.

Lighting
Natural lighting is often poorly designed, though information is available. Energy efficient lights are available but underutilised.

Technological Innovation with Solar Design and Solar Water Heating
The NOW house brief restricts innovation in this sector to solar water heating. This is available and durable enough to give a payback under most circumstances. Major improvements could be made in this technology. Other technologies are available but are considered unaffordable under most circumstances. Other renewable technologies such as wind and water power are also considered unaffordable at this time. Much research and development is being undertaken on all areas of renewable energy production.

Life Cycle Analysis
Tools are available to calculate embodied energy and CO_2 equivalents. New Zealand has some of the most accurate figures anywhere in the world.

Appliance Efficiency
EECA have had a Minimum Energy Performance System (MEPS) available for a number of years but it has not been adopted or utilised. As appliances account for 30 percent of energy use, Beacon could consider promoting its use.

Specific examples of technologies **U**nderutilised in New Zealand, not yet **A**vailable, or **N**ot yet developed in New Zealand or internationally are:

- (U) Passive ventilation systems
- (A) Coatings that cool by absorbing moisture when exposed to sun
- (N) Thin cost effective retrofit insulation
- (N) Durable, cost effective improved glazing systems
- (N) Small (portable?) low tech thermostat controlled healthy heating systems

In energy, the major barrier to uptake of existing technology is lack of understanding of the implications of decisions made by designer or owner on the comfort or energy performance of a home. The greatest need therefore is for better information systems to overcome these.

Recommendations
In addition to major recommendations given at the beginning of this report the following further recommendations are made:

1) Improve up-take and efficient use of existing available technologies.
2) Review the NEW R-value figures to be applied both to existing and new houses taking account of the constructional/cost implications.

3) Consider the whole envelope R-value requirement in relation to NOW house wall, floor and roof values defined. There is little point in high solid area figures if windows are single glazed for instance.
4) Maintain a careful watch on new technologies. This is a very rapidly moving area for development.

Barriers
- Lack of take-up of existing technologies for energy saving
- Potential savings usually taken up with increased comfort levels therefore potential savings are not realised and users loose confidence in payback predictions
- Failure to look at energy use in a holistic way
- Very few existing New Zealand houses can easily take advantage of passive energy design
- Lack of general knowledge and use of existing tools
- Very limited government incentives.

6.3 Health

New Zealand houses are seriously under-heated. The degree of the health effects of this under-heating are still being investigated but preliminary results supports anecdotal evidence of major detriment and harm. Noise and indoor air quality are the other two main health related elements with technological aspects. In general terms New Zealand houses are not regarded as being particularly healthy.

The impact of urban intensification on health may require the introduction of more sophisticated technologies, many of which are available internationally. These solutions must be holistic; they cannot focus merely on a single issue. For example, the sealing of a building against noise requires careful design not to exacerbate already problematic air quality.

External Noise
The technology is available to control noise levels but application is inadequate.

Internal Noise
The technology is available but is under-utilised and the subject is poorly understood throughout the industry. More education and careful design and construction are more likely to succeed rather than employment of more sophisticated technology.

Air Quality and Energy Efficiency
Better passive ventilation and a greater understanding/appreciation of the issues and simple methods to improve air quality are the keys to success. Better measurement and information tools are required.

Low Toxicity Materials
These are available in most areas and new materials are under development.

Separation of Health Affecting Pollutants from People
A number of materials such as formaldehyde and many 'cleaning' and other household chemicals have negative health affects. Education and the development of healthy alternatives are the key success factors.

In existing houses materials such as old lead paint, asbestos, PCBs and dust from a variety of sources can be present and be inimical without being toxic per se. The technology required here involves the safe removal and disposal of health damaging materials. Again methods and

technology is available and improving. However disposal technology requires significant investment.

Limiting the Effects of Electromagnetic Fields
This is an area that remains fraught with controversy. Much research has been done with very mixed and disputed results. The precautionary principal might be applied her. It is essentially a design rather than a technological issue although technology and techniques have been evolved to minimise potential harm.

Warm Shade Provision
The technology is available but knowledge of the issues of UV related health damage and the deployment of the technology is minimal.

Hygiene
Technology is available but is little used.

Loose Fit
This is largely a design issue. Sliding and folding screens and the hardware to facilitate movement can be expensive.
Specific examples of technologies **U**nderutilised in New Zealand, not yet **A**vailable, or **N**ot yet developed in New Zealand or internationally are:

- (U) Building façade systems & technologies that seal against noise and wind driven air leakage and yet allow the building to breathe to preserve air quality
- (A) Construction practices that emphasise and encourage flushing of VOCs etc during and immediately after construction or retrofit
- (A) Catalytic coatings for removal of some VOCs from indoor air
- (N) Tools for selecting healthy technologies and practices

Recommendations
In addition to major recommendations given at the beginning of this report the following further recommendations are made:

1) Develop effective passive ventilation systems, especially for winter use, which allow pollutant migration with minimal heat loss.
2) Legislate for defined limits for toxic and other inimical chemicals in building materials used in the building industry.
3) Develop hazardous materials destruction sites throughout New Zealand i.e. not just wrapping them up and putting them into landfills for future generations to deal with.

Barriers
As with energy, the greatest barrier to uptake of healthy building practice is a general understanding of the issues and of the impact of design or operation decisions on the quality of life of the people in a house.

6.4 Water

The NOW house brief primarily focuses on aspects of the conservation issue and is very deterministic even in that respect. There are four main aspects when dealing with water from a sustainability viewpoint: water conservation; stormwater detention; water quality; on-site water treatment. All of these factors can be dealt with by the intelligent employment of existing technologies.

The greatest barrier to sustainable water management is that water is generally not valued as a scarce commodity by most participants in the building industry. It is still very difficult to overcome

the innate conservatism of the installers and regulatory authorities to the deployment of a new technology or new design approach to water conservation especially in reticulated water zones. Many technologies exist for water recycling, water conservation in use and site water management, but few are used.

Internal Conservation
Measures called up in the NOW House brief for water conservation are modest. We could go much further with the existing technologies available. Mandatory water metering and use based water charging is the necessary precursor to making serious water savings. Good water savings could be achieved by only permitting sale of appliances that met a stringent water saving standard. They are currently available and if they became the norm, are likely to become affordable as a mass market rather than as a premium market appliance.

External Conservation
Adequate technology is available for use with both new and existing houses

There are many other well tested technologies available. Specific examples of technologies **U**nderutilised in New Zealand, not yet **A**vailable, or **N**ot yet developed in New Zealand or internationally are:

- (U) Water efficient appliances and fittings
- (U) Greywater recycling in the house
- (U) On demand hot water pumps
- (A) Colour coded PEX water piping systems to ensure separation of potable from other water in the house and make retrofit of waste water recycling simpler, plus remove copper contamination
- (A) Hot water return loop supply plumbing properly designed has the potential to save huge quantities of water
- (N) Low pressure, water efficient appliances and fittings

Recommendations
In addition to major recommendations given at the beginning of this report the following further recommendations are made:

1) Prepare a NZ Standard for the performance of water purifiers and require compliance.
2) Develop with others an agreed code of conduct for the installation and maintenance of on-site water treatment systems (including composting toilets) in reticulated areas.
3) Encourage and support the development of reliable, durable, low maintenance, environmentally friendly, piping systems with built in insulation qualities where appropriate made from recycled or waste sourced materials.

Barriers

- Stormwater detention is not taken seriously in most areas of the country
- Point of use/point of entry water purifiers are not regulated in this country and so actual performance in terms of improving water quality is uncertain.
- Water is not valued as a scarce commodity.
- On-site water treatment and composting toilets are not currently permitted in reticulated water zones.

6.5 Materials

The biggest challenge we face in terms of materials is to make our buildings resource neutral. The NOW house brief has requirements relating to all four major areas of material sustainability: use of sustainable and healthy materials, use of pre-used, recycled or waste sourced materials, waste reduction; efficient use of materials. Greener materials are available and these are gradually becoming more affordable, available and able to match the performance of less sustainable materials. It is a rapidly moving area with many new materials being marketed every year.

The greatest barrier in this sector is the lack of trustworthy information and advice on the sustainability and health associated attributes and performance of materials and products in the marketplace. This applies to both specifiers and clients. A similar lack of reliable information also applies to resource recovery, waste reduction and the efficient use of materials. This lack of certainty is allied with the natural conservatism of the home buyer and the reticence of building professionals when employing unproven technologies or techniques.

Use of Sustainable Materials
Strictly speaking there are no such things as sustainable materials, all material use damages the environment to some extent, all results in a degree of resource depletion. We are therefore dealing with using those materials which have the minimum negative effects. The concept of 'greener' materials is useful in this context. There are many materials that fit into this category. The problem is to select between them. Inevitably many other factors relating to cost, availability, performance, durability, maintenance and disposal affect job specific selection.

This is one of the most prolific areas of invention, research and development in the world and new materials and products appear constantly.

Reuse and Recycling
The challenge is to carry out this work at no greater cost than standard construction. Techniques and tools have been developed to maximise resource recovery. New technologies are required to facilitate design for disassembly. The main barriers are reluctance of designers, builders and often clients to use 'second hand materials due to lack of availability, increased time required to source and use the materials, aesthetic constraints and performance concerns when the materials are used structurally. Up-take is the main problem but this is a marketing, rather than a technological issue. Certification of second–use materials and products remains an issue.

Waste Reduction
This is primarily a design and techniques issue rather than a technological issue.

Efficient Use of Structural Materials
Considerable work has been done in this area. The technology is largely available, but take-up is minimal.

Specific examples of technologies **U**nderutilised in New Zealand, not yet **A**vailable, or **N**ot yet developed in New Zealand or internationally are:

- (N) Design for deconstruction and waste reduction
- Use of natural healthy materials and products e.g.: (U) paints, oils, hard wax coatings, adhesives, cleaners; (N) high strength natural adhesives
- Use of non-traditional renewable materials in construction e.g. wool based insulation; (U) (U) bamboo; (A) flax insulation;
- Use of recycled or waste sourced materials in construction – e.g. (U) materials from used tyres; (A) materials from waste plastic; (U) plasterboard from recycled plasterboard; (A) maize residue based plastics; (A) wood residue or recycled wood insulation and engineered composites; (N)recycled crushed concrete aggregate
- Use of innovative materials: (N) fibre reinforced geo polymers; (A) phase change materials; (A) plastic composite nails; (A) low e glass; (U) low e applied coatings

Recommendations

In addition to major recommendations given at the beginning of this report the following further recommendations are made

1) Promote the identification and stocking of greener materials and products in building warehouses and trade outlets
2) Work with other organisations to develop more markets for all forms of pre- and post-consumer 'waste' sourced materials.
3) Encourage and where necessary sponsor the invention, development and marketing of new materials made from 'waste'
4) Actively encourage and support the development of affordable, greener materials in NZ.
5) Encourage the planting of inherently rot and insect resistant timber species and the genetic modification of pinus radiata to give it rot and insect resistant properties.
6) Work with others to produce reliable and trusted labeling/certification schemes for greener and pre-used and recycled materials.
7) Work with others to encourage government to set and adopt 'greener' purchasing criteria for all its building work and for that of government funded agencies such as HNZ. Beacon could help to establish such purchasing criteria.
8) Work with others in encouraging government to include specific minimas of pre-used and recycled materials in all its building work and for that of government funded agencies such as HNZ. Beacon could help to establish such purchasing criteria.
9) Encourage and support the plantings of natural, renewable materials and support the development, marketing and sale of materials and products from these sources.

Barriers

- The lack of take-up of greener materials, products, technologies and techniques.
- Lack of appreciation or understanding of the personal, corporate and national benefits of employing sustainable, healthy and waste sourced materials and products in a resource efficient manner and the benefits and opportunities inherent in resource recovery.
- The lack of trustworthy information and advice on the sustainability and health associated attributes and performance of materials and products in the marketplace.
- The lack of certainty regarding the durability and especially the structural performance of pre-used materials.
- The uncertainty of the market for greener materials and products, which inhibits the developing and marketing of such materials at an affordable price in NZ.
- The perception that pre-used materials and products are inferior, are more difficult to access and use, are more expensive to incorporate and are stylistically inappropriate compared with new materials and products.
- Standard specifications normally call up new materials. Building Consent and Inspection personnel are often suspicious, even reluctant to approve the incorporation of pre-used materials and products in areas of houses which are covered by building regulations.

7 Summary of CBPR and Reviewers' Views in Tabular Form

ENERGY

The general trend in energy research is today focused on – as one reviewer said – "the best means of supporting consumer choice of energy options". Information for these consumers is critical to energy efficiency, as is pricing. This reviewer also noted "research is needed on longer-term effects of both the retrofits of the mid-1990s, and education programmes of the same vintage". With this type of approach comes a very different attitude to energy efficiency: 'client-centred' energy audits become very important in this type of environment. There is no single solution, and quite possibly very few intrinsically unsuitable technologies. A system that assists renters as well as owners to make decisions is also essential.

Issue/NOW Brief	**Weathertightness / infiltration** ***Goal***: Sealing against uncontrolled air leakage into the livable volumes of the house (as far as practicable) but providing a weathertight and breathable envelope.
Overview/Introduction	The 4 D's of building moisture management: Deflection, Drainage, Drying, and Durability are spelt out in the NOW home specification for weathertightness illustrating the multidimensionality of the issue. Envelopes designed to these principles for dealing with driving rain and other water penetration issues could make buildings less energy efficient unless they are designed in conjunction with materials and construction practice that allow the whole skin, from outside to inside the building to breathe. Current building technology for natural ventilation is very little improved on the hole in the Medieval castle wall with skins tied across for weather protection – out windows open to let air in / out but not in controlled amounts dependent on indoor temperature, outdoor wind speed, or rainfall.
Existing technology adequate for purpose	No – there are certainly plenty of specific solutions and technologies that relate to weather tightness and to air tightness, but less so to the holistic combination of these.
Technology in NZ but not much used	Claims being made about imported buildings papers – Smart vapor retarders limit the transmission of water vapor from inside the house into the wall cavity. However, when humidity levels within a wall cavity are high, the vapor retarder becomes permeable, and allows drying toward the inside living space of the home. **www.certainteed.com**
Technology overseas	Construction that uses moisture permeable internal linings with no vapour barrier, but moisture absorbing insulation are being trialed in places in the UK. Better technology for wind/rain screening separate from air / heat barriers to inside. Better window technology to control wind flow through ventilator gaps as well as through construction gaps.
New technology needed	Better vapour barrier technologies to seal construction cavities from moisture but to allow cavity ventilation without over-ventilation in strong winds. Window opening / designs that enable better or easier control of ventilation. Often New Zealand homes' occupied spaces are too airtight for the health of the occupants, and the construction cavities are air tight where they should not be for water removal – solving this health and weathertightness issue without compromising energy is the challenge. A technology to supply external air to fires like wood burners. At the moment we are sucking in 25 cubic metres of

	cold air for every 5kg wood burnt. This air is sucked in through the bedrooms potentially making the rest of the house colder.
Questions	Is there a possible dynamic product that closes up the building envelope in response to strong winds, but allows it to be more open when the weather is less severe? Is there an opportunity for energy conservation in building retrofits resulting from the 'leaky buildings' problems?
Sources of information for new technologies	Unknown
Barriers to uptake of technologies	New Zealanders' behaviour is thought to be not like that of European or North American – we are thought to be unique in our desire to 'air out' our houses and thus much less tolerant of highly efficient, sealed buildings. However, this trend to 'air out' buildings is found in much colder (e.g. central Switzerland) climates than ours.
Means of assessing impact of technology	Unknown – technology need? With air tightness, there are two difficulties: 1) predicting the air leakage on the basis of design decisions and 2) checking or verifying that the low air leakage goals have been achieved.

Issue/NOW Brief	**Reduction of Heat Loss:** ***Goal:*** Recommended Insulation R-Values: Walls: total installed Minimum R-value R3.4 Climate Zones 1 & 2 & 3 Roof: total installed Minimum R-value R5.2 Climate Zones 1 & 2 & 3 Floor: total installed Minimum R-value R4.4 Climate Zones 1 & 2 & 3 Glazing total installed Minimum R-value R0.16 Climate Zones 1 & 2 & 3 (No specific reference currently in NOW House brief – 0.16 is low compared to rest of NOW home insulation levels!) Perhaps 0.26 – single Low E in Zone 1 and double glazed 0.33 elsewhere (or equivalent simulated Building Performance Index)
Overview/Introduction	Existing Minimum R-values (New NZ Standard 4218) Walls: total installed Minimum R-value R1.5 Climate Zones 1 & 2 and R1.9 in climate Zone 3 Roof: total installed Minimum R-value 1.9 Climate Zones 1 & 2 and R2.5 in climate Zone 3 Floor: total installed Minimum R-value R1.3 Climate Zones 1 & 2 and R1.3 in climate Zone 3 Glazing total installed Minimum R-value R0.15 Climate Zones 1 & 2 and R0.26 in climate Zone 3
Existing technology adequate for purpose	Wall of R3.4 in context: 150mm frame + fiberglass Ins. = R2.8; current walls are typically ex 100mm frame. Existing technology therefore not adequate for purpose. Timber frame construction readily adapted for greater insulation thickness if needed. Achieving even the current NZ Standard levels in existing uninsulated houses is a major technical challenge. Achieving higher insulation levels in most new and existing ceilings is relatively easy. Achieving R4.4 in floors when they are cheap on-ground concrete slabs is difficult in new and impossible in existing construction.
Technology in NZ but not much used	None that we are aware of.

Technology overseas	Higher R value sheet materials – external walls – e.g. vacuum insulation. Higher R value sheet materials – internal walls Re-roofing products that insulate better and generate electricity PV tiles. BEDZED devices that are air to air heat exchangers largely driven by natural convection forces – not fans.
New technology needed	Reduction of surface (convection) heat loss in our generally high wind climate from roof and walls. Higher R value in same thickness for full retrofit walls – injection systems or surface applications. Higher R value (for the same thickness) insulation materials – there is improvement possible in fibre-glass insulation. Is there in other materials? Heat recovery ventilation – it is probable as we get more and more insulated homes that the air sealing will be a major effect: the most efficient way of doing this currently known (see results of IEA Task 13 Ultra Low Energy house research www.iea-shc.org) is to fully seal the house and then to mechanically ventilate with heat recovery. Raises the issue of whether heat recovery is possible with natural ventilation? This may be beyond the NOW home brief – but may also be needed to achieve the weathertightness / infiltration goal. Less ventilation is needed if less moisture is generated in the house: clothes drier rooms that are not electrically heated, and do not expel moist air into the rest of the house? Better extract systems from kitchen and bathroom that recycle the heat whilst dumping the moisture.
Questions	If heat loss through floor is to the ground directly, we might ask what the necessity for R4.4 is, but also what might be an appropriate goal for concrete slab on grade as opposed to suspended floors? Are there other surface applications that might increase effective R values?
Sources of information for new technologies	In general, internet sources and scientific journals.
Barriers to uptake of technologies	Cost and complexity of retrofit. "Heating" season is brief. Heat recovery ventilation useful where all-house heating is wanted, and only where people are prepared to keep windows and exterior doors shut.
Means of assessing impact of technology	Energy simulation tools exist to allow energy use prediction. However, there are no simple to use tools that can be used to check that the R values planned have actually been installed.

Issue/NOW Brief	**Passive Solar design** ***Goal:*** Is efficiency and comfort. This means no or little equipment to achieve an ambient temperature of between 18 and 25 degrees C, for all but 10 days of the year. Incorporate shading to prevent overheating, protection from the wind, UV and water. Optimise room layout.

Overview/Introduction	New Zealand Houses are frequently below 14 degrees Celsius and occasionally below 10 degrees which is well below the WHO recommendation of 16 degrees C to maintain a healthy environment. The need in Passive Solar Design is to make it the norm. What is also needed is probably a set of products that address the usability of Passive Solar – e.g. not covering the thermal mass heat store with carpets; or shading it by pulling curtains to reduce glare or stop furnishings fading; improving the effectiveness of thermal storage; making it possible to retrofit thermal storage into existing buildings.
Existing technology adequate for purpose	Design tools such as simulation programs like Energy Plus, ESP and SuNREL are adequate, but unused. Design guides are adequate but unused. Strategy of making Passive Solar indistinguishable from 'normal' buildings has made it hard to market. It is easier to understand a product like an oversized heating appliance than 'good design'
Technology in NZ but not much used	What is here is well-used except for the design tools and guides. Design tools and design guides are better focused on new build rather than existing retrofits. Thermostat or other automatic control fans or vents for heat transfer for heating or cooling. Phase change materials are able to be imported and available through specialist suppliers, but not used? Ducts that transfer heat from one room to another. Appropriate (size and controllability) heating technology for the times when supplemental heat is required.
Technology overseas	Better shading technology for shading when overheating and capturing when underheated – smart glass technology such as thermo and electro chromic materials.
New technology needed	Improved interface to design tool(s). Simple to use tools like Ecotect and EnergyPlus could work in tandem, and are increasingly being introduced into Building Science curricula. However, to be effective they need: - A system for ensuring that we avoid the Garbage-In-Garbage-Out problem of computer modeling – a means of establishing how to trust the calculations; i.e. how do we know we have a model that represents what is really going to happen? - A trusted set of standard weather files for standard New Zealand situations; the Typical weather files and Hot Dry, Hot Windy etc. years created by Victoria University in the early 1990's are based on synthetic solar data AND do not include wind data - Local support for the users of these tools. Better window technology for capturing heat, especially transfer to heat storage. Heat storage floor technologies – lighter weight higher thermal capacity (perhaps phase change)? Heat storage wall panel technologies – able to be added to existing internal walls in association with insulating layer? Heat storage "wall paper" or coatings – selective absorber surface for collecting more heat. Heat storage ceiling technologies - lighter weight higher thermal capacity able to efficiently store heat from thermocirculation rather than direct solar radiation? Develop a smart-home software package – whenever you log on to your home computer you have a chance of re-setting default options e.g. "I want to supplement my solar water heat today." Could develop a computer simulation, "game-style" to show where heat comes and goes to in your house, similar for electricity

	use.
Questions	What is the role of curtains and blinds in practice? Are they used in an energy efficient manner?
Sources of information for new technologies	Passivhaus Institute Germany – www.passiv.de
Barriers to uptake of technologies	Norm in suburban house to orient towards anything else but the sun. There is neither enough expertise nor willingness in the industry to use new technologies. Failure to understand importance of passive solar.
Means of assessing impact of technology	Thermal simulation tools exist and are increasingly well used. Mostly applied to new build rather than existing buildings.

Issue/NOW Brief	**Means of Heating:** ***Goal:*** Is heating and cooling equipment is minimal size and maximum efficiency. In warm climate zones (i.e. Auckland), no in-built heating. In cool climate zones options include: COP greater than 3; no net CO_2 emissions; integration with water heating.
Overview/Introduction	New Zealand Houses are frequently below 14 degrees Celsius and occasionally below 10 degrees which is well below the WHO recommendation of 16 degrees C. New Zealand has a higher winter mortality rate than other western nations with much harsher winters such as Sweden. LPG gas – issue is apparently people who use this air polluting heat source through portable in-house flue-less heaters value its controllability in terms of budget and size of output: do the meters currently available for electricity meet this same market? Wood burners – issue is size of output in single place and hence optimum distribution and control of heat output; a case could be made that at present a 12kW heater in one room burning wood should be banned as an unsustainable CO_2 generator – because of the unnecessary or inefficient burning of wood to generate much more heat for the one room than is actually needed in the room Electric Heaters – issue is these are easiest to control in time and temperature terms. Can we harness this controllability in a sustainable use of our resources? Most options like Heat Pumps seem to be ridiculous wastes of resources as they are considerably more expensive than simple electric resistance heating. Comment from one reviewer was: "Wood burning (or pellets) gives the potential for self-funding due to its ability to reduce demand peaks or even winter energy shortage. Those two issues are now being addressed by the Electricity Commission, who could commit potential expenditure of billions of dollars (1.5 billion by Tpower before around 2009). A similar amount or more will be spent by local network companies, and similar amount on gas exploration and development, plus coal. All those investments point towards more fossil fuel use.

	Redirected into end-use hardware, education and pricing structures. Householders are changing their heating options much more frequently than doing retrofits – consumers choose between resistance heaters, lpg heaters, dehumidifiers, wood burners, heat pumps, natural gas appliances, and or heat-exchanging ventilators. It is these choices which I believe offer NZ's greatest opportunity for moving rapidly towards sustainability in existing houses (once ceiling and underfloor insulation has been installed and other low-cost measures)".
Existing technology adequate for purpose	If one does the calculations, a reasonably insulated house even in a cold climate only requires 5-6 2kW electric heaters to maintain comfort all year. There is a lack of appropriate technology in three areas: - The capital cost (in energy and dollar terms) of most alternatives to simple electric heaters is huge relative to the cost of the simple electric resistance heater. Many of the technologies used by people pollute the atmosphere inside or outside the home. - These large alternatives to the electric resistance heater are single units that make it expensive and difficult to achieve appropriate heat distribution to where it is needed around the house. - Even the low tech, low capital cost electric heater has many flaws (apart from the obvious mis-use of high quality electrical energy for low quality heat): short life-time; inaccessible fans; dust blown and burnt causing allergenic reactions etc.
Technology in NZ but not much used	Radiant heating systems? Small size wood burning systems with low-cost heat distribution. Controllable output to place heat, only where needed.
Technology overseas	Wood burning and pellet burners: extensive research and development in Europe – Sweden and Austria are believed to support domestic wood burning with strong policies. Some wood burners are catalytic (not thought to be a winner by one reviewer) – This reviewer thinks some have CO_2 or other detectors that control input of secondary air: "I think this would be a winner".
New technology needed	Heat distribution systems for heat from wood burners that can efficiently and cheaply take heat from where it is generated to where it is needed. Whole house control systems that work the way the human mind thinks – not the way the heating/cooling system 'thinks'. Typically at present systems heat and cool the building rather than servicing the needs of people. A system to spread the energy load over a 24 hour day with minimum losses. Current night store heaters are not very effective. A system for wood burners could be beneficial..
Questions	Do electric blankets reduce dust mites in beds and pillows?
Sources of information for new technologies	As above.
Barriers to uptake of technologies	Householder behaviour! One reviewer noted: '*some traditional Indian cooking involves long cooking with lid off*'. Research needed on effectiveness of education programmes attached to retrofit programmes. Precious Joules (EECA) Energy Action (Negawatt Resources), Environschools, (MFE?) etc. There's an education component to Energy Smart retrofits, too.
Means of assessing impact of technology	Thermal simulation tools exist and are increasingly well used. Mostly applied to new build rather than existing buildings.

Issue/NOW Brief	**Natural Lighting** ***Goal:*** Wherever possible: Ensure every room has access to appropriate (no glare, etc) natural light. i.e. Rooms do not require artificial lighting during 9am-4pm year-round **Efficient lighting** ***Goal:*** Where practical: All lamps used in house are low wattage fluorescent
Overview/Introduction	Natural lighting better for health, energy efficiency and productivity. Efficient lighting reduces energy used and excess heat generated. Adequate daylight for elderly people to read at home without electric light to assist them – typically the elderly need 2x or more light of that in standard. Good – energy efficient - lighting for all purposes in the home is not yet a reality. Installing Compact Fluorescent Lamps (CFL's) in major living spaces in New Zealand would achieve power savings equivalent to a medium sized power station output. The NZ Building Code requirement for daylight in habitable spaces requires only a minimum of 30 lux (candlelight)
Existing technology adequate for purpose	Existing systems are not being designed or checked with this in mind. In many smaller houses the rules of thumb about window to floor area proportions will probably work to achieve much higher than the 30lux minimum in the NZBC. If the goal is as specified here, then many existing as well as new building designs will have to change.
Technology in NZ but not much used	Compact Fluorescent lamps are still more expensive than Tungsten filament, but they are widely available. Colour rendering of some of the cheaper ones is now well documented for the consumer.
Technology overseas	LED lighting is going ahead in leaps and bounds internationally. Daylight redirection systems. With an increasing trend to build two storey buildings anidolic reflectors are catching the sun's light and directing it into the depths of a building to reduce the need for electric light. Transparent/translucent insulation
New technology needed	Better and alternative (day)light redirection systems. Electroluminescent systems can be used for safety lighting – could they be used for general lighting?
Questions	
Sources of information for new technologies	
Barriers to uptake of technologies	
Means of assessing impact of technology	

Issue/NOW Brief	**Technical Innovation in Solar Technology** ***Goal:*** Utilise solar water heating circulation system and thermal mass storage for under-floor or preliminary water-heating.
Overview/Introduction	The NOW home goal is specific to that house. What is required is a review of what other solar technologies might be applicable here? PV is still a huge cost.
Existing technology adequate for purpose	Underfloor heating systems based on fluid distribution could be used to distribute solar heat gain. Currently not used. Barriers likely to be cost.
Technology in NZ but not much used	Domestic Solar Water Heaters well understood mature technology in NZ, though still 7-10 year simple 'payback'.
Technology overseas	PV roofing tiles – to replace roofing iron PV wall panels – for weatherproofing
New technology needed	Better quality fresh air distribution from ventilation openings such as windows to people/rooms well away from perimeter Better quality heat distribution from solar collector (living room?) to other rooms in the house (bedroom?) (cf. transfer ducts in Passive Design section earlier)
Questions	Is this not really just another dimension of Passive Solar Design?
Sources of information for new technologies	
Barriers to uptake of technologies	
Means of assessing impact of technology	

Issue/NOW Brief	**Water Heating** ***Goal:*** Passive solar-panel for pre-heating of hot water
Overview/Introduction	The NOW home goal is specific to that house. What is required is a review of what other water heating technologies might be applicable?
Existing technology adequate for purpose	Good solar panel water heaters with 7-10 year simple payback available. (See above)
Technology in NZ but not much used	Heat recovery technologies are available but little utilized in New Zealand houses at present.

Technology overseas	Combined PV and Solar Water Heating.
New technology needed	Studies needed are about usage patterns and appropriate utilization of the technology: - Solar water heater technologies in conjunction with instantaneous heating technologies - Distributed water heating vs central storage
Questions	R&D Question might well be with this, what is the most efficient and healthy way of heating water – efficient instantaneous vs solar boosted storage?
Sources of information for new technologies;	
Barriers to uptake of technologies	Instant electric water heating is not desirable to an electricity industry that gets its greatest reward from running all its plant as often and for as long as possible.
Means of assessing impact of technology	

Issue/NOW Brief	**Life Cycle Analysis** ***Goal:*** Embodied energy and CO_2 of house designs to be calculated and life cycle costs of materials including 50 year energy use to be minimized as far as is practicable.
Overview/Introduction	New Zealand has available some of the highest quality information on embodied energy in buildings anywhere in the world. What we do not have is a calculation system that permits the average practitioner or their consultant to calculate the lifetime energy costs of various alternative designs taking account of varying maintenance requirements (e.g. application of paint every 10 years - replacement of roofing iron every 20-25 years)
Existing technology adequate for purpose	Data very good – technology in terms of design tools inadequate.
Technology in NZ but not much used	Existing technology like the SimaPro software used at the VUW School of Architecture for doing the LCA is not easy for the practitioner to use. The programs have been tried and the reports can be produced, but their meaning and the ease of use has not been worked on. NZ needs for example to have its base set of embodied energy data put into a simple to use calculation tool associated with the normal Archicad, AutoCAD, Revit, Microstation, VectorWorks software.
Technology overseas	The computer programs are international. Their application must necessarily be local.
New technology needed	Interfaces and worked examples in a database format.
Questions	
Sources of information for new	

technologies	
Barriers to uptake of technologies	
Means of assessing impact of technology	

Issue/NOW Brief	**Appliance Energy Use** ***Goal:*** No NOW Home Goal?
Overview/Introduction	EECA have worked on Minimum Energy Performance Standards (MEPS) for appliances for a number of years. The data is published. Knowledge of how to use the data and its influence in the marketplace is poor.
Existing technology adequate for purpose	We have a MEPS in place.
Technology in NZ but not much used	MEPS does nothing for existing appliances that will still be around in 2012.
Technology overseas	
New technology needed	Ridding the home of the energy thieves in LCD displays, warm on-off stereo/TV control etc – achieve same/similar convenience without energy theft Documentation about or interactive education/marketing tools to help people comprehend MEPS? Better cooking technologies?
Questions	Do we know whether there has been any action as a result of Jan Wright's work 15+ years ago identifying instant-on TV's as producing a demand equivalent to a small power station?
Sources of information for new technologies	
Barriers to uptake of technologies	
Means of assessing impact of technology	

HEALTH

Technologies can only produce solutions for technical problems.
For example noise is a technical problem and can be solved by technical solutions and resulting standards, addressing mainly quantitative levels.
Life quality is determined rather by the quality of sound, quite different to noise.
There are many health issues associated to the quality of sound, apart from the quantity of noise.

Issue/NOW Brief	**External Noise** **Living Areas** – $L_{A,eq}$ over 24 hours should be less than 30dB(A) **Bedrooms/Study's -** $L_{A,eq}$ over 24 hours should be less than 27dB (A) **Wet Area's** (Bathrooms/ensuites/laundries) $L_{A,eq}$ over 24 hours should be less than 40dB(A) for both intermittent and continuous noises. **Outdoor Living/Living with Doors or Windows open-** should be less than 40 dB(A) at times they are likely to be used. **Ventilation** -A fully open bedroom ventilation system should not increase the noise levels in the room by more than 1dB. (Strip vents in windows should achieve this). **Building Elements** - Use $R'_w+C_{tr,50\text{-}2500}$ ratings for building envelope elements (Walls, windows, doors).
Overview/Introduction	Noise can affect people physically, psychologically, emotionally and socially. Noise affects everyone and has an impact on the environment equal to other forms of pollution. We can't control the noise being made outside the home in the same way we can control internal noise sources if needed. The external envelope is critical to achieving an acceptable level of peace and quiet that is beneficial to the health of the homes occupants. Sustainable design of communities will examine ways of grouping houses so that the 'noise' intrusion is more likely to be positive sounds like children playing, rather than cars and trucks. There should also be a livable area of the house, which can have its windows open without undue noise intrusion. A passive venting system should not allow significant external noise penetration, but should be present so that occupants don't have to open windows to get enough air (especially when sleeping)
Existing technology adequate for purpose	Problems in New Zealand are largely that construction is poorly assembled on-site, rather than application of technologies: technologies are available, but application inadequate.
Technology in NZ but not much used	No technologies have been suggested that address these issues. Rather they are design and construction issues.
Technology overseas	No technologies have been found that address external noise.
New technology needed	Probably not.
Questions	Is it possible anywhere to meet the requirements for openable windows and keep out environmental noise that has not been stopped by external noise suppression at the source, or barriers such as mounds and walls? Given that trees have no sound barrier/absorption qualities what in the human psyche makes people think that trees between them and noise do reduce sound levels, and can we use this in building/community design?
Sources of information for new	

technologies	
Barriers to uptake of technologies	
Means of assessing impact of technology	

Issue/NOW Brief	**<u>Internal Noise</u>** Bedroom and quiet areas should remain at less than 27 dB(A) even when other activities are taking place in the home, wall (and ceiling and floor) structures to these rooms should have an acoustic rating of at least $R'_w = 45$
Overview/Introduction	Many health problems are being associated with disruption of sleep. Juxtaposition of noisy and noise sensitive areas on plan will increase building costs to achieve required levels - if levels are achievable at all. Allow for quiet areas at all times even when various other activities are taking place throughout the home.
Existing technology adequate for purpose	This is a design not a technology issue. What is not known and ill-understood in the building industry – designing, building, selling or buying - is how to define and measure quality as well as quantity of sound in a manner that matches people's wishes. Here the need is for a tool to make the decibels and sound qualities understandable, able to be checked by a site manager or new buyer.
Technology in NZ but not much used	None known.
Technology overseas	None known.
New technology needed	Not a building technology – but an information technology.
Questions	How can beneficial sound quality be created? How can better design resolve issues of internal noise? How can appliances and equipment be installed in the home that is and performs more quietly? How can the building respond to this?
Sources of information for new technologies	
Barriers to uptake of technologies	
Means of assessing impact of technology	

Issue/NOW Brief	**Air Quality and Energy Efficiency** No high-tech HVAC or ventilation heat recovery solutions. Simple, low-tech solutions such as passive vents, etc. Living space air should be between 40-60% RH, for bedrooms 40-70% RH. Require adequate (NOT DEFINED?) fresh air changes.
Overview/Introduction	High-tech HVAC is not traditional in NZ houses, and can be energy intensive and intrusive. HVAC systems are occasionally unreliable and require occupant education, maintenance etc. HVAC systems suspected (known?) to increase risk of airborne pollution and contaminants. An important air quality problem in residential buildings is generally bio contaminants (mould, mildew, dust mites, bacteria).
Existing technology adequate for purpose	There is ample evidence that windows as they are currently designed, installed and used, do not achieve their intended purpose. Air quality depends on temperature, moisture, pollutants from particles, bacteria, offgassing chemicals, electric charges and ionization.
Technology in NZ but not much used	No. Simple fan extract systems are inadequate to the need. Building need to keep moisture from rain out but also to release internal moisture from sleep, bath and kitchen, to the outside. Installation of automatic dehumidifier for bedrooms, moisture mechanically driven heat recovery systems and expel systems for shower, sink and dryer.
Technology overseas	Mechanically driven, fan driven heat recovery systems are available internationally.
New technology needed	A thermostat that people understand Feedback that relates indoor temperatures to energy use that helps people manage their health cost effectively Heat recovery ventilation that is driven by natural buoyancy.
Questions	Why should mechanical ventilation be excluded? Would it not be better in the long run to understand what the problems are that cause people not to like mechanical air systems?
Sources of information for new technologies	
Barriers to uptake of technologies	
Means of assessing impact of technology	

Issue/NOW Brief	**Low toxicity materials** Products should be chosen for low toxicity including VOCs, There are a number of articles showing the toxicity and unhealthy levels of current homes due to the presence of moulds, use of cleaners, and lack of appropriate layout for safety, and moisture control and ventilation.
Overview/Introduction	Indoor Air Quality is important to Human Health because we spend as much as 80% of our time indoors. The cost to the country in terms of Asthma alone is estimated to be at least $825 million a year and Asthma has a significant impact on

	sufferers' quality if life. Asthma has been linked to house dust mites in the indoor living environment
Existing technology adequate for purpose	No.
Technology in NZ but not much used	It is relatively simple to overheat and to ventilate a building well before occupancy to force the offgassing of building materials before occupancy. But this is not done and is not written into the Building Code or any Standards as the norm.
Technology overseas	Catalytic wallpapers that absorb pollutants and catalyse them under light, converting them to non-toxic materials – available in Japan. A technology that is suited to existing buildings but should not be needed in new build.
New technology needed	Non-polluting materials – a guide to selection? One is available in Switzerland. Ventilation controller that detects VOCs not CO_2 Dynamic ventilation systems that can keep a controlled level of ventilation/fresh air despite vicissitudes of climate
Questions	How can manufacturers be held accountable for offgassing pollution? How can a varying use be standardised, such as heat exposure? How can people be controlled to avoid misuse? How can the public be informed adequately/ How can cheap polluting solutions be avoided such as pvc blinds? Why does New Zealand have to wait until enough citizens suffer and it has been scientifically proven? Why can common sense not be applied?
Sources of information for new technologies	
Barriers to uptake of technologies	
Means of assessing impact of technology	

Issue/NOW Brief	**Separation of health affecting pollutants from people** Provision for laundry to be dried outside in a sheltered (and private) area. Provision of indoor drying rack or line for wet days. Layout vents so that moisture-generating appliances are addressed through passive ventilation. Plan ventilation as part of passive solar design. A ventilation methodology. Use security vents, screens, passive ventilation for windows to allow venting while people not at home.
Overview/Introduction	Require minimal condensation to prevent mould growth and material degradation. See NZBC E3. BRANZ are in the final stages of developing BRANZ Vent (it is undergoing a technical audit), this helps in identifying air change rates etc. in conjunction with the changes to E3.
Existing technology adequate	Reduced energy from dryer appliance.

for purpose	Bacteria killed from UV light–healthy option. RH problems from drying clothes inside can lead to mould and other health affecting symptoms.
Technology in NZ but not much used	There is no evidence of awareness in the design or use of buildings that the awareness of the need for removal of water vapour or other polluting gases from the air at source is a priority. Rather, appliances like dehumidifiers are often used to remove high levels of moisture already in the room atmosphere.
Technology overseas	This is identified as a design and operation – an education – issue, rather than a technology issue.
New technology needed	No.
Questions	Why are the lessons learned by the clothing industry, catering for the human second skin, not taken on board by the building industry that caters for the human third skin? And why are studies of the human first skin not considered in the design of our third membrane?
Sources of information for new technologies	
Barriers to uptake of technologies	
Means of assessing impact of technology	

Issue/NOW Brief	**Limiting potential harm from Electro-Magnetic Fields.** ***Goal:*** E.g. 4m separation from switchboard to bedrooms
Overview/Introduction	EMF's are perceived/believed to cause negative health impacts, from mild headaches to cancer, with no scientific consensus view on their risk. In the absence of conclusive evidence for or against prudent avoidance of exposure seems the healthy approach. To quote Reinhard Kanuka-Fuchs: *There are 7 basic emf pollutants:* *A. AC electric fields such as from high-voltage power lines, transformers, switchboards, switches, power points, wiring and appliances. The human body electric field can become affected if exposed too close (generally max 100m from high voltage power lines, 4 m from switchboard, 1 m from wiring, etc. – depending on conduction and induction circumstances. Electric fields can be shielded and earthed.* *B. AC magnetic field from flowing current in cables, appliances, etc. As above, except they cannot be shielded and only diverted such as by mu metal in computers. They affect the magnetic field of the human body. Since each human cell has a magnetic field and electric charge.* *C. Electrostatic charges predominantly in low rh offices and on unearthed surfaces, especially synthetics.* *D. DC magnetism from reinforcing steel, structural metal, metal grids, metal innersprung mattresses, all causing potential distortion of human polarisation*

	E. Microwave and radio frequencies, such as microwave antennas and ovens, cellular phones, etc. Causing in human cells an unhealthy increase of frequency and distortion of healthy structure. *F. Radioactive levels in building materials may exceed acceptable levels of human exposure.* *G. Geopathic pollution from distorted earth frequencies can cause cellular growth disturbances.* Any process of addressing EMF's needs to address each of these.
Existing technology adequate for purpose	Prudent avoidance is mostly good planning.
Technology in NZ but not much used	Careful placement of reinforcing steel grids can work well, if done.
Technology overseas	People who are concerned about this issue recommend demand switches, but design of buildings (and communities) for separation from sources seems more than adequate.
New technology needed	No.
Questions	With a topic so complex and so controversial, it is difficult to imagine how the proponents of either extreme of the spectrum of views might be satisfied. At present it is arguable that there is no guidance available that would make prudent avoidance something one could ask a designer or an electrician to practice, nor would it be something that could be readily checked by the builder or owner.
Sources of information for new technologies	
Barriers to uptake of technologies	
Means of assessing impact of technology	

Issue/NOW Brief	**Warm Shade Provision** ***Goal:*** Provide shading against UV radiation in outdoor environment that also allows warmth of the sun to combat NZ's generally cool climate.
Overview/Introduction	'Warm Shade' is a concept developed at the Victoria University School of Architecture and Design by Christina McKay to describe the dilemma that faces New Zealand which has a naturally very high cancer inducing UV index but mild temperatures necessitating warmth from the sun to mitigate the effects of cool temperatures and breezes on comfort outdoors.
Existing technology adequate for purpose	The use of transparent and translucent materials such as polycarbonate rather than 'shade cloth' type materials which create dark cold shade will clearly solve the UV protection vs warming solar radiation equation. However, there is very little design

	guidance that might help architects or building scientists balance heat gain and daylight access for adjacent windows in a building against protection from UV.
Technology in NZ but not much used	As above, the use of translucent/transparent materials solves most of the issues. The BBE also promote a variant of this idea; radiant heating or cooling to balance air temperatures. E.g. In these outdoor environments, a wall or ground surface irradiated by the sun can form a warm surrounding environment that reduces the effect of the chill in the air, with much less risk of UV damage to the skin.
Technology overseas	Nothing different to that available in New Zealand.
New technology needed	Shading technologies that solve the UV - health equation without making outdoor areas too cold. Active shading that provides shading when necessary, and information systems to assist people, for example to take action in terms of UV protection that matches exposure to skin type.
Questions	Which transparent and translucent materials are available that cause no detrimental effect, e.g. offgassing pollutants (pvc) or distortion of natural light spectrum? Again, there is a lack of information readily available to the building designer, builder or owner.
Sources of information for new technologies	
Barriers to uptake of technologies	
Means of assessing impact of technology	

Issue/NOW Brief	**Hygiene**
Overview/Introduction	Focus of this project is on house design. So long as certain minimum support standards are met (provision of space outdoors for composting, for hygienic safe storage of segregated waste for re-cycling etc) then building design may not do more than this. Reinhard Kanuka-Fuchs argues that *Holistic understanding of the element water is required, e.g. the degree of pollution, e.g. ranging from water for drinking, for cooking, for washing food, for dental care, for washing the body, for washing the clothes, for watering the garden, for cleaning the home, for washing the car, for storm water, grey water from kitchen, etc., black water from toilet, chemically polluted water.* *Different uses should result in different systems for purification to guarantee the flow and continuation of the water life cycle* While this is probably more relevant to the water section of this report, it is also relevant to consideration of hygiene issues.
Existing technology adequate for purpose	Kitchen technologies for clean handling of food Recycling technologies permitting safe grey water handling Recycling technologies allowing hygienic composting Recycling technologies pre-sorting waste into recycling bins Smart refrigerators that save energy and manage food quality

Technology in NZ but not much used	Kitchen material separation systems are on wide availability for sale, but small actual numbers. Systems exist for separation of food preparation surfaces by food type (meat, dairy, vegetables) for health Composting is well-known, little used.
Technology overseas	Smart home management systems that assist the management of food age/health factors though their links to refrigerators.
New technology needed	No.
Questions	How can the appropriate use of adequate technologies be ensured? How can sterile hygiene be brought in balance with natural hygiene? (comparison of a pvc board with a timber board)
Sources of information for new technologies	
Barriers to uptake of technologies	
Means of assessing impact of technology	

Issue/NOW Brief	**Loose fit technology so the building can adapt easily to changing circumstances and ownership**
Overview/Introduction	The building design as a technology that adapts easily to changing age/circumstances of the 'family unit' housed.
Existing technology adequate for purpose	No. The manner in which we prepare and sell basic building materials does not make it easy to assemble homes in a manner that makes disassembly relatively easy.
Technology in NZ but not much used	Bolting, screwing and otherwise assembling building products into systems that are relatively easily altered through disassembly and assembly.
Technology overseas	
New technology needed	Yes. Panels, and modular construction systems which are able to be re-used based on wall module sizes rather than the current 100x50 component 'module'.
Questions	
Sources of information for new technologies	
Barriers to uptake of technologies	
Means of assessing impact of technology	

WATER

Issue/NOW Brief	**Internal Conservation** Install low flow showerheads and taps (9l/min.or less)
Overview/Introduction	Simple measure to reduce water consumption. Easily accommodated in new buildings. The issue in existing houses is that low flow technology is often associated with mains pressure or pumped water reticulation systems which are often not fitted in older homes. New homes with solar hot water systems and/or wetbacks are often on low pressure systems and low flow fixture choice is very limited in this situation.
Existing technology adequate for purpose	OK for mains pressure new installations Some existing installations can be fitted with flow limiters
Technology in NZ but not much used	Timers and photoelectric switches available but not used in homes Aerators available but not used much
Technology overseas	On demand hot water pumps, that reduce energy consumption and reduce water wastage, so save energy and water. Notably these weren't mentioned in either the energy or water section. They are available in the UK and the US. Stop flush systems for those without water conservation toilets. Greywater diversion systems that divert grey water to toilets and or to garden uses. Raintank systems for toilet flushing and wash water. Water efficient appliances, i.e. Australian AAA rating system (i.e. front load washers etc.) Composting toilet systems to reduce wastewater/sewage.
New technology needed	A wider choice of stylish low flow fittings suitable for use with low pressure water reticulation systems
Questions	Should this measure be mandatory? Would metering be worthwhile? Should we make all new cisterns dual flush 3l half flush 6l full flush? Should we have 6l/min limit on all bathroom/cloakroom taps apart from bath tap which should be 9l/min. maximum flow?
Sources of information for new technologies	'Greenbuild' Conference and Exhibition (US) Info - Link magazine (NZ) Specialist Websites
Barriers to uptake of technologies	Cost of fittings. Water still not valued as a scarce commodity. Perception by many owners that water conservation is not a high priority investment measure. Incorrect perception that low flow means inadequate flow, for washing or showering – modern purpose designed fittings are fit for purpose.
Means of assessing impact of technology	Expert reference panel

Issue/NOW Brief	**External Conservation** Provide for rainwater collection and reuse. Reuse for toilets and garden. Goal is for at least 80% reduction in average water use for toilets and garden
Overview/Introduction	While rainwater tanks are costly to buy and install it is possible to use a decorative pond as an alternative storage area. This can also be useful as a stormwater detention measure. Swales can also be incorporated in to designs at negligible cost
Existing technology adequate for purpose	Adequate technology is available for use in both new and existing houses
Technology in NZ but not much used	Technology is available but not much used in reticulated areas. e.g. External stormwater reduction devices, i.e. raintanks for either flush/wash/garden water Paved surface replacements with permeable materials, i.e. pervious paving stones etc Managed garden irrigation systems
Technology overseas	None that is not available in NZ
New technology needed	None
Questions	
Sources of information for new technologies	'Greenbuild' Conference and Exhibition (US) Info - Link magazine (NZ) Specialist Websites e.g. http://www.gothotwater.com/Company/default.asp
Barriers to uptake of technologies	Perceived as extra cost with no incentive to invest in this measure.
Means of assessing impact of technology	Expert reference panel

General Comment

All other NOW house brief measures for water and waste are unrelated to technology.

MATERIALS

Issue/NOW Brief	**Use of Sustainable Materials** Use materials that will not damage the environment, are durable and low maintenance. Use only naturally sustainable and renewable (bio-based) materials in core systems and products unless it is inappropriate to do so (i.e. does not meet core design brief criteria, or no bio-based products/systems currently available that meet performance needs). Use of materials with lowest toxicity and health impacts practicable, if known.
Overview/Introduction	These two criteria overlap with each other and so are dealt with together. **Sustainable materials** are: - Renewable materials from sustainability managed sources or - materials made from 100% uniformly recycled resources or - materials made from manufacturing or agricultural residues or - materials made from abundant (everlasting) resources such as earth These sustainable materials should also be: - Low in embodied energy - used as close to their original state as possible - supplied from locations close to the worksite (locally sourced) - have high durability - low maintenance - be easy to reuse or be easy to recycle and incorporate into new materials used for the same purpose **The further the material characteristics are removed from this ideal state the less sustainable the material will be.** **Healthy materials** are: - Materials which have zero emissions of inimical, noxious or toxic chemicals at any stage in their lifecycle and are in themselves not inimical, noxious or toxic at any stage in their lifecycle and - do not create or leave any hazardous or inimical, noxious or toxic substances at any stage in their lifecycle and - do not require the deployment or use of any hazardous or inimical, noxious or toxic substances at any stage in their lifecycle **Environmentally friendly materials** are: - Materials which do not pollute or damage any environmental or ecological system at any stage during their life cycle and - do not deplete the earth's resources

	This seems a very high test for selecting materials. If this test is applied then there are no materials on the planet that would meet such standards, if they were strictly applied. The word 'green' is often used as shorthand to cover all three aspects covered in the brief. It is suggested that a more realistic approach might be to use materials which are 'greener' than other materials used for any given purpose. The biggest challenges appear to be in existing houses. How to make them greener and give them improved performance without tearing them apart. VUW wrote Life Cycle Environmental Impact Charts for the NZIA 1996 to help designers choose environmentally friendly materials. VUW has a nearly complete and very substantial Greener Buildings Directory listing greener materials and products with contact details.
Existing technology adequate for purpose	There are many materials that fit into this category if 'greener' is the criteria.
Technology in NZ but not much used	Bamboo – rapidly renewable and plantation grown – flooring, boarding, veneer Floor tiles made from recycled tyres Gypsum plasterboard made from 100% recycled wallboard Reconstituted polystyrene insulation from post consumer waste Natural paints, oils, hard wax, coatings and finishing's, adhesives and cleaning products (Auro, Biofa – premium cost products) Geo-polymer (very new, low embodied energy cement substitute) Woolbloc insulation made from pre-consumer carpet residues Self coloured mineral render and hard plaster (vapour permeable and requires low maintenance) Bio-cable Low-e glass Low-e paint applied coatings
Technology overseas	Wheatboard and Stramit boards made from straw Bio plastics made from maize residues (new and not many products yet but worth watching) STEICO - Insulating soft board made from (93%) pine waste and sawmill residue, free from chemical binder additives. Timber board products incorporating various amounts of chipped recycled timber Soybean-oil-based polyurethane spray foam insulation which replaces petroleum-based polyurethane foam. Mineral silicate paints which have extremely high durability have no VOCs and odour, offer excellent permeability to moisture, natural and nontoxic ingredients, absolute non-combustibility, resistance to acid rain, and natural resistance to fungi and algae.
New technology needed	Developing NZ standards for crushed recycled concrete to be reused for concrete aggregate in buildings

	Zero emission natural wood glues for use in timber board and timber engineered products (under development) Non-leaching environmentally and mammal friendly timber preservative treatments (under development) Thin, affordable and durable interior surface applied insulation Affordable phase change solar thermal storage systems Air infiltration membrane that does not let water in and controls air movement through the membrane yet still permits the outward flow of moisture and chemical offgassing vapour Having a resource such as specifications for recycled construction products as part of the UK's National Green Specification website (www.greenspec.co.uk). It is a central government funded project being carried out by the Building Research Establishment. The specifications and clauses help designers and specifiers to make informed choices in terms of the protection of the environment, material resources, embodied energy, life expectancy and durability. Source: www.bre.co.uk/news.jsp?id=222
Questions	There have been detailed studies on gypsum plasterboard made from 100% recycled wallboard by Winstone Wallboards – apparently, our market is not large enough to make this viable?
Sources of information for new technologies	'Greenbuild' Conference and Exhibition (US) Info - Link magazine (NZ) Specialist Websites www.bre.co.uk/news.jsp?id=222
Barriers to uptake of technologies	Lack of knowledge. Lack of easy to use comparative tools which are freely available and are independently assessed, based on LCA measures, and therefore the lack of comparative knowledge in the public arena. Some greener products command premium prices. Reused and recycled source materials often made by small companies and are not always adequately tested before going to market. Such companies are often short lived. Availability can be an issue.
Means of assessing impact of technology	Expert reference panel

Issue/NOW Brief	**Reuse and Recycling** Easy reuse/recycling of the house by increasing the de-construction potential. Prefer demountable, non-composite, screwed-in high quality materials and components.
Overview / Introduction	There are plenty of materials that will satisfy this requirement. Many of these will also be greener materials. Many of the factors here relate to the employment of sensible techniques rather than new technology. A fundamental factor is to achieve this result at no increase in cost as the person/people commissioning the building are unlikely to reap financial benefit for carrying out this work. Establishing markets for the reusable and recycled materials is another big issue.
Existing technology adequate for purpose	There are existing technologies that could be employed.

Technology in NZ but not much used	Technologies are not employed to any significant extent.
Technology overseas	Overseas technologies are no better than our own. Perhaps from some German car manufacturers, where extended producer responsibility is required. Much of this technology could be applied to the building industry.
New technology needed	There is effectively no definitive information on de-construction techniques available anywhere in the world. There is an unpublished PhD thesis entitled 'Design for Disassembly' but this is not a detailing guide. **There is a need for two texts**. One Design for Disassembly' and the other 'De-construction Detailing'. Currently designers and Demolition companies use their native wit and experience to do the best job possible. There is also a need for developing easy to use, low cost and reliable, reversible, fixings and connectors.
Questions	
Sources of information for new technologies	'Greenbuild' Conference and Exhibition (US) Info - Link magazine (NZ) Specialist Websites
Barriers to uptake of technologies	Beneficiaries are the nation, and possibly the people who own the building at the time of demolition, not the people who originally commission the building. Lack of practical solutions for deconstruction in the public domain – therefore a lack of knowledge. Best way to remove this barrier is through applied (in-situ) research.
Means of assessing impact of technology	Expert reference panel

Issue/NOW Brief	**Waste reduction** Reduce construction off cuts and allow for ease of reuse and recycling: rooms based on standard sheet sizes, separate construction wastes.
Overview / Introduction	There have been quite a few demonstration programmes of this nature carried out. However there seems to be little or no comprehensive guidance concerning this activity. Are there figures available for wastage that would occur on a comparable normal house? Will there be a cost benefit analysis of this work. Are there markets for the separated wastes or is this an exercise? How will it be monitored?
Existing technology adequate for purpose	This is essentially a low tech process. REBRI site, www.rebri.org.nz has a whole suite of guidance documents/informational and educational sources, including trade-specific tools. There is **guide to waste reduction on a house building site** available – the "Easy Guide to Reducing Construction Waste" – a NZ specific guide downloadable from www.rebri.org.nz This guide is being extended as part of the National Construction

	and Demolition Waste Project, targeting seven industry sectors.
Technology in NZ but not much used	Such technology that could be employed seldom is at the moment.
Technology overseas	Overseas technologies are no better than our own.
New technology needed	While there is a reasonable amount of information on modular design the information on waste reduction is less readily available. Space is always at a premium on building sites. Old oil drums are normally used to separate out wastes. There may be an opportunity for the design of some sort of stacking or **multi-compartment skip/waste container** which would take up less room than a number of ad hoc containers. This type of waste separation is certainly going to increase in the future with so many local authorities signing the zero waste protocol.
Questions	
Sources of information for new technologies	'Greenbuild' Conference and Exhibition (US) Info - Link magazine (NZ) Specialist Websites www.rebri.org.nz
Barriers to uptake of technologies	There are no incentives to minimise waste in most areas of the country. Unless it is written into the brief it is unlikely to happen. Most builders see it as an additional burden rather than an opportunity to improve their profit margins which could be the case. The fragmented and conservative nature of the building industry, the lack of an umbrella group/focus body which can easily disseminate this type of information, and the time and space pressures on a building site. Some of these issues are being addressed by the National Construction and Demolition Waste Reduction Project '03 –'05, through industry participation and workshops, guidelines and background documentation.
Means of assessing impact of technology	Expert reference panel

General Comment

There seems to be a missing link in the NOW House brief. One of the biggest issues in recovering resources for reuse and recycling is to establish markets and end uses for secondary (pre-used) materials and materials made from recycled materials/residues or even materials with significant recycled content. If the NOW House does not incorporate significant amounts of secondary and recycled materials and products how can we expect others to take this idea seriously. It may be that it is considered that this is already covered by the clause on the use of sustainable materials. However, it would be much clearer if a percentage figure, **say 20% incorporation of reused/recycled materials**, was actually stated in the brief (recycled content materials could have there recycled content included in the calculation.

Issue/NOW Brief	**Efficient Use of Structural Materials** Structural alternatives to be explored: egg alternative stud spacing/lining materials combinations or a redesigned timber framed wall of lower grade timber material. New Zealand Building Code (NZBC) compliance required.
Overview / Introduction	The briefing clause taken in context with the other clauses suggests that the explorations will be restricted to systems involving the use of timber and timber derived products. The very nature of this clause tends to suggest that current designs/techniques and possibly technologies are not considered to be adequate for use in this forward looking design.
Existing technology adequate for purpose	
Technology in NZ but not much used	Studio of Pacific Design Architects employed a timber portal frame design on the entry for the Wellington eco-house. This enabled clear spans between the portals and non-load bearing interior walls, for adaptable planning.
Technology overseas	A great deal of work was done in the US in the 60's and 70's on improving timber frame design. The potential in the system eventually evolved was up to 30% savings in framing/lining timber. The scheme was called Optimum Value Engineering (OVE). This might be a useful starting point.
New technology needed	New technology may not be needed but new techniques which could have wide application in new housing could be developed with considerable benefit.
Questions	
Sources of information for new technologies	'Greenbuild' Conference and Exhibition (US) Info - Link magazine (NZ) Specialist Websites
Barriers to uptake of technologies	Industry inertia
Means of assessing impact of technology	Expert reference panel

General Comment

The idea of having thicker walls to allow more space for conventional thermal insulation and permit clear structural spans which in turn provide significant improvements in interior partition adaptability is attractive and worth further exploration. Cost is likely to be a very significant factor.

8 Useful links recommended by expert consultants

BBE recommendations:
www.ecoprojects.co.nz/about/bbe
www.waitakere.govt.nz/ecocity/ecobuild/sustainable
www.baubiologieusa.com
http://www.maes.de/
http://baubiologie-ibn.de/
www.buildinggreen.com/press/topten/top-10-list.cfm

For comparative material tools/publications:
The UK's Building Research Establishment www.bre.co.uk
The USA's GrenSpec at www.buildinggreen.com/menus/index.cfm ; and
Australia's www.ecospecifier.org/
International Energy Agency www.iea-shc.org
Other sources:
The USA National Institute of Standards and Technology has a very good Building for Environmental and Economic Sustainability system (BEES).
The Association of Chartered Certified Accountants (www.accaglobal.com) has very good guidelines used for Environmental reporting as part of the triple bottom line reporting procedures. The most reliable quantified information will come from companies and they can drive sustainability through process and product development.