Ministry for the Environment
Manatū Mō Te Taiao

Value Case for Sustainable Building in New Zealand

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The value case for sustainable building is now compelling:

- For owner occupiers, a 20-year whole-of-life cost view indicates the marginal cost increase of sustainable building is likely to be repaid between five or six times by operating cost savings alone.
- For tenants, the probable 20-year rental premium for sustainable buildings is likely to be repaid by a factor of approximately three from operating cost savings only.
- For owner occupiers, developers and investment funders, a residual land value analysis shows a sustainable office building may have a land value of 40% more than that of a conventional building. Its true worth is nearly 40% more than a conventional building.
- The case studies show that to achieve the above investment returns, the difference in the initial capital cost of sustainable buildings compared to conventional good quality buildings varies from 15% less to 11.5% more, with sustainable features initially costing an average of 2–6% more.

Sustainable buildings are intrinsically more economic to run over their whole lifetime. They reduce waste and are much more efficient in their use of key resources such as land, energy, water and materials. They can also be healthier and more comfortable, and support greater productivity, with improved levels of natural light, cleaner air and a higher degree of personal control. They are also adaptable and durable enough to meet the requirements for flexibility and needs of future generations of building occupiers.

Significant rises in energy costs and, to a lesser extent, water costs continue to make sustainable buildings increasingly attractive. This situation will continue, with additional user charges such as carbon taxes, making new generation sustainable building even more attractive.

Public sector clients have incentives known as ‘Crown Loans’ to offset any capital cost premiums associated with adopting sustainable building strategies. Part funding is also available from the Energy Efficiency and Conservation Authority (EECA) for design audits and modelling which test the cost/benefits of sustainable building.

Scope

Sustainable building principles can be applied to all building types. It is a proven technology with more than 20 buildings of varying types in New Zealand operating successfully. Many of these are award winning and are well liked by their users, with comfort, health and productivity benefits in comparison to conventional buildings.

The next few years will almost certainly see the introduction of an environmental rating system for commercial buildings into New Zealand, with higher rated buildings realising market advantages. 'Green leases' giving continuing certainty of environmental performance are also likely to be developed in response.

This *Value Case for Sustainable Building in New Zealand* provides material that can be used to demonstrate the business case for building sustainable buildings in New Zealand to key decision-makers including:

- public sector chief financial officers
- owner occupiers
- investment funders
- developers
- tenants.

Implementation

Government and the public sector can play a leading role in sustainable building, but the longer-term success of sustainable building will also depend on its adoption by the private sector.

Sustainable building needs to be implemented on a cooperative and integrated basis by client, design team and contractor. Planning for sustainable building needs to take place as early as possible; by the time the first 1% of a project's up-front costs are spent, up to 70% of its life-cycle costs may already be committed.

The future for sustainable building in New Zealand is bright. It lies in applying highly inventive and cost-effective approaches and technologies that are suited to our relative isolation, small population, benign climate, relative reliance on renewable energy, and economic agility. We are in an excellent position to create a new sustainable building paradigm.

1 Introduction

This *Value Case for Sustainable Building in New Zealand* concentrates on the environmental and economic issues related to mainstream New Zealand buildings. It is intended to provide material that can be used to demonstrate the business case for sustainable buildings to key decision-makers including:

- public sector chief financial officers
- owner occupiers
- investment funders
- developers
- tenants.

Definitions of sustainable or green buildings vary widely (e-Dialogues for Sustainable Development, 2004). In the context of this report, they are characterised by:

- radically reduced energy consumption
- improved resource efficiency
- reduced environmental impacts
- improved indoor environment
- lower impact on local infrastructure
- being easier to manage.

These characteristics enhance a building's marketability and asset value.

The Value Case focuses on new non-residential public and commercial buildings including:

- offices
- schools
- hospitals and health care buildings
- tertiary institutions
- libraries.

Sustainable building strategies could also be applied, and have been in some instances, to other building types such as hotels, supermarkets, retail centres, sports venues, prisons and transport centres. They apply to both new buildings and to building refurbishments.

As well as providing some relevant case studies, this report describes the New Zealand context for sustainable building, its economics and its implementation. It contrasts these with overseas trends and finally looks at the potential drivers for sustainable building in the future as we approach the beginning of the end of cheap fossil fuel.

We have tried to make this report as non-technical possible, and a glossary of terms commonly used in sustainable building is included in Appendix 5 of this report.

2 New Zealand Context

The application of sustainable building principles to larger-scale non-residential building in New Zealand is relatively recent. Much of the New Zealand experience is reflected in the case studies in Section 3.0. Apart from the value case itself, other factors that encourage sustainable building in New Zealand include:

- the promotion of sustainability in government operations through programmes such as the Sustainable Development Programme of Action, Govt[3] and EECA's EnergyWise Government programme
- Agenda 21 and the Cities for Climate Protection programmes, to which a number of local authorities have committed themselves
- regulation such as the Resource Management Act and the recent Building Act
- establishment of an interim Green Building Council
- overseas trends
- perceived or real marketing benefits.

Internationally, government and other public bodies are increasingly asking for sustainable buildings, which are also being widely encouraged and implemented by a responsive property construction sector. This has led to increasingly sophisticated and innovative building designs and technologies that encourage both energy conservation and CO_2 reduction. The future in New Zealand may lie in a hybrid approach – drawing on international experience and developing locally a range of inventive and cost-effective approaches and technologies suited to our relative isolation, benign climate, relative reliance on renewable energy, and economic agility. We are in an excellent position to become leaders in sustainable building.

2.1 Funding assistance

Up to 50% funding is available from the Energy Efficiency and Conservation Authority (EECA) for professional fees for design auditing and modelling the energy component of sustainable building design. This means the relative costs and benefits of energy-saving strategies can be more accurately assessed at the design stage. If this assessment is not done, the opportunities for energy efficient design can be lost.

Through its Crown Loan Scheme, EECA also offers full or partial funding of government and local government projects to achieve energy cost savings. Current figures show that the ongoing annual savings for projects in New Zealand funded by the scheme are almost $3.8 million a year, with reductions in CO_2 emissions of almost 20,000 tonnes a year. The aim of the fund is to reduce the barriers to cost-effective energy efficiency investments (WEB 1, 2005). One of the case study buildings, Waitakere Hospital, was the first such building to use both these incentives.

The long term success of any type of funding will rely on finding ways to bridge the gap between capital investment and annual running costs.

3 Sustainable Building Case Studies

3.1 Introduction

Five detailed case studies in Section 3.4 cover the following types of buildings:

- university
- community library
- high school
- sub-district hospital
- office.

While the case studies concentrate on individual buildings, their analysis has been supported by the additional review of up to four other projects for each building type, where possible. More than 20 non-residential buildings in New Zealand have now adopted sustainable strategies to a lesser or greater extent.

3.2 Specific findings

Costs

It is difficult to draw definitive conclusions about the costs of sustainable buildings, as their nature and extent varies widely. It can also be difficult to differentiate between sustainable design and architectural features. Table 1 shows the indicative cost/benefits for the case study buildings. Some of the case study buildings have proved cheaper, others cost-neutral, and some more expensive. In forming our view on the value case for sustainable building we have therefore supplemented the case study data with overseas experience, where the extent and market for sustainable buildings is more developed.

Table 1: Indicative cost/benefit summary for case study ecologically sustainable development (ESD) buildings

Building type	Benchmark building capital cost $/m^2	ESD building capital cost $/m^2	ESD building premium (saving) $/m^2	ESD building premium (saving) %	Annual energy cost savings $/m^2	Annual water cost savings $/m^2	Total annual cost savings $/m^2	Simple payback (years)	20-year NPV for ESD measures $/m^2
Tertiary education	2300	2000	-300	-15.0	6.3	0.0	6.3	N/A	-338
Hospital	2400	2435	35	1.5	9.5	1.0	10.5	3.33	-72
Secondary school	2430	2570	140	5.7	7.5	0.6	8.1	17.3	41
Library	2384	2494	110	4.9	7.5	0.0	7.5	14.67	32
Office – low/ medium ESD	2000	2130	120	6.0	11.0	0.3	11.3	10.65	-3
Office –medium/ high ESD	2000	2230	230	11.5	17.0	0.6	17.6	13.09	-23
Average	**2252**	**2310**	**56**	**2.43**	**9.80**	**0.42**	**N/A**	**N/A**	**N/A**
Median	**2342**	**2333**	**115**	**5.30**	**8.50**	**0.45**	**N/A**	**N/A**	**N/A**

Notes:

1. Discount rate of 8.5%
2. Energy and water costs assumed to increase at 3% above inflation.
3. Three-year pre-design and construction period, with 20-year consideration period.
4. Costs have been normalised to 2005.
5. The library case study includes a number of materials features which add significantly to the sustainability of the building but which do not have a direct payback to the building owner. These include certified timber, alternative to CCA and LOSP timber treatment, recycled wool acoustic insulation, ceiling tiles with 70% recycled content, plant systems endorsed under the environmental choice labelling scheme, modular carpets with 100% recycled face fibre, cement with 70% fly ash content, crushed demolition materials as hardcore, alternatives to PVC and on-site waste management. These measures were generally included within a 1% premium on top of the construction cost.
6. Alternative on-site stormwater management systems such as swales and rain gardens can generally be achieved for little or no cost premium provided the budget includes a reasonable allowance for landscaping. The hospital case study included a stormwater retention pond which attracted a relatively significant cost premium.

We conclude that the purely sustainable features of a building add around 2–6% to the cost, compared with a conventional building. As discussed elsewhere in this report, operating cost savings pay this back many times over during the life of the building. This compares to international data as follows:

- Australia 2–4%
- United Kingdom 10%
- United States 0.7–6.5%

Building type affects the economics

The range of buildings illustrates that sustainable building strategies can be applied to any building type. The value case will, however, apply more to high intensity / long duration activities such as hospitals, than to low intensity / short duration activities such as schools. The nature of the building use may, however, make it harder to adopt certain sustainable strategies. Natural ventilation may have only limited application in hospitals, for instance, due to requirements for infection control, but can be widely adopted in other buildings such as schools. So although sustainable strategies can be applied to any building, their extent and value case differ significantly and require specific consideration.

Energy and water savings

The New Zealand case study buildings have all reduced energy and water usage (where conservation strategies have been implemented) compared to other buildings of the same type. However, predictions of energy used for the case study buildings have been generally optimistic compared to real data, generally because of extended hours of operation, inappropriate use of the building (particularly in the first year of operation), and factors that were not anticipated or interpreted correctly at the design stage.

Buildings enjoyed by users

The individual New Zealand case study buildings are almost all well liked by their users, as confirmed by both formal post-occupancy evaluations and anecdotal response. The sample is small and relates more to the better buildings, but New Zealand sustainable buildings generally have positive user satisfaction and potential benefits in terms of productivity, and are within the upper 5% of buildings surveyed by the Probe Study methodology (Leaman and Bordass, 2001). This may be largely due to the nature of the projects, with motivated clients and users, the relative simplicity / clarity of design intent of the sustainable strategies, and the interest, follow up and fine tuning of performance post-occupancy.

Time and budget constraints lead to lost opportunities

A number of the case study buildings faced an initial scepticism to adopting sustainable building strategies due to unfamiliarity, concerns about cost and performance and a lack of completed projects in the New Zealand context. In many instances, sustainable features were regarded as optional and were compromised – particularly when budgets were under pressure – even if they were not the cause of the situation. Sustainable features can be seen as soft targets for cost cutting – particularly for quantity surveyors and project managers.

Sustainable buildings prove to be reliable

The design and technologies employed in the case study buildings have generally proved reliable and fit for purpose. Any issues have been resolved during the first year of operation, as is normally the case for a conventional building. Some issues of summertime overheating in naturally ventilated buildings in the hotter and more humid Auckland environment could have been better addressed at the design stage – normally by a reduction in glass area or by better shading.

Award winning

Most of the case study buildings are of a high architectural quality, as shown by the architectural awards they have received. This has undoubtedly added to the experience for all involved – client, design team and users. It has also added to the general user satisfaction of some of the case study buildings subject to post-occupancy evaluation. Combining sustainability and architectural excellence requires a much more involved, and therefore expensive, design process. Some of the perceived extra costs of sustainable buildings may be due to this combination.

Generally, the completed case study buildings may be considered state-of-the-art rather than leading edge, at least in an international context, and are therefore not highly innovative. The challenge has been to reinterpret some international approaches in terms of availability of materials and equipment within the constraints of the New Zealand construction market and cost envelope. Clients and design teams have been challenged to think harder and leaner to change the normal construction process and, in doing so, have unintentionally added to the sustainability of the overall solution in comparison to overseas buildings.

Commitment from clients

In all the case study buildings, clients have accepted the sustainable path. In hindsight, some would have gone further. The increased capital cost premium paid by some has quickly looked like a sound, far-sighted investment as energy costs have increased beyond expectation over the past 10 years. The statement is often made – "I wish we had done more".

3.3 Conclusions

Some general conclusions can be drawn from the case study buildings:

- The difference in the initial capital cost of the case study buildings compared to conventional good quality buildings varies quite widely (from 15% less to 11.5% more), with sustainable features initially costing an average of 2–6% more.
- Energy costs for the case study buildings are 35–50% of those for similar conventional buildings.
- The sample is small and relates to perhaps the better quality buildings, but it can be concluded that New Zealand's sustainable buildings generally have positive user satisfaction and potential benefits in terms of productivity. They are within the upper 5% of buildings surveyed by the Probe Study methodology.
- The range of case study buildings illustrates that sustainable building strategies can be applied to any building type.
- The range of sustainable strategies being adopted is growing and has moved from conscious attempts to save energy to increasingly holistic approaches, which address not just energy but a wider range of environmental issues including water use, materials selection and waste management.
- The design and technologies employed in the case study buildings have proved generally reliable and fit for purpose.

- Many of the sustainable buildings are award winning and are of a high architectural standard. However, this has sometimes led to the costs of the sustainable aspects of the building appearing higher than they actually were.
- Sustainable design is most successful when experienced consultants are brought in at an early stage in the initial design brief and the procurement process.

Sustainable buildings represent a viable and increasingly attractive alternative to conventional buildings with benefits in terms of operating costs, user satisfaction, future proofing and environmental protection.

3.4 The case studies

University – Mathematics, Statistics and Computer Science Building

Summary

Client	University of Canterbury
Site address	University of Canterbury, Ilam, Christchurch
Total floor area	11,500m^2
Cost/m²	$2000 (adjusted to 2005)
Conventional cost/m²	$2300 (15% above project cost)
Contract value	$22 million (adjusted to 2005)

Economics

The indicative economics for this case study building are in the table below. The building primarily focuses on low energy design as there is no payback for water saving measures due to the method of charging for water use in Christchurch.

The capital cost for the building was significantly below the campus benchmark even though the pre-tender estimate indicated it would be more expensive. This was due mainly to the reduction in scope and size of the mechanical systems required. Rather than re-investing the savings into additional sustainable design features the University chose to incorporate additional student computer labs.

Building type	Benchmark building capital cost $\$/m^2$	ESD building capital cost $\$/m^2$	ESD building premium (saving) $\$/m^2$	ESD building premium (saving) %	Annual energy cost savings $\$/m^2$	Annual water cost savings $\$/m^2$	Total annual cost savings $\$/m^2$	Simple payback (years)	20-year NPV for ESD measures $\$/m^2$
University	2300	2000	-300	-15.0	6.3	0.0	6.3	N/A	-338

Environmental summary

- Energy used – 135 kWh/m^2.
- Stormwater design – connected to campus stormwater system.
- Site – uses artesian borehole for cooling and sit boilers for the heating; site orientated north/south.
- Waste – no specific strategy.
- Material – limited finishes, high use of local materials; high-performance sine wave slab serving multiple functions.

Client brief

The building was the subject of an architectural design competition won by Architectus CHS Royal Associates. In developing the brief, the University of Canterbury required the building to have low energy consumption. This was supported by both the architects' and engineers' desire for a passive low energy building, maximising both natural ventilation and large amounts of daylight.

Facilities

Housing two academic departments, Mathematics and Statistics, and Computer Science the 11,500 m^2 project is split into two main accommodation blocks separated by a five-storey high glass atrium.

The first block comprises three seven-storey blocks containing staff and postgraduate offices (orientated towards north), while the second four-storey block houses the undergraduate teaching facilities. A basement under the atrium contains further teaching and service spaces, with circulation towers enclosing the glass roofed atrium at each end.

Site

The building has its long axis lying north-west to south-east and follows the university grid pattern.

Concept

The designers insisted on the inclusion of effective natural climate control and innovative ventilation strategies from the start. For the offices this included a northerly orientation and fixed overhangs, exposed thermally massive interior walls and ceilings, fixed and adjustable exterior and adjustable interior solar shading devices, and a large number of window or louvre opening options. The 90 individual cellular offices have a wide range of ways to control the environment without using external energy.

The four-storey, 15.7 m deep by 55 m long south-west-facing teaching wing is designed to accommodate large open computing laboratories and tutorial spaces. The 6.8 m-wide atrium links the two wings. Its sloping glazed roof is oriented to the south-west, while its glazed internal walls have openable windows to the adjoining wings. Bridges link the two main wings at each level.

Building began in 1996, when waste and water minimisation was not a high priority. The main driver for this building was minimising energy use.

Teaching block design

Energy

The passive (non-mechanical) low-energy concept design focuses on the following:

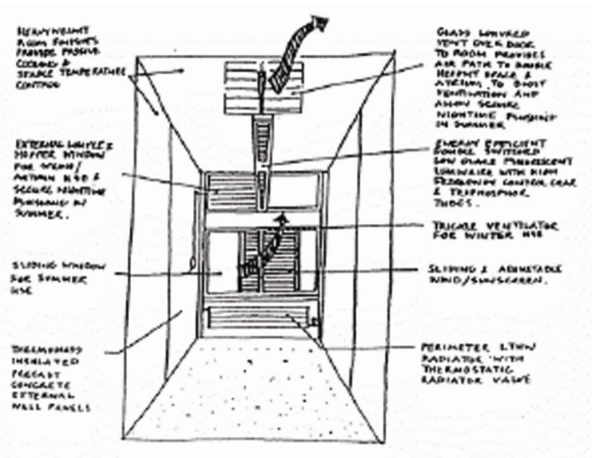
- atrium-assisted natural and smoke ventilation
- passive solar temperature control using thermal mass
- extensive use of daylight via a central atrium and adjoining double-height spaces
- supply air passing through horizontal ducting built in to the sinusoidal concrete structural floor slab. This makes use of the slab's thermal mass to maintain an even temperature.

These passive strategies were overlaid with the following active (mechanical) strategies to further minimise energy costs:

- a highly efficient artificial lighting system with an electricity consumption of 9 W/m^2 (half the current New Zealand standard)

- a sine wave structural floor system integrated with an underfloor air conditioning system. This arrangement combines five functions (column free structure, air supply, cable reticulation, ceiling surface and thermal heat sink) and also reflects the mathematical function of the building
- ground water cooling
- a high level of individual control in the academic offices with a wide range of ways to control the environment without using external energy
- plant and motorised window openers controlled via a building management system.

Academic block design



Post-occupancy evaluation

In 2001, a post-occupancy evaluation was carried out on the building to give occupants feedback on its performance and to compare the ratings with national (UK) benchmarks.

Students and staff rated the building highly. It reached a level of satisfaction (measured by noise, lighting, overall comfort, summer and winter temperatures) in the top five percentile of the 2001 benchmark data set.

Summer and winter temperatures were rated as comfortable by both staff and students. Noise levels were found to be generally acceptable, with overall air quality and lighting being rated highly.

All staff have access to a user manual for the building, and it was pleasing to find that all user control ratings were in the top 15% of the benchmark data set, significantly higher than the benchmark.

The UK benchmark for perceived productivity for 2001 was minus 1.87%. The productivity score at MSCS was plus 9.80% (percentile 97%). This should be read to mean ‘occupants think that the building boosts their productivity at work by about 10%, compared with their experience of other working environments’.

Materials

A restricted palette of materials was used for the building – including concrete, glass, plywood and cedar sunscreens – making the structure resource efficient. The philosophy of the building was ‘what you see is what you get’ using materials in their raw state with minimal applied finishes.

High-performance building elements were also used, such as the air floor that serves five functions – structure, air distribution, cable distribution, ceiling finish and exposed thermal mass.

Site

Thermal mass was used specifically to provide stable and natural temperature control for Canterbury’s wide range of temperatures, thanks to the northwest/southerly wind shifts.

The building is in the new Science West Precinct that will also include the Future Sciences Library building. The MSCS building and the Future Sciences Library building share a new, centrally located artesian borehole for cooling. The borehole water is discharged back to and supplements the flow back in the nearby Oakover stream.

Offices have been placed to maximise views of the Southern Alps. The more densely occupied teaching facility with computers is orientated to the south. The sun is controlled to the east and west by massive shear walls with restricted openings.

Transport

The building is an integral part of the out-of-town campus. Buildings are mainly accessed by students on foot and by public transport.

Bicycle parks are provided throughout the university campus, while a small car park is available for staff and visitors.

Water

There are no specific water saving features, as this was not an issue at the time of construction. Water conservation would be addressed more fully if the building were to be designed and built today.

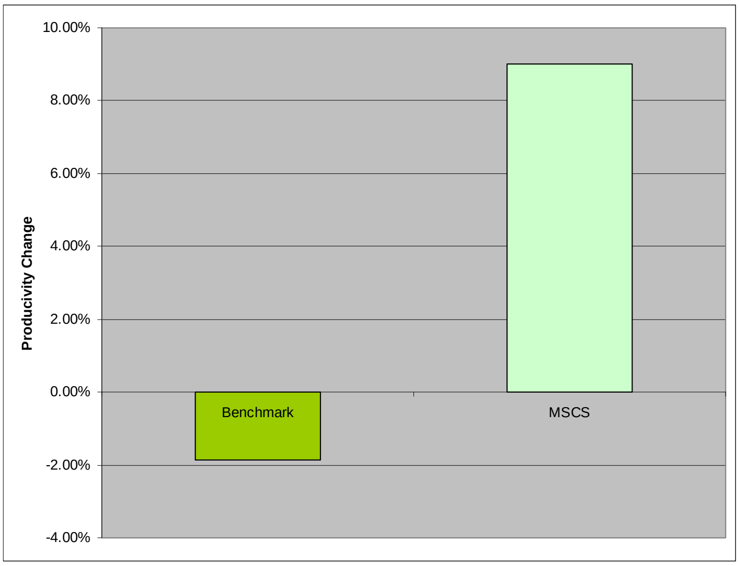
Process

Key to the success of the building's environmental design lies in the initial architectural concept, the collaborative approach taken by the designers, and the exploitation of its potential for environmental control and low energy use.

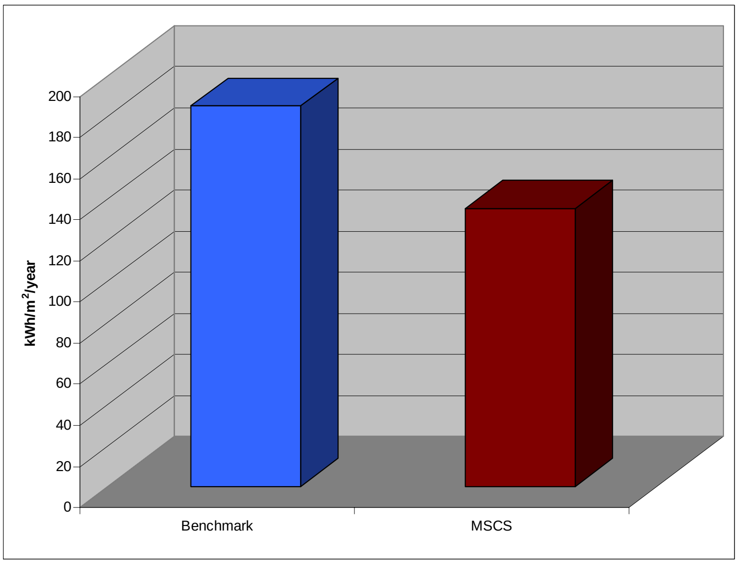
The main components of the design process are:

- a design brief outlining low energy consumption as a priority
- parallel development of traditional and innovative design solutions for review and comparison with the client
- an increased pre-tender design time of three months
- post-occupancy evaluation to improve and explain the performance of the building from the occupants' perspective
- stakeholder involvement in the project brief and design development from the outset.

Productivity



Energy



Lessons learnt

The MSCS building is a good example of hybrid design (with both active and passive thermal environmental control systems) showing how successful a collaborative design approach is when used from the outset of the project.

Including effective natural climate control and innovative ventilation strategies in the building's design added up to money in the bank, with the building significantly under budget, and costing less to run than a typical university building of its size.

Credits

Client	University of Canterbury
Project manager	University of Canterbury
Architects	Architectus CHS Royal Associates
Quantity surveyors	Shipston Davies
Contractor	Naylor Love
Mechanical, electrical and fire engineers	Ove Arup and Partners New Zealand Ltd

Community library – South Christchurch Library and Service Centre

Summary

Client	Christchurch City Council
Site address	Cnr Colombo Street and Hunter Terrace, Beckenham, Christchurch
Total floor area	2400m^2
Cost/m²	$2494 (2005, including park, landscaping and roading)
Conventional cost/m²	$2384 (4.9% below project cost)
Contract value	$4.6 m including park, landscaping and new road

Economics

The indicative economics for this case study building are set out in the table below. Note that water saving measures do not show any payback due to the method of charging water in Christchurch. However, this situation is likely to change in the future as water supplies come under increasing pressure.

Incorporating a considerable number of environmentally preferable materials and technologies in the building also has no direct payback but was accomplished for less than 1% of the total construction costs. Taking these factors into account, along with the fact that this type of building is less intensively serviced, makes this type of sustainable building a medium to long-term investment – normally acceptable to a local authority client.

Building type	Benchmark building capital cost $/m^2	ESD building capital cost $/m^2	ESD building premium (saving) $/m^2	ESD building premium (saving) %	Annual energy cost savings $/m^2	Annual water cost savings $/m^2	Total annual cost savings $/m^2	Simple payback (years)	20-year NPV for ESD measures $/m^2
Library	2384	2494	110	4.9	7.5	0.0	7.5	14.67	32

Environmental summary

Energy use:

- 120 kwh/m^2/annum

Water use:

- Low-water-use plumbing fittings
- Rain water harvesting

Stormwater design:

- Landscape features used to retain and filter stormwater

Site:

- Retention of mature vegetation
- Predominant use of local indigenous species

Material:

- Low-impact materials

Waste:

- On-site waste management
- Use of materials with recycled components.

Client brief

The client brief was to provide a library building that would give a much needed focus for the lower Cashmere Community in Christchurch. The building design was developed through an extensive community consultation process.

It was to be sympathetic to the residential character of the area while at the same time maintaining a civic presence. A key component of the brief was also to meet the Council's policies on environmental sustainability and energy use.

Facilities

The building houses three key functions: a community library, an education centre, and the local council service centre and advocacy team. It also provides a number of other community facilities such as formal and informal meeting rooms, a display space, a café and offices for the community constable.

Site

The site was council-owned. It had an existing building, with the rest of the site fenced off for use by the Christchurch City Council water services department.

There was a significant number of mature trees and vegetation as well as hardstand areas, several aquifier water supply wells, pump stations and other ancillary facilities. To the north, the site was bounded by Hunter Terrace and the Heathcote River.

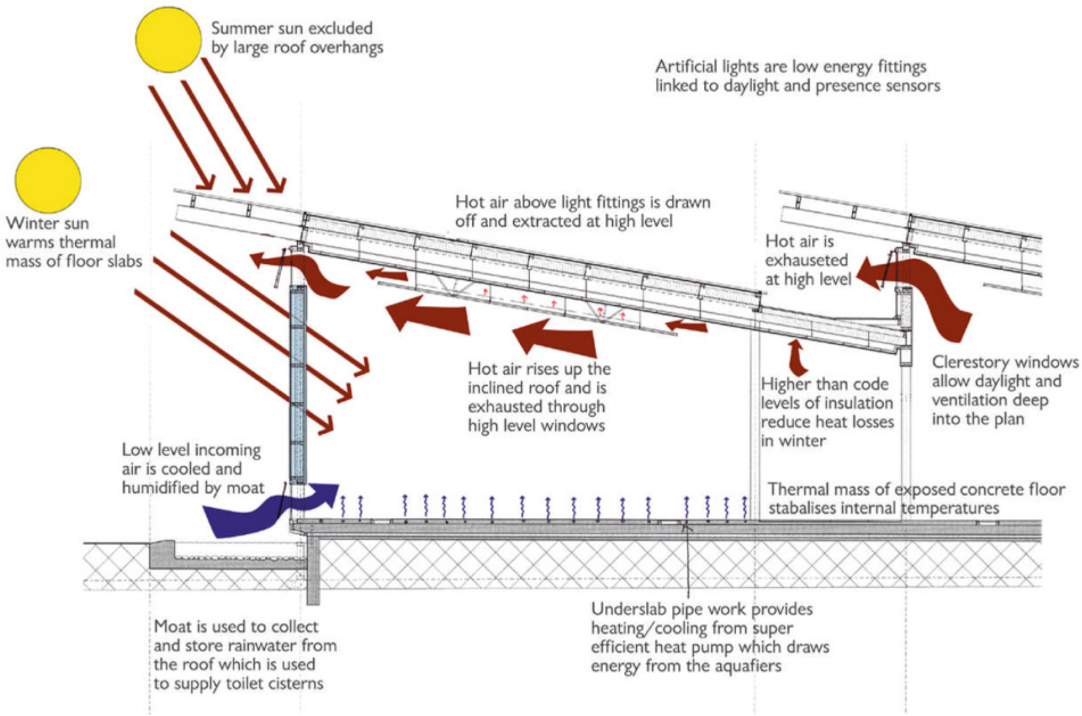
Concept

A low-rise single-storey building in keeping with the residential nature of the site, it uses a dramatic saw-tooth form and a stepped plan sitting in a water-filled moat to create a distinctive presence.

The site was cleared of buildings, and the mature vegetation retained and tidied to create a public park for the community. In time, part of Hunter Terrace to the north of the park will be closed off and the park will spread down to the edge of the river.

The building is solid and heavily insulated to the south where back-of-house facilities are located, and gradually opens up to the park in the north. Visitors enter the building from the south and are led across to the public spaces in the north which look out onto the landscape.

The saw-tooth roof form breaks the building into four distinct blocks and allows daylight and ventilation to penetrate deep into the plan.



Energy

The passive low-energy concept design focused on the following:

- double glazing and higher than code insulation levels
- north-facing glazing and large roof overhangs combined with mature vegetation to optimise solar gains
- saw-tooth roof form to allow daylight and ventilation throughout the building
- optimised orientation for passive solar design with north-facing glazed public areas and south-facing well insulated support spaces
- optimised wall-to-window ratios determined through 3D energy modelling
- strategic placement of thermal mass determined through 3D energy modelling
- opening windows throughout the building.

These passive strategies were overlaid with the following active strategies to further minimise energy use:

- aquifer water in Christchurch's mains supply pipes was used as energy source for a heat pump-based heating and cooling system
- water-based under-floor heating / cooling of the slab
- motorised window openers to optimise the use of natural ventilation and utilise free cooling
- low-energy T5 light fittings on shared ballasts linked to daylight sensors
- chilled-beam air conditioning in high-load rooms only, linked to presence sensors and contact switches on manual windows to ensure system switches are off when not required.

In all cases, low-energy design solutions were rigorously tested through 3D energy modelling to ensure they met the client's payback criteria, which was five years for equipment, but longer for fabric changes such as double glazing and insulation.

Project image

Water

Water conservation was not a high priority, however a number of innovative techniques were employed to reduce water use and minimise the volume of sewage leaving the site. Low-water-use plumbing fittings were specified throughout, including:

- dual-flush 3/6 litre toilet cisterns
- waterless urinals
- low-flow shower heads
- taps with flow restrictors, aerators and automatic shut off.

The water-filled moat around the building is also used as a collection and holding tank for rainwater supply for the toilet cisterns.

Waste

Waste minimisation was an issue of key importance to the client:

- The building was used as a pilot for Christchurch City Council Target Zero waste in construction study and a site-specific waste management plan was adopted and monitored during the construction.
- The demolition contract encouraged recycling and salvage of demolition components. Volume of material salvaged and recycled was recorded and monitored.
- The hardfill beneath the new building is partly composed of demolition material from the buildings that previously occupied the site.
- Products with a high recycled waste component (such as ceiling tiles, cement, insulation, carpet and furniture) were specifically selected for use.
- Space was allocated for the collection and separation of recyclable waste.

Materials

Within budget constraints, the designers sought to select environmentally preferable materials, including:

- sustainably sourced timber and timber veneers
- alternatives to CCA and LOSP timber treatments
- water-based paint systems endorsed by the Environmental Choice labelling scheme
- woollen acoustic insulation
- rubber flexible sheet flooring
- ceramic tiles in high-traffic areas for thermal mass and durability
- carpet systems produced by a Natural Step company manufactured from recycled materials
- durable external surfaces requiring no applied surface finishes (stone, glass and aluminium)
- materials with a high recycled content
- CFC and HCFC free polystyrene sheet insulation and pipe lagging
- low toxicity, low-emission materials, water-based paints, low formaldehyde mdf, phenollformaldehyde plywood, low emission ceiling tiles and avoidance of flexible PVC floor coverings.

Site

The site design is an integral part of the ecological design.

- The building footprint was designed to keep as much of the existing mature vegetation as possible.
- With the exception of the specimen trees in the car park, the new landscape consists of native indigenous plants
- The landscape has been designed to need no irrigation after the initial establishment.
- Rooftop rainwater from the front three blocks is collected and harvested in the moat surrounding the building, minimising stormwater run off.
- Rooftop rainwater from the back block is run ‘gutter free’ into a riverstone and gravel filter trough and then slowly finds its way into the rain garden.
- Polluted car park stormwater is channelled into a landscaped drainage swale to filter and delay the water before discharging into the landscaped rain garden.

Transport

The building has a large 70-space car park that is often full. However, the client tries to reduce vehicle use by:

- locating the facility in a suburban centre
- relocating a bus stops to the entrance of the library
- providing cycle stands for public and staff
- providing staff shower and locker facilities to encourage cycle use
- a council policy of not allocating parking spaces to staff.

Process

Key changes to the normal procurement process were pivotal to the environmental success of the project:

- a design brief that clearly demanded that ecologically sustainable development (ESD) be a priority of the design
- a realistic but taxing energy brief and a separate energy budget to pay for low-energy strategies with approved payback periods
- the use of 3D energy modelling
- an interview process which stressed the importance of ESD
- a design team and project management committed to making the effort to try new techniques
- a knowledgeable client and specific input at key dates from the Natural Step and the Christchurch City Council Target Zero team
- a contractor who bought into the ideals of the project
- a shopping list of energy saving and ESD options, which allowed the client to approve the adoption of specific ESD strategies based on importance, cost and payback.

Lessons learnt

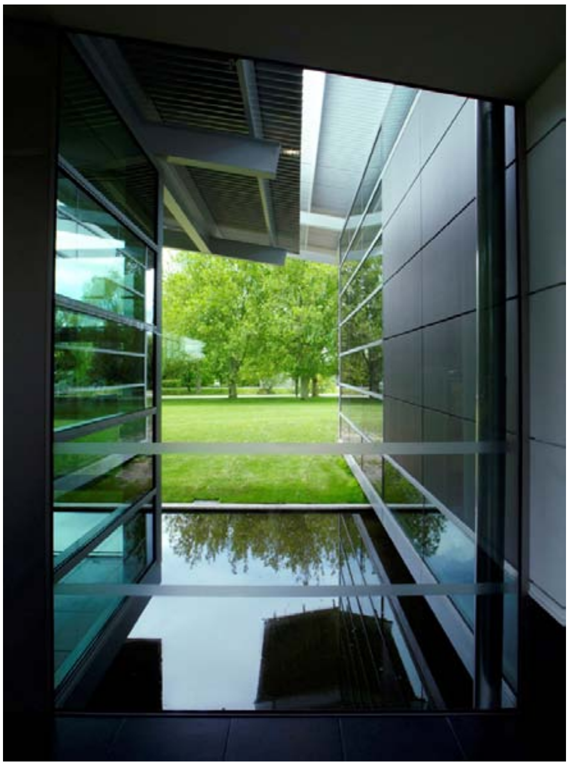
Since its opening, the facility has been hugely successful, with the informal character and café attracting more visitors than anticipated. The building is also well liked by the staff and – because of this – some of the more unusual features seem to be well understood and managed.

However, it remains to be seen whether or not the building will continue to be managed as well when the novelty wears off.

Engineers took significant time and effort during commissioning and monitoring energy uses. This commissioning continues and the engineers are confident that further energy savings will be achieved.

The water-filled moat caused particular problems during commissioning. Algae build-up was not controlled sufficiently by the proposed enzyme treatment and filtration system. The actual effect of the moat on overall water use is not known because water must be topped to cope with evaporation losses.

The moat has been designed with a river boulder base to look like a dry riverbed in droughts. This facility has yet to be used and does create some additional cleaning requirements. However, the moat is a successful architectural feature and the security it provides means the building can have opening windows and doors.



Credits

Client	Christchurch City Council
Project manager	City Solutions
Architects	Warren and Mahoney
Quantity surveyors	Shipston Davies
Contractor	Mainzeal
Landscape architect	City Solutions
Structural and civil engineers	City Solutions
Electrical engineer	Beca Carter Hollings & Ferner Ltd
Mechanical and fire engineers	Beca Carter Hollings & Ferner Ltd

High school – Albany Junior High School

Summary

Client	The Ministry of Education
Site address	Appleby Road, Albany, North Shore
Total floor area	8,633m^2
Cost/m²	$2570 (adjusted to 2005)
Conventional cost/m²	$2430 (5.7% below project cost)
Contract value	$22.2 million

Economics

The indicative economics for this case study building are in the table below. The savings over the benchmark suggest that the benchmark may be increasing due to longer operating hours and community use. The intensity of site usage is also increasing, such as, for example, the use of two-storey buildings and increasing use of computers.

Building type	Benchmark building capital cost $/m^2	ESD building capital cost $/m^2	ESD building premium (saving) $/m^2	ESD building premium (saving) %	Annual energy cost savings $/m^2	Annual water cost savings $/m^2	Total annual cost savings $/m^2	Simple payback (years)	20-year NPV for ESD measures $/m^2
Secondary school	2430	2570	140	5.7	7.5	0.6	8.1	17.3	41

Environmental summary

The Albany Junior High School development included the following measures to promote positive social, environmental and economic outcomes:

- passive solar design and building orientation
- optimisation of window-to-wall ratios and thermally efficient glazing systems in selected areas to promote high level of daylight and energy efficiency
- design of a central atrium to the administration building to promote daylight levels and natural ventilation
- energy-efficient lighting systems including luminaries and daylight controls
- energy-efficient façade design and higher level of insulation than New Zealand Building Code requirements

- use of mixed mode ventilation systems to promote indoor air quality and energy efficiency
- energy-efficient heating systems and solar hot water heating to serve the gymnasium change rooms
- provision of stormwater collection and re-use.

Project description

Located in the Albany basin, the Albany Junior High School is a new concept for the Ministry of Education. Established around concepts of 'integrated learning', the co-educational school provides facilities for students from years 7 to 10. The first stage of the development is configured for 780 pupils, with a second stage set to increase this number to 1400.

Stage one includes three whanau (classroom) buildings, an administration building, gymnasium and Performing Arts Centre. The future stage two development will include two further whanau buildings. All of the buildings are two storeys high. Specialist knowledge areas such as visual arts, science and technology are divided between each of the whanau buildings. Sports fields and hard surface courts have also been provided.

The whanau concept breaks down the scale of the school into manageable and identifiable groups for the students to relate to. Each whanau group is then broken down in to core teaching areas, specialist knowledge areas, gathering space, resource and office areas.

The design team for this project brought together experience from the design of the first two secondary schools to be developed by the Ministry of Education in 25 years (Botany Downs Secondary College and Alfriston College both completed in 2004) as well as from the Establishment Board.

A significant factor in the design of the school's built environment was the consideration of ecologically sustainable development (ESD) measures, particularly to promote positive educational outcomes, improved teaching and learning environments, minimisation of energy use and reduced environmental impact.

Project images

Site plan

Energy

Efficiency

- Insulation in roofs and walls at higher than building code levels reduce heating energy use.
- High performance glazing on larger window areas reduces heat loss in winter.
- Underfloor insulation improves the performance of the atria underfloor heating system.
- Passive solar design techniques make best use of window wall areas to improve daylight levels and reducing energy use.
- Efficient lights along with time, occupancy and daylight sensors reduced energy use.
- A mixed-mode ventilation system provides naturally ventilated spaces throughout the year.
- The air ventilation systems serving the classrooms use air-to-air heat exchangers to pre-heat outdoor air and reduce heating energy use in winter.
- The air conditioning unit serving the Performing Arts Centre supplies full fresh air to the space for improved indoor air quality. An air-to-air heat exchanger recovers heat or cool air to minimise energy consumption.

Supply

- A condensing boiler improves the energy generation efficiency of the central gas-fired heating system.
- Allowing wider temperature differentials in the heating system reduces pipe and pump sizes and keeps down capital and running costs.

Renewable energy

- Solar hot water units on the roof of the gymnasium heat the water used in the changing rooms.
- The student centre atrium roof is oriented to allow for the future provision of photovoltaics. The location at the front of the site will allow a visible and iconic architectural form to educate users and public.

Energy use targets

- The annual energy use target for the entire site is predicted to be less than 80 kWh/m^2/annum. This figure represents an average energy use across the whole site including offices, classrooms, IT facilities etc.

Water

- Surface water is treated in rain gardens and swales strategically located around the site.
- A buried stormwater pipe collects surface water, which is re-used for irrigating the sports field, cutting down the use of potable water.
- Rainwater from the three whanau buildings roofs is collected in buried tanks. The rainwater is used for toilet flushing and for general irrigation to reduce the use of potable water.
- Low-flow water fixtures are used including taps and showerheads.
- Occupancy sensors are used for demand control of urinal flushing.

Materials and waste

- Construction waste was reduced by changing the façade design. Standard material sizes were used to minimise construction waste.
- The waste management sub-contractor sorted construction waste to minimise landfill. Construction waste was monitored monthly, with reporting provided on tonnage to recycling versus tonnage to landfill.
- Thermal mass is used extensively to regulate internal temperatures to promote thermal comfort and help with passive solar heating in winter, particularly in the atria.
- Multiplex’s project management plan identified environmental impact reduction strategies.
- Provision was made for on-site filtration and collection of paint and materials including cleaning liquids, which were then disposed of off-site monthly.

Indoor environmental quality

Measures to promote positive indoor environmental quality include:

- window-to-wall ratios to balance solar heat gain, reduce glare and promote high daylight levels
- external shading assessment and shading design
- design of south-lights to the art classrooms to promote daylight levels and natural ventilation
- design of the administration building to promote daylight levels and natural ventilation
- using thermally efficient glazing in some areas
- using thermal mass and insulation to improve thermal comfort
- a mixed-mode (more than one type) ventilation strategy responds to seasonal changes and promotes indoor air quality and energy efficiency
- supplying full outdoor air to the classrooms in winter improves indoor air quality and a healthier learning environment.

Health

- Extensive use is made of natural daylight. The variability of natural daylight levels can also provide more visual stimulation. Spaces that are lit mainly with daylight can have a positive physiological impact, creating better learning environments that encourage increased performance from students and teachers.
- Natural ventilation throughout the school improves indoor air quality.
- Full outdoor air systems with heat recovery are used in winter to promote indoor air quality when windows need to be closed to retain heat or when quiet is required.

Site

Incorporating sustainability into the management and curriculum of the school is possible in a number of ways. This includes waste management, recycling systems, capitalising on existing land use and ecology, and promoting transportation initiatives that minimise environmental impact.

The school has established an environmental management plan in line with ISO14001. Their 'walk it in, walk it out' policy is particularly interesting. With no rubbish bins on-site the pupils must take all their rubbish home for disposal and recycling.

Monitoring and results

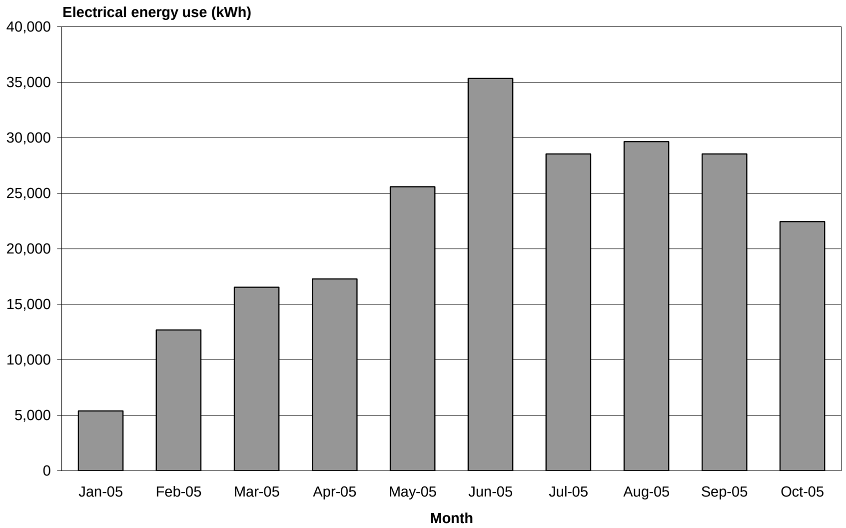
Only electrical energy use data was available because of discrepancies with the water and gas supply billing.

The monthly electrical energy use is presented in the table below. A gross floor area of 8633m^2 projects electrical energy use based on current data to be 37.5 kWh/m^2/annum. This projection assumes energy use from November 2005 to April 2006 to be the same as that for May 2005.

The electrical energy use data must be tempered by the fact that two of the whanau blocks are currently not being totally used.

School holidays and an increased role for 2006 will affect the final energy consumption figures.

Figure 1 Summary of electrical energy use by month



A conservative assessment obtained by removing the gross floor area of these two whanau buildings from the projected annual energy use results in 62.3 kWh/m^2/annum. This projection is less than 80 kWh/m^2/annum and does not include gas consumption for primary heating.

Also note however that at 2032m^2, whanau A is 621 m^2 larger than whanau B. This projected energy use is an average of both classroom blocks and offices facilities that typically have very different energy use profiles, which may skew these projections.

Only time can yield more accurate results of annual energy use, however current available data looks promising for the first year of school operation with systems still bedding in and buildings being conditioned.

Lessons learnt

- Construction waste reduction strategies need to be implemented early in the project to ensure design and construction teams (including sub-contractors) focus on waste minimisation throughout the development of the project.
- Subcontractors need to be educated early about environmentally sustainable design (ESD) developments so they clearly understand the vision and will support innovative design aspects.
- Sub-metering of individual building energy and water use as well as stormwater harvesting can help with building commissioning and tuning as well as ongoing resource management and as an educational tool.
- Investment in ESD measures has both direct and indirect benefits. Capital cost and return on investment cannot be considered alone. Ongoing research into measures that promote positive social and environmental outcomes is also needed to understand the less tangible benefits.

Credits

Client	The Ministry of Education
Project manager	Beca
Architects	Warren & Mahoney
ESD	Connell Mott MacDonald
Building services & fire engineering	Connell Mott MacDonald
Structural engineers	Structure Design
Quantity surveyors	WT Partnership
Acoustics	Marshall Day Acoustics
Civil engineers	GHD
Contractor	Multiplex

Sub-district hospital – Waitakere Hospital

Summary

Client	Waitemata District Health Board
Site address	Lincoln Road, Henderson, Auckland
Total floor area	14,700m^2
Cost/m²	$2435 (adjusted to 2005)
Conventional cost/m²	$2400 (1.5% below project cost)
Contract value	$35 million

Economics

The indicative economics for this case study building are set out in the table below. Adding sustainable building strategies was initially seen as too expensive, but a subsequent feasibility study and loan funded by the Energy Efficiency and Conservation Authority (EECA) under its design energy audit and Crown loan scheme proved otherwise. A grant was also received from Infrastructure Auckland for the stormwater measures included in the project (not accounted for in the table below).

Building type	Benchmark building capital cost $/m^2	ESD building capital cost $/m^2	ESD building premium (saving) $/m^2	ESD building premium (saving) %	Annual energy cost savings $/m^2	Annual water cost savings $/m^2	Total annual cost savings $/m^2	Simple payback (years)	20-year NPV for ESD measures $/m^2
Hospital	2400	2435	35	1.5	9.5	1.0	10.5	3.33	-72

Due to their intensive use and highly serviced nature, hospitals can be excellent examples of sustainable building.

Environmental summary

Site:

- Courtyard building forms for natural light and ventilation.
- Culturally inclusive and barrier-free facilities.
- Stormwater retention and filtration integrated as water treatment.

Material:

- Simple, cost-effective measures were included.

Waste:

- Re-use of existing buildings, and waste strategies were adopted during construction and are being implemented in operation.

Client brief

The Waitemata District Health Board and Waitakere City Council worked in partnership with the community to ensure that the hospital fitted with Waitakere City's Eco City vision.

Facilities

The two-level hospital block comprises:

- the ground floor with three medical/surgical wards (70 beds), including six-bed coronary care unit; four operating theatres; new radiology/imaging department; emergency department/acute assessment unit and a cafeteria
- the lower ground floor with two assessment, treatment and rehabilitation wards (51 beds); occupational therapy/physiotherapy; kitchen facilities; hospital support services; cultural health facility and home health services.

Site

The site development included partial refurbishment of existing buildings and the construction of new facilities. Courtyards were created in the middle of the building to bring sun, light and air into the interior and provide green space for the occupants. A landscaped stormwater retention and treatment pond provides a public amenity for the site.

Concept

As part of the project development, a series of design principles was created, underpinning the design direction. These included:

- putting the patients and their families at the centre of the design process
- designing for energy efficiency
- being environmentally friendly, which included avoiding waste, safe disposal of hazardous goods
- recycling as much material as possible
- maximising the use of natural lighting
- specifying the use of sustainable and environmentally friendly materials
- reducing and controlling stormwater runoff and wastewater, providing quality stormwater treatment and reusing waste.

Site plan

Energy

Energy-savings options were modelled and tested to identify their cost benefits. The first was for the partial recirculation of air using an economiser cycle. This improves the efficiency of the system by using outside air for cooling when conditions permit.

High-efficiency lighting was used, which included:

- tailoring lighting levels to each individual space
- increasing the level of localised switching and using luminaires fitted with low loss ballasts
- fitting high-frequency dimmable ballasts to selected areas (such as corridors and courtyards) to allow daylight to complement artificial lighting
- installing occupancy sensors in partially occupied areas such as toilets and storerooms, ensuring lighting is used only during occupied periods.

The levels of insulation were increased from code levels, with R 2.0 insulation in the walls and R 3.5 in the ceiling.

Natural ventilation was provided to the assessment, treatment and rehabilitation (AT&R) wards and to cultural health.

The pump and fan energy use has been reduced by the use of low-pressure loss systems and high-efficiency motors.

The building management system (BMS) controls all systems serving the hospital in an energy-efficient way, based on time of day, outside weather conditions, internal conditions and the presence of people. It also provides an energy management tool to ensure energy use can be monitored.

The table below shows the economics for the energy savings measures that formed the basis of the Crown loan application. Taking into account the capital costs saving for adopting natural ventilation, the capital cost premium fell to $50,000 and the payback period to 0.33 years.

Energy savings measures

	Gas consumption saving (kWh)	Electrical consumption saving (kWh)	Gas energy cost saving ($)	Electricity cost saving ($)	Total cost saving ($)	Capital cost ($)	Simple payback period (years)
Partial recirculation of air	1,000,000	410,000	27,550	34,850	62,400	50,000	0.8
Higher standards of insulation in roof and walls	172,000	36,000	4738	3060	7798	55,000	7.0
High efficiency lighting system	(200,000)	560,000	(5510)	47,600	42,090	180,000	4.3
Non-air conditioning of AT&R wards and cultural health	–	110,000	–	9350	9350	Cost neutral	N/A
Low loss systems and high efficiency motors	–	64,000	–	5440	5440	12,000	2.2
Solar water heating to cultural health	16,000	–	440	–	440	8000	18.2
VAV air conditioning to specific areas	–	112,000	–	9520	9520	67,000	7.0
Total	**988,000**	**1,292,000**	**27,218**	**109,820**	**137,038**	**372,000**	**2.7**

Notes:

1. Maintenance costs of the energy saving measures are considered to be cost neutral when compared with benchmark systems.
2. Measures apply to new hospital only.

Hospital foyer

Water

Stormwater from the hospital flows into a landscaped stormwater pond before flowing into nearby Henderson Creek. The car park stormwater flows into swales and rain gardens and then flows into the same creek. This cleanses the water of sediment and pollutants and also prevents flooding downstream.

Swales: Stormwater from the new car park and access road at the back of the hospital site runs off into the swales. About 450m of lineal swales were installed to cope with approximately $3400m^2$ (30% of the paved area on the site) of road area.

Two sand filters: These have been fitted next to the new main car park to help treat the existing 300 car park spaces.

Rain gardens: Installed at the end of the swales, these naturally filter run-off from the car parks before the water enters the stormwater system.

Stormwater treatment pond: This 1900m^2 pond treats the stormwater to 75% efficiency. It treats stormwater from an 18 ha catchment area.

Rainwater tanks: Six 250m^3 tanks collect rainwater run-off from the main hospital roof, with the water used mainly for toilet flushing and cooling tower make-up. Estimated savings from reusing this water equate to annual water consumptions bills being reduced by $15,000 per annum, a significant saving given that during 2005 water costs in Auckland increased from \$1/m^3 to \$4.50/m^3.

On-site green tanks

Waste minimisation

Wherever possible, existing hospital elements have been re-used, upgraded and integrated in the new community hospital, with about 50% of the hospital being retained and progressively upgraded.

No formal system of waste management was established, but the contractor was well organised and minimised the amount of prefabrication, re-work and waste disposal.

The hospital is moving towards establishing a formal waste management system like the one being implemented by Wellington Hospital. Clinical waste costs about 25 times more to dispose of than general waste – and up to 75% of the materials disposed of as clinical waste are actually general waste. The waste management system will include:

- implementing systems for refuse collection, including general and clinical waste which require incineration
- educating staff to help them understand the environmental impact of waste generation and how personal actions can reduce waste impact
- working with suppliers to minimise the use of non-recyclable or non-biodegradable packaging
- recycling systems for ease of segregation and staff use.

As identified at Wellington Hospital, quick gains can be made by addressing specific items such as gloves, IV bags and nappies.

Site

Existing buildings were re-used and refurbished. Stormwater retention and treatment ponds serve as a public amenity. Swales and rain gardens are used to deal with run-off from car parks.

Public access has been improved and made easier with a barrier-free philosophy.

Transport

Waitakere residents previously had to travel to the North Shore for accident and emergency facilities. The new hospital in West Auckland reduces car trips significantly.

A new traffic light interchange at the hospital entry improves traffic flows and safety.

Materials

The choice of materials and their environmental effects were considered, but the lack of a direct return on investment and higher cost made uptake limited. Some specific measures showing a positive return on investment were adopted.

- The building generally uses relatively simple, low-cost materials, simple pitched/barrel-vaulted roofs and avoids use of high-tech cladding solutions. Instead walls use a robust, vandal-proof base and lightweight, highly insulated top portion.
- A post-tensioned ground floor slab was used. This was cheaper, quicker and more structurally efficient and used less material. This approach is widely used in Australia but less so in New Zealand.
- Polypropylene hot and cold pipework systems were used instead of traditional pipework. This material was initially questioned by facilities management, but a demonstration and testing convinced them it should be included.
- The mixed use of fibreglass and polyester insulation provided the optimum solution to insulation materials use. Fibreglass was used in encapsulated locations and polyester in exposed locations.
- Chillers use no ozone-depleting refrigerants.
- The air diffuser design was chosen to minimise cleaning requirements.
- Art was placed and integrated in all areas of the hospital, acknowledging the role of the environment in aiding recovery and wellness.
- The hospital is moving towards a gluteraldehyde-free operation.

Process

A master plan was first developed by the hospital general manager, with the hospital's Orion Programme management team, Di Carlo Potts Architects, project managers Carson Group, quantity surveyors Rider Hunt and Maunsell Consultants.

Hospital staff then put together a brief for each department and a business plan was put to the government.

Other consultants were brought into the process, including services engineers and energy modellers Connell Mott MacDonald, civil engineer Harrison Grierson and structural engineer Buller George.

An advisory group including Waitakere City Council, the Energy Efficiency and Conservation Authority (EECA) and Robert Vale from Uniservices stimulated interest in the development of an 'Eco Hospital'.

A cost/benefit analysis of energy and water savings, funded by EECA's Design Audit Scheme, was carried out by Connell Mott MacDonald. This justified contributions and loans from EECA and Infrastructure Auckland, and meant the project was the first to benefit from EECA funding for both a design audit and Crown Loan.

Lessons learnt

Unfortunately, with no detailed design brief available at the start of the design process, no clear objectives were set for energy saving and no benchmarks were made. This will make judging the success of the energy-efficient design very difficult.

Robert Vale (a sustainable building consultant on the design team) recommends the following process for future projects:

- construct the design brief *after* key stakeholders have identified key issues
- strike up partnerships with outside companies or organisations for sources of funding
- draw up the brief in collaboration with both specialist consultants and key stakeholders, before design consultants are engaged
- establish checkpoints to review whether design objectives have been reached
- use energy modelling and life-cycle costing on systems and construction to identify real opportunities for cost-effective design.

Credits

Client:	Waitemata District Health Board
Project manager:	Carson Group
Architects:	Di Carlo Potts Architects (Sydney)
Quantity surveyors:	Rider Hunt
Services engineers and energy consultant:	Connel Mott MacDonald
Civil engineer:	Harrison Grierson
Structural engineer:	Buller George
Sustainable design consultant:	Robert Vale, Waitakere City Council Sustainable Design Advisor

Office – CentrePort / Statistics New Zealand Building, Wellington

Summary

Client	CentrePort / Statistics New Zealand
Site address	Hinemoa Street, CentrePort, Wellington
Total floor area	9,300m^2 (NLA)
Cost/m²	Yet to be finalised
Conventional cost/m²	$2000
Contract value	Yet to be finalised

Economics

Unfortunately final construction costs are yet to be determined and are subject to commercial sensitivities at this stage. However, as part of the design process a detailed cost/benefit study was carried out to assess the suitability of several sustainability features. Some, such as the high-performance glazing, were found to have significant benefits, not only in terms of energy use but also in equipment sizing for air conditioning. Other sustainable features, such as solar water heating, were not included in the final fit-out (due to the relatively low hot water demand in commercial buildings).

Energy modelling predicts that the building will save around \$14.7/m^2 in energy costs. With water savings included the sustainable benefits would be around \$15/m^2. Using overseas examples as a precedent it can be expected that the ecologically sustainable development (ESD) premium would be around 5%, this gives a simple payback of under seven years.

For office buildings in general, results of overseas studies show that returns from ESD are best for owner/occupiers; for speculative commercial buildings the increased cost of sustainable building will need to be reflected in increased rentals. It has been found that for tenants, the rental premium is likely to be repaid by a factor of three over a 20-year lease period. This includes a modest productivity benefit which may arise from having a more comfortable working environment.

Environmental summary

- Energy used – 102 kWh (predicted).
- Stormwater design – swales used to control rainwater run-off.
- Site – re-use of redundant wharf area.
- Waste – 80% of construction waste re-used or recycled.

Client brief

The client wanted a modern working environment that would support the 'whole of business' objectives. The building design was to provide a high quality internal environment that would satisfy Statistics New Zealand's objective to create a place of work that encouraged collaboration, professionalism and a united culture.

As part of the process, Statistics New Zealand and its consultants developed a highly specific brief that required features such as large floor plates, regular plan shape, minimal core to glass distances, and a high level of modular coordination.

Process

Statistics New Zealand established the criteria, which included sustainable design, energy efficiency and a high-quality working environment.

The selected design team worked with Statistics New Zealand's consultants to develop the building that best reflected the initial planning intentions proposed within the brief.

Late in the design phase DEGW, Statistics New Zealand's interior design consultants, reviewed the base building design. The main result of this review was to separate the core area to form a 'gathering space'. Although this moved the design away from the initial parameter, the reconfiguration was seen as a valid design improvement.

Concept

The large open-plan floor plates are designed around central hubs, which provide core facilities, vertical circulation and 'gathering spaces'.

These central spaces provide refreshment and conversation zones. An important benefit of this space, and the adjacent central stairs, is the ability for staff to get together and share knowledge across the organisation.

An attractive and spacious staircase was created to enhance the visual connection between floors. The result is a honed concrete and steel staircase within a three-sided floor-to-ceiling fire-rated glass enclosure.

Three lifts serve the building, but its low-rise structure means the stairs should be popular for moving between floors.

Facilities

- Secure covered car parks within the building.
- Office accommodation for approximately 500 staff.
- Truck dock / loading bay.
- Showers / lockers / bike racks.
- Café and commercial kitchen.
- Open deck with glazed canopy.

Site

The building is on land previously used by CentrePort for car parking and bulk storage. It is close to Parliament and other key Government agencies and stakeholders.

The long axis of the building lies north to south, maximising views of the Wellington CBD, Mt Victoria and Matiu (Somes) Island, while maintaining view corridors from city to sea.

Materials

The building's fabric has been designed to enhance comfort and reduce energy consumption (thermal performance).

A fully glazed curtain wall using high-performance double glazing allows high levels of natural light, while the narrow floor plates and office space planning give staff good access to daylight and views.

The internal floors generally use a 'shell and core' format with little or no internal finishing or with the fit-out integrated with the base structure.

Transport

The building is a five-minute walk from Wellington's main railway station. Employees can use both rail and bus services to the central city using the station terminus.

Cycling facilities ('parking' space, showers and lockers) are provided for employees and visitors.

Water

Water saving measures within the building include low-flow fittings for showers and taps, and dual low-flow flush cisterns for toilets. The landscaping uses a water-efficient irrigation system with drip feeders and automatic timers.

Energy

The building and its services are designed to achieve a high quality internal environment, and energy efficient solutions.

The client included an energy performance target of 145 kWh/m^2/year (of net lettable area) in the design brief. A preliminary energy study using modelling based on the Australian GreenStar method – backed by EECA – predicted an energy use of 102 kWh/m^2/year.

The model assumes good management of the lighting only – not daylight dimming. However, modelling does tend to underestimate actual usage due to longer operating hours and higher than predicted plug loads.

Despite this, it is likely that the building will perform below the client's benchmark level in terms of energy use.

The predicted energy use compares well with the National Energy Efficiency and Conservation Strategy target for new buildings of 100 kWh/m^2/year.

A low-pressure system (VAV) was picked as the most suitable heating, ventilation and cooling (HVAC) system for the building. The VAV system is designed to achieve good internal environmental quality. The system includes economiser cycles, CO^2 control, and free-cooling controls to take advantage of Wellington's mild climate. These features, along with the building management system (BMS), reduce the demands on the ventilation fans and pumps to mimimise energy consumption.

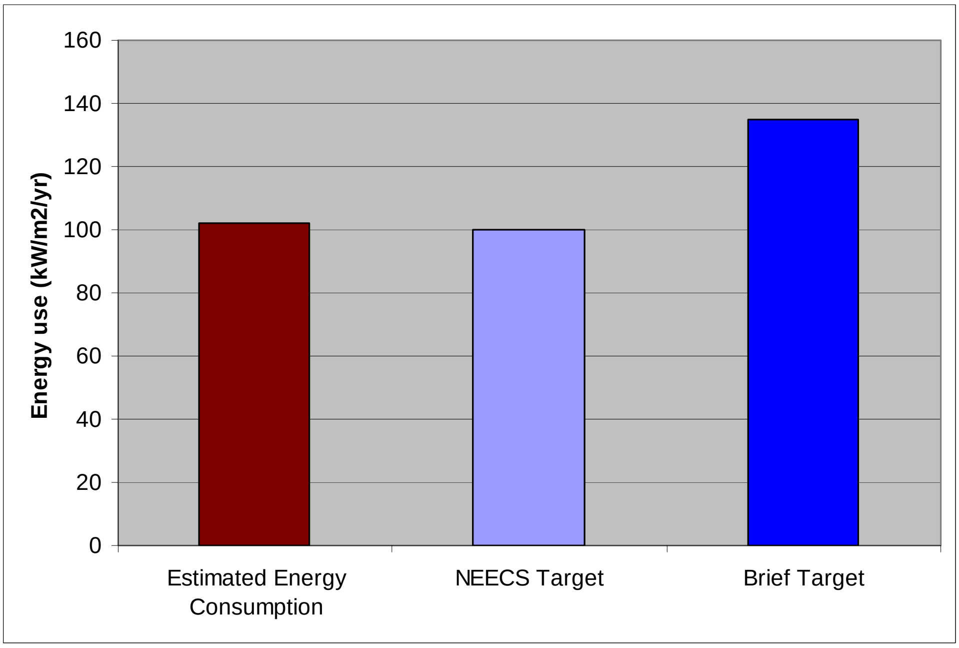
The office lighting systems are designed to take full advantage of natural lighting. Energy efficient dimmable lamps (T5) and daylight compensation controls take advantage of natural lighting, giving a lighting power density of around 12.5 W/m^2.

Occupancy sensor control of the lighting is provided to appropriate areas.

The BMS monitors and controls the building services to balance comfort and energy use. It also allows the energy consumption of separate features and areas to be monitored, enabling features and areas of high energy consumption to be identified and fixed.

Energy-saving strategies used include:

- variable speed drives for fans and pumps
- low-flow water fittings, reducing hot water usage
- building management system with control of out-of-hours usage
- economy cycle control for free cooling has been incorporated in the chiller plant
- higher-than-code levels of insulation.



Credits

Client	CentrePort Limited
Contractor	Fletcher Construction
Tenant	Statistics New Zealand
Project manager – client	Rawlinsons
Project manager – tenant	Mallard Cooke
Architect	JASMAX Wellington
Fitout architect – tenant	Studio of Pacific Architecture/DEGW
Structural engineer	Dunning Thornton
Services engineer	Beca Carter Hollings & Ferner
Acoustic consultants	Marshall Day Acoustics (Wellington)
Surveyor	Spencer Holmes
Fire engineering	Spencer Holmes

4 Value Case

A review of international trends in sustainable building in Appendix 1 highlights a compelling value case for sustainable building (Property Council of Australia, 2003) including:

- tenant benefits:
  - lower operating costs for energy, water and waste
  - higher levels of occupancy satisfaction, health and productivity benefits
  - identification with corporate environmental responsibility
- investor benefits
  - marketing advantages due to point of difference
  - a faster lease-up period
  - marginal increases in rental
  - higher tenant retention rates due to enhanced user satisfaction, health, comfort and productivity
  - higher loan value and lower equity requirements
  - higher building value on sale and appraisal
  - asset protection
  - overall greater return on investment.

Based on the New Zealand case studies and similar methodologies to those adopted internationally, this report provides a value case for sustainable buildings in New Zealand.

4.1 Whole-of-life costs

By the time the design for a development is completed, 80-90% of its life-cycle economic and environmental costs will have already been made inevitable. More importantly, when just 1% of a development's up-front costs have been spent, up to 70% of its whole-of-life costs may already be committed (Romm and Browning, 1998).

So decisions on sustainable buildings options should not be made on inadequate information or just in terms of simple payback, as is often the case. The investment return estimate from sustainable building should always be based on a sound evaluation of the life-cycle costs, including both initial capital and operating costs over a defined period or life (Standards Australia, 1990 and Competitive Australia, 1998). The 'period' or 'life' of the building could be considered to be the initial lease periods for a commercial building or its whole economic life for leases of public sector buildings.

4.1.1 Initial capital costs

Most detailed studies on the costing of sustainable building suggest no generalised premium can be identified for all buildings. It is very much about developing an appropriate budget for each individual project.

There is, however, a general perception that sustainable buildings cost more. The case studies show a fairly wide range – from 15% less to 10% more – in the initial capital cost compared to conventional good quality buildings, with an average initial capital cost premium for sustainable features of only 2–6%.

This suggests that clients and designers are finding ways to incorporate project goals and values regardless of budget, by making more appropriate choices.

The range of premium costs is largely determined by the baseline budget and building quality. Sustainable building can be achieved with relative ease for a good-quality building. For a low-quality building it will be difficult, if not impossible, to justify.

It is also important to look at the relative values of all the building elements as a whole, rather than as optional add-ons. Sustainable design strategies should be reflected at the outset across the whole budget. Each element can then be refined to meet the target budget.

When new technologies are being tried, or when buildings are over refined, the added costs and complexities may be wrongly attributed to sustainable building principles. However, in most cases it is possible to design attractive, uncomplicated sustainable buildings that operate in a straightforward manner, achieve high standards of energy efficiency, and incur little or no additional cost. This ideal is seldom achieved without the appropriate knowledgeable and open-minded consultants being involved at every stage of the design – particularly the early stages.

It is also important that quantity surveyors build up a database of sustainable building costs. This could initially be implemented through an industry publication such as Rawlinsons.

A recent survey of UK quantity surveyors revealed that they tend to over-estimate the on-costs of sustainable buildings, and underestimate the potential for cost savings as trade-offs. The study also concluded that quantity surveyors believed that sustainable buildings cost between 5% and 15% more to build from the outset. However, if sustainable design features are integrated into the design from inception and are actively value managed, then additional costs should not be more than 1% (Barlett and Howard, 2000). This is also the case in New Zealand where sustainable building strategies are often abandoned due to lack of appropriate costing information for anything out of the norm.

Capital costs for buildings have also been rising significantly over the past few years, owing to an overheated market and shortages of resources and labour. This may be a short-term supply and demand effect, but it is unlikely, based on previous experience, that costs will return to their previous levels. This is likely to help the case for sustainable building, with any premiums becoming more marginal in percentage terms or being absorbed within a similar cost envelope.

It is also probable that any downturn in the property market will hit the low-budget commercial market hardest, with a continuing demand in particular for higher value owner-occupied public sector buildings and good quality niche commercial developments. Sustainable building is ideally suited to these types of development.

4.1.2 Operating costs

The case studies showed that energy costs for mainstream sustainable buildings in New Zealand are likely to be 35–50% of those for conventional buildings.

Energy costs have moved well above inflation over the past 10 years and are predicted to rise by a minimum of 3% above inflation over the next 10 years. Carbon taxes and new generation charge increases may be added to this.

Water charges have remained static in most parts of the country except for Auckland where they have recently risen from $\$1/m^3$ to $\$4.50/m^3$. The cost of water may also increase soon in supply-affected areas such as Christchurch. The effect of these increases has made and will continue to make sustainable building strategies more cost-effective in the long term.

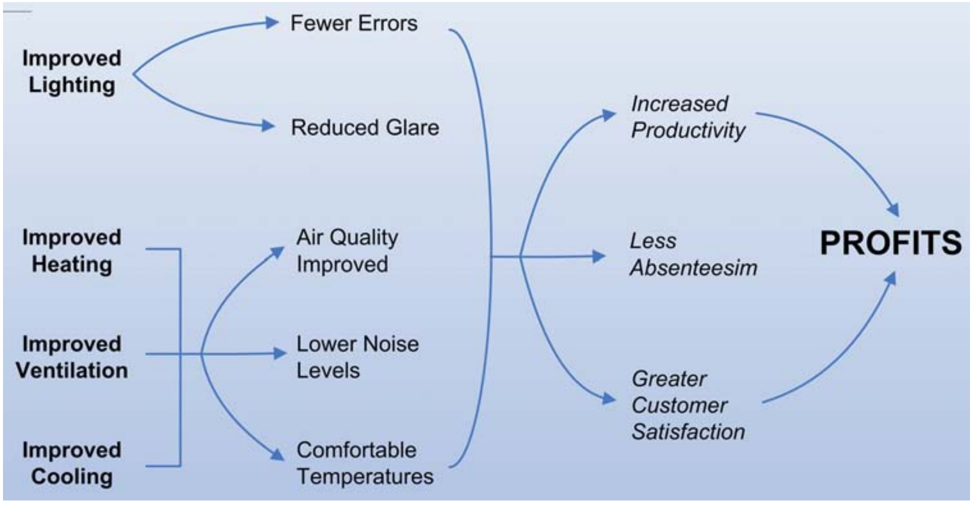
Operating and maintenance costs are also likely to be reduced as sustainable buildings generally have smaller, less sophisticated and more integrated building systems.

Whole-of-life costing of some of the New Zealand sustainable case study buildings was based on the energy cost at the time rather than on predictions of energy costs, meaning payback periods were often over estimated. This may seem a sensible low-risk way of estimating return on investment but it means potential clients and investors have unreliable information, leading them to overlook sustainable strategies that may have been viable.

4.1.3 Productivity benefits

As well as the direct and more tangible energy and water cost benefits, there are potentially 'softer' and less tangible benefits due to improvements in occupancy comfort, heath and productivity (Commission for Architecture and the Built Environment, 2005, Allen et al, 2004 and Haynes et al, 2000). Using a cost formula to quantify the impact of improved user satisfaction is not yet possible (Lister et al, 1998). The intangible benefits of sustainability can be best illustrated in the following diagram.

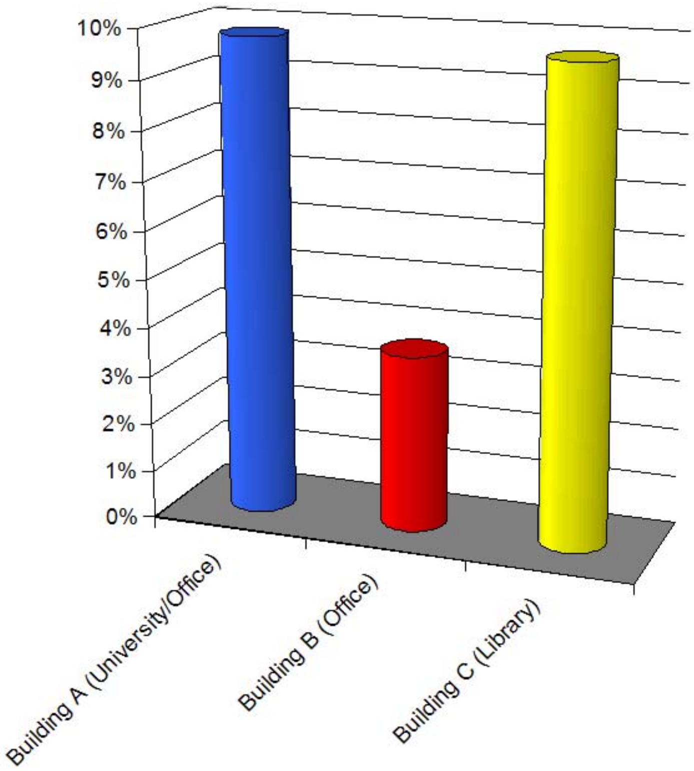
Figure 2: Intangible benefits of energy efficiency



Source: US Environmental Protection Agency, June 1998

These benefits are difficult to quantify, but may be equivalent to 3-5 times more than the direct energy and water cost savings, based on a nominal improvement in productivity. Research has shown that effects of plus or minus 5% to 15% in productivity could be attributed to indoor environmental issues. Overseas post-occupancy studies suggest that sustainable buildings and user satisfaction are not generally mutually inclusive (Leaman, 2001). However, the New Zealand case study buildings that have been subject to post-occupancy evaluation have generally shown a positive correlation, with perceived productivity **benefits of up to 10%** (as seen in Figure 3 below).

Figure 3: Summary of perceived productivity benefits in New Zealand buildings



Source: Centre for Building Performance Research (CBPR), Victoria University of Wellington

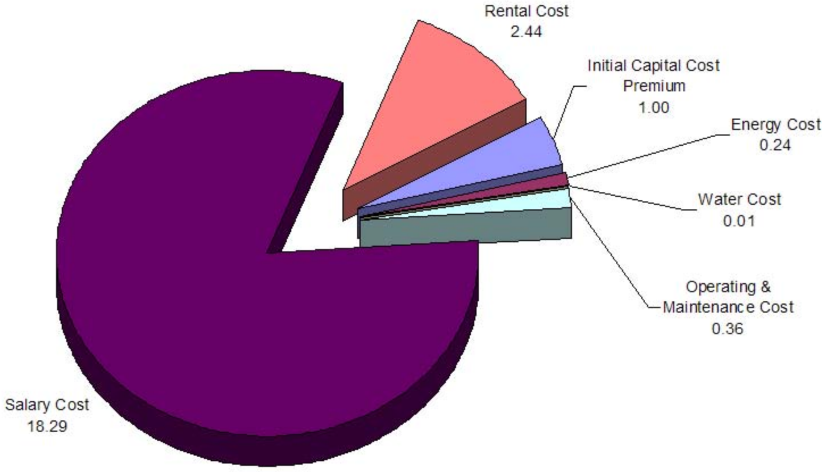
Productivity and user-comfort improvements benefit individual businesses and the economy. The price for consumer products declines as business profits rise. So increased user satisfaction, better productivity, sustainability and energy efficiency are inherently anti-inflationary, which benefits us all (US EPA, 1998). Further benefits of improved user satisfaction include better staff retention and the ability to attract more staff and more skilled labour from overseas.

If a defined process could capture these benefits, it would transform the economics of the commercial sector of sustainable building. If these 'soft payback' issues are taken into account, then overall paybacks of less than five years for sustainable buildings could be realised.

4.1.4 Present value analysis

In considering the benefits of a sustainable office building, the relative present values over a 20-year period are quite revealing.

Figure 4: Office building – 20-year present values



NB: Relative to the initial capital cost premium.

Figure 4 shows the importance of salary costs relative to the total operating costs associated with the building. The 20-year present value of salaries is around 18 times the value of the initial cost of the building, yet salary costs and productivity are rarely considered during the design process.

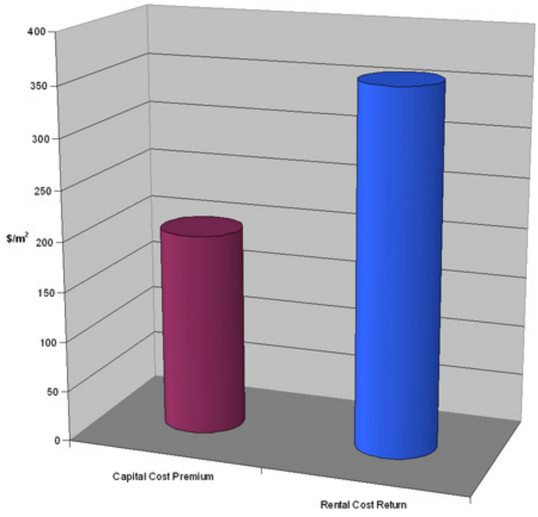
Figures 4 and 5 show the relative 20-year present values in more detail on an area basis per annum for a typical sustainable office building (with a capital cost premium of $200/m^2), based on the following premiums and benefits:

- rental premium $30/m^2/year
- energy cost saving $15/m^2/year
- water cost saving $1/m^2/year
- productivity benefit $75/m^2/year

The 20-year present values are also based on an 8.5% discount rate, a 3% above real inflation rate for energy, water and rental costs, and a modest productivity improvement of 2.5%.

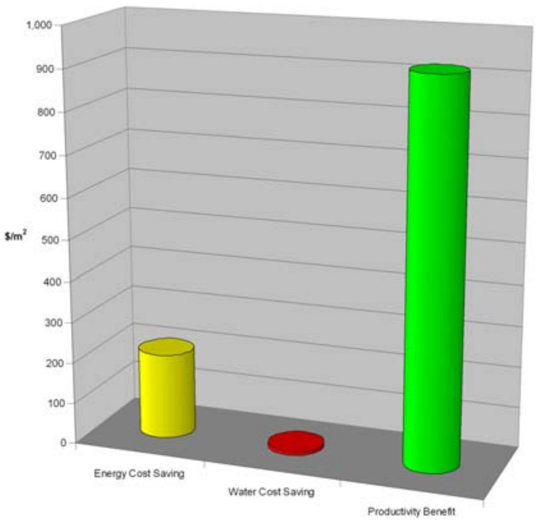
The extra paid upfront to construct the building by the developer/investment funder and the increased rental premium paid by the tenant are shown in Figure 5. Benefits for the tenant, including energy and water cost savings and productivity benefits, are shown in Figure 6.

Figure 5: Office building – 20-year present values \$/m^2 from developers'/funders' viewpoint



NB: Capital cost is one off.

Figure 6: Office building – 20-year present values \$/m^2 from tenants' viewpoint



From this model, the 20-year present value for a sustainable office building is about **5.7 times** the extra amount a sustainable building takes to design and building (initial capital cost premium). From a developer / investment funder's point of view, the increased rental premiums have a present value of around **1.8 times** the extra it would cost to construct the building. From a tenant's point of view, the 20-year present value for a sustainable office building is around **three times** the 20-year present value for the extra it costs to rent the building.

The above scenario assumes a nominal 2.5% increase in productivity that dramatically improves the investment returns from a sustainable building. Taking advantage of this scenario will require a radical rethink of how buildings are financed, designed, procured and leased, with 'Tenancy Lifetime Care' and 'Total Occupancy Cost Neutral Green Leases' potentially transforming the property industry. The industry needs to move from selling 'bricks and mortar' to selling 'sustainable and productive environments'.

As the commercial market for sustainable buildings becomes established, their true worth will also start to be reflected in property valuation and analysis (Davis Langdon Australia, 2004). Historically a development is valued using any comparable existing building leases (Power, 2004). However, this reflects what the market has historically been paying and does not necessarily reflect the true worth nor what it should be paying for a new development concept such as a sustainable building.

The residual value analysis in Appendix 3 (based on a methodology by Robinson (2005)) suggests that if the benefits of a sustainable office building are fully taken into account, they could generate a residual land value of 30% more than that of a conventional office building – and a sustainable office building could be worth nearly 40% more than a conventional office building.

4.1.5 Cost benefit analysis of short- and medium-term payback sustainable building strategies

Sustainable buildings usually incur three types of premium costs – those with:

- ‘hard’ returns (eg, energy and water costs)
- ‘soft’ returns (eg, improved indoor environmental quality with cost benefits in terms of improved health, comfort and productivity)
- no direct returns at all (eg, the use of environmentally friendly materials that are often more expensive initially due to a perceived niche market. Once the sustainable building market has matured many of these costs will reduce).

The return on investment on individual ‘hard’ sustainable strategies varies considerably. Some sustainable design features, such as lighting and lighting control, break even in around five years and provide a high rate of return (about 15%) over a relatively short life span of around 10 years. Others, such as a highly efficient building façade, only break even in around 20–25 years and provide a more modest but sustained rate of return (6–8%) over a 50-year building life.

An important consideration is to relate the investment criteria to the life-cycle of the component. In doing so, a sustainable building can be thought of as a portfolio of investments related to the component lives. Ideally, for investment returns to be realised, the break-even point should be 50% at most of the component life.

Table 1 in Appendix 2 is based on data from Davis Langdon in Australia (2004) for sustainable buildings and shows the cost premiums and investment returns for a range of short- to medium-term sustainable office building strategies. Data for New Zealand offices can be assumed to be similar.

However, any building is not only a portfolio of investments but also a portfolio of risks. Building providers invest in risk in many different ways without necessarily considering the risks of each investment. Unknown or unquantified investments are often made to protect the design consultants, the approving body, or the contractor without the knowledge of the building provider. For instance, over-sizing structure or mechanical plant, protection against flooding, and timber treatment are all investments to mitigate risks. On the other hand, greater and more short-term risks such as the future flexibility, adaptability, durability and operating costs of a building are often considered but not provided for.

4.2 Investment perspectives

Key decision-makers involved in the building process often have differing perspectives on the value of sustainable buildings (Bartlett and Howard, 2000):

- **Tenants** pay the most for the use of a building over its life, often in leasing cycles of 5–15 years. However, operating costs are only a small proportion of the total costs of occupying the building. Considered in isolation, these have historically been unlikely to significantly motivate tenants towards a sustainable building. However, user satisfaction with a building may have a significant effect on the health, comfort and productivity of the organisation occupying it. The benefits associated with comfortable staff are significantly higher than the energy and water costs, and a building will become more desirable if it can provide a higher level of environmental quality (thermal, lighting, indoor air quality etc) for its occupants.
- **Owner-occupiers** view all the costs and returns of a building as relevant. Owner-occupiers should therefore have a strong vested interest in sustainable building, particularly with its potential benefits of increased value, energy efficiency and low running costs. They might also be interested in the wider issues of sustainability if, for example, as a local council they have community and infrastructure obligations.
- **Investment funders** also view all the costs and returns over the life of the building as relevant, including buying the site, constructing the building and maintaining it. They also benefit from the rent received as income over its lifetime and the residual value of the site and building at the end of its economic life. However, investment funders seldom pay for the running costs as these are either paid for directly by the tenant or indirectly as an operating charge, so the concept of a sustainable building tends to have less relevance. Investment funders are, however, interested in keeping good tenants happy and in owning a low-risk long-term value investment. Sustainable building can help achieve this.
- **Developers** incur all the initial costs and risks, including site purchase, design and construction, and receive all their revenue (site and building sale) at the beginning of a 50-year life for a building (for example). The developer's interest in sustainable building is therefore likely to focus only on the marketing benefits at the time of sale – ie, will a sustainable building attract potential tenants, sell quicker and for a higher price.

Owner-occupiers and tenants, as *users* of buildings, are therefore the potential market makers for sustainable buildings. Owner-occupiers have provided the initial catalyst to demonstrate the benefits of sustainable building. This should then inform and stimulate demand by tenants, which will in turn influence developers and investment funders as *providers* of commercial buildings. This trend has been seen recently in the procurement of new commercial leases for government departments in Wellington, including new headquarters office buildings for the New Zealand Defence Force, Statistics New Zealand, Ministry for the Environment and the Department of Conservation. This is also beginning to influence the larger-scale commercial property market and may be the start of a the more widespread development of sustainable buildings in New Zealand.

4.3 Investment returns

The investment returns required for sustainable buildings will vary depending on building type and the nature of the client – eg, public sector or private sector (investment funder, developer or owner-occupier). The nature of the building and the client are broadly represented below in terms of public sector and private sector building types. Public sector buildings include hospitals, libraries, schools and university buildings while private sector buildings represent mainly commercial offices and retail centres. Within these broad categories the case studies provide more detail for individual building and client types.

4.3.1 Public sector buildings

Government buildings are almost exclusively procured on the basis of commercial leases for buildings from developers, investment funders and building owners. The Ministry for the Environment's Govt[3] programme has been working with government agencies to improve the sustainability of their activities. As one of the largest collective tenants for office spaces, particularly in Wellington, government agencies are therefore in a strong position to influence the market for sustainable office buildings.

Key aspects of procuring a lease for a commercial sustainable building include:

- The need to incorporate sustainable building requirements into the initial briefs/requests for proposals to developers, investment funders and building owners. This has been improving with each new government tenancy, but the value case for a number of recent buildings has been compromised by trying to add sustainable building requirements after the agreement to lease has been made. At this stage, the negotiating position on sustainable features is lost due to time constraints and premium pricing of additional features during building.
- Support by performance measurements for key aspects such as energy and water use, and an environmental rating such as Greenstar or similar New Zealand-specified rating tool. A minimum Greenstar standard of four to five stars should be aimed for with the current level of commercial sustainable building in New Zealand.
- Reviewing leasing proposals on the basis of total occupancy costs over the period of the lease rather than base rental rates, in line with Ministry of Economic Development requirements for whole-of-life costing. A recent review of office building costs on this basis has confirmed the validity of the sustainable building value case, with the 20-year rental premium likely to be repaid by three times over just from operating cost savings.
- Extending the length of the lease period to accommodate the returns on sustainable building requirements for government tenancies.
- Adopting performance-based 'green' leases (like Australia) for government tenancies to ensure sustainable performance based upon an agreed set of criteria is adopted by the provider and the government agency as the tenant.

For public sector organisations, recommended discount rates should be used (usually about 5% real) with a long-term (15–20 years) assessment period. Paybacks as long as 10 to 20 years and internal rates of return of 7–10% may be viable. Ministry of Economic Development rules also require governmental agencies to take into account a whole-of-life cost view. The economics for case study office buildings are taken from Table 1 and presented as Table 2 below.

Table 2: Indicative cost/benefits of case study office buildings

Building type	Benchmark building capital cost $/m^2$	ESD building capital cost $/m^2$	ESD building premium (saving) $/m^2$	ESD building premium (saving) %	Annual energy cost savings $/m^2$	Annual water cost savings $/m^2$	Total annual cost savings $/m^2$	Simple payback (years)	20-year NPV for ESD measures $/m^2$
Office – low/ medium ESD	2000	2130	120	6.0	11.0	0.3	11.3	10.65	-3
Office – medium/ high ESD	2000	2230	230	11.5	17.0	0.6	17.6	13.09	-23

The value case for public buildings is more varied than for commercial buildings, due to the differing nature of building projects and client bodies, as shown by the following overview.

Local authority buildings

Unlike commercial clients, most local authorities take a longer term view as owner-occupiers responsible for whole-of-life costs. Balanced social, environmental, economic and cultural outcomes are important concerns for a local authority project. Many councils also adopt a public consultation process where sustainability is favoured. The client also has multiple stakeholders including:

- the mayor and councillors
- community board members
- local trusts / societies
- local iwi
- council officers and staff
- council specialists eg, sustainability
- artists
- the local community.

With so many stakeholders and competing interests, it is not uncommon for the sustainability considerations to be diluted during building projects. Local authority capital funding may also be more limited than for commercial clients. Budgets are often set for political expedience rather than the absolute needs of a project, which may limit developing a fully sustainable building project. The economics for community centres and libraries are not as strong as more intensively serviced buildings. The relevant economics are taken from Table 1 and presented below in Table 3. Value for money and getting the most for their community's dollar are therefore key concerns.

Table 3: Indicative cost/benefits for the case study library

Building type	Benchmark building capital cost $/m^2$	ESD building capital cost $/m^2$	ESD building premium (saving) $/m^2$	ESD building premium (saving) %	Annual energy cost savings $/m^2$	Annual water cost savings $/m^2$	Total annual cost savings $/m^2$	Simple payback (years)	20-year NPV for ESD measures $/m^2$
Library	2384	2494	110	4.9	7.5	0.0	7.5	14.67	32

School buildings

Demographic changes in the Auckland region have triggered a major new school building programme, the first for nearly 25 years. The Ministry of Education was keen to implement sustainability and energy efficiency in the design of new schools.

The overall economic effects of including sustainable measures into a standard briefed Ministry of Education school were determined as follows (Connell Mott MacDonald, 2002):

- capital cost increase 6–7%
- energy cost decrease 40–50%
- simple payback of measures 13 years
- 20-year internal rate of return 5%

While the value case for schools, with relatively light usage patterns, was not particularly strong, the initiative has continued with the personal support of then Minister of Education Trevor Mallard, and a number of new primary and secondary schools have proceeded with a range of sustainable features included. The relevant economics are taken from Table 1 and presented below in Table 4.

Table 4: Indicative cost benefits for the case study schools

Building type	Benchmark building capital cost $/m^2	ESD building capital cost $/m^2	ESD building premium (saving) $/m^2	ESD building premium (saving) %	Annual energy cost savings $/m^2	Annual water cost savings $/m^2	Total annual cost savings $/m^2	Simple payback (years)	20-year NPV for ESD measures $/m^2
Secondary school	2430	2570	140	5.7	7.5	0.6	8.1	17.3	41

Hospital buildings

A similar initiative has not been widely implemented as part of the major hospital redevelopment programme. However, the recent redevelopment of Waitakere Hospital has pioneered the idea of a sustainable hospital in the 'eco-city' of New Zealand.

Encouraged by Waitemata District Health Board and Waitakere City Council, and funded by a grant from Energy Efficiency and Conservation Authority (EECA), a feasibility study was carried out to look at a range of energy saving strategies. The cost premium for implementing the proposed energy efficiency measures was $50,000 or 0.13% of the project budget. Predicted energy cost savings were $137,038 per annum, giving a sample payback of 0.33 years.

The feasibility study proved the excellent economics of energy efficiency measures for hospital-type projects with intensive uses and long operating periods. A Crown energy efficiency loan is funding the cost premium for the energy efficiency measures, with repayments accounted for by projected energy cost savings. The hospital also features water-conserving measures including the re-use of roof water for flushing and irrigation. Stormwater overflow from the recovery system and run off from the car parks and roofs is discharged into a stormwater treatment and retention pond that also forms part of a community reserve within the hospital grounds. Infrastructure Auckland and Waitakere City Council funded the cost premium for these measures. The relevant economics are taken from Table 1 and presented below in Table 5.

Table 5: Indicative cost benefits for the case study hospital

Building type	Benchmark building capital cost $/m^2	ESD building capital cost $/m^2	ESD building premium (saving) $/m^2	ESD building premium (saving) %	Annual energy cost savings $/m^2	Annual water cost savings $/m^2	Total annual cost savings $/m^2	Simple payback (years)	20-year NPV for ESD measures $/m^2
Hospital	2400	2435	35	1.5	9.5	1.0	10.5	3.33	-72

University buildings

University buildings are also good cases for sustainable building, with increasingly intensive usage and longer operating hours. Projects to date have tended to concentrate on energy efficiency rather than the full range of sustainable strategies. University academic offices have also traditionally been naturally ventilated, which complements sustainable building both environmentally and economically. Projects with sustainable strategies have been either cost-neutral or better, with significant energy savings making them an excellent investment. The challenge now is to increase the range of strategies beyond simply energy. The relevant economics are taken from Table 1 and presented below in Table 6.

Table 6: Indicative cost benefits for the case study university building

Building type	Benchmark building capital cost $/m^2	ESD building capital cost $/m^2	ESD building premium (saving) $/m^2	ESD building premium (saving) %	Annual energy cost savings $/m^2	Annual water cost savings $/m^2	Total annual cost savings $/m^2	Simple payback (years)	20-year NPV for ESD measures $/m^2
University	2300	2000	-300	-15.0	6.3	0.0	6.3	N/A	-338

4.3.2 Private sector commercial buildings

The value of commercial buildings has traditionally been judged in terms of location, quality, function and aesthetics. This is then reflected in the rental return and capitalisation rate. It is difficult to set a value on commercial sustainable buildings until a fully established market exists. For the current market to expand there needs to be:

- a stronger demand from users/tenants
- a proven, authentic product from building providers including developers and investment funders. This should be defined by measurable standards and benefits over the term of the lease period. Measurement could be in the form of leasing specifications, auditing by rating systems at the design and completion stages, and by performance-based leases in operation
- an investment scenario that represents true worth and good value rather than lowest cost, and provides an equitable rate of return for both the provider and user of the building
- recognition of future environmental and associated economic challenges in which we are all stakeholders.

Developers will have little concern for sustainable building issues unless there is a marketing advantage, tenant and/or funder requirement and a short-term return. Little or no information is publicly available on the lease rates and resale of sustainable buildings. The demand from tenants for features of sustainable buildings is, however, growing, with a number of recent briefs for commercial buildings including a sustainable building component. With the likely introduction and acceptance of sustainable building rating schemes such as the Green Building Council of Australia GreenStar Rating Scheme into the marketplace, buildings with higher ratings will also start to realise market advantages.

The commercial property sector in New Zealand needs to redefine its standards, which tend to be followed verbatim by real estate agents, developers, investment funders and building professionals with little consideration for the relevancy or viability for the future. Leasing documents and specifications tend to be recycled from one project to the next, perpetuating short-term leases, built-in obsolescence and synthetic rather than real requirements. By contrast, The British Council of Offices (BCO) in the UK has developed a new standard office specification that addresses sustainable design issues from a commercially driven perspective. Encouragingly, a number of recent tenant briefs for office space in Wellington are attempting to redefine standards in a similar if not more advanced way.

Any cost premium due to sustainable building, however marginal, must be reflected in a higher building value, rental premium and also a commercially attractive return on investment. For commercial projects, higher rates of return are required. These will typically be around 6–15% with shorter investment horizons of five to 10 years. Returns will also be compared in terms of the level of risk and rates of return available (net of inflation) from alternative investments.

The duration of the lease period for a commercial building will also have an effect in terms of capitalisation and may need to be longer for sustainable buildings. Leases greater than 10 years might become more the norm for sustainable buildings. An interesting approach that might be adopted is the concept of ‘whole-of-lease period cost neutrality’ where the length of lease period is directly related to the payback period or net present value of the sustainable building features included. Alternatively a ‘total occupancy cost neutral’ (rental plus all operating and maintenance costs) approach could be adopted. These types of approaches are more equitable and create more incentives for sustainable building. When combined with a longer lease period, they represent a more binding partnership between the provider and user of a building.

The future introduction and marketing of environmental rating schemes also raises the possibility of ‘green leases’ (Power, 2004), which are currently being promoted for public sector buildings in Australia as a way to ensure initial and continuing environmental performance. These leases are being specifically developed for sustainable buildings, and place an onus on the building owner to achieve agreed environmental performance levels and on the tenant in terms of their fit-out standards and use of the building in relation to environmental issues. There is little point in demanding a sustainable base building only for tenants to introduce unsustainable practices during the fit-out.

For investment funders, sustainable buildings also have the advantage of medium to long term future-proofing and de-risking of their property portfolio/asset base. The 1960s and 1970s saw office developments become obsolete because they could not accommodate the 1980s demands for information technology and air conditioning. Adopting sustainable building safeguards against similar obsolescence related to a worsening energy and environmental situation in New Zealand over the next 15 years.

5 Implementing Sustainable Building

5.1 Introduction

Implementing a sustainable building is no more complicated than for a conventional building. It does, however, require more in-depth analysis, design and buy-in from all stakeholders. In many ways, it results in a more considered, balanced and valued building and can reduce much of the risk in the procurement process by focusing more attention on the initial design phase.

5.2 Key tips

When implementing a sustainable building:

- consider sustainable building strategies in the initial briefing of the project
- visit sustainable buildings of a similar nature during the development of the brief
- select a professional team with a concern and understanding of sustainable building
- encourage an integrated and co-operative design approach
- adopt measurement tools throughout the design, construction and first years of operation
- include a suitable budget and across-the-board allowances for sustainable building
- ensure cost advice is on the basis of whole-of-life-costs and not just capital costs, with net present value and internal rate of return rather than simple payback as the financial measures
- investigate external funding available for implementing sustainable building strategies (eg, the Energy Efficiency and Conservation Authority design and energy audits and Crown loan schemes)
- avoid over-elaborate solutions and compromising on sustainable building strategies to enable extravagant design
- fine-tune and evaluate the building in use and optimise its continued sustainability
- communicate and market the sustainable building message to all parties including building users.

5.3 Briefing

It is important that client, designers and construction team are familiar with sustainable practices and are willing to commit to a process that allows sustainable strategies to be incorporated from the outset. The overarching project goals and objectives should be clearly spelt out as part of the brief and the main design features that respond to these goals should also be identified. Sustainable measures, such as those given in Greenstar and National Australian Built Environment Rating System can provide a more detailed and useful starting point in the development of projects. These should be supplemented by project-specific design measures to meet the sustainable building project goals. Work at the briefing stage can be collected and summarised by an outline specification that can be used by owner-occupiers as the basis of design development or as a schedule of leasing requirements to give to a development team for a commercial client. Even at the briefing stage, many of the essential features can be identified, visualised and incorporated into the project cost model.

5.4 Integrated and cooperative design

The greatest gains in sustainable building are achieved through good integrated and cooperative design early in a project's development. This covers many issues, with the overall aim being to achieve a result that is greater than the sum of the parts – synergy. This requires teamwork from initial briefing through to completion, as well as a commitment by all, including architects, engineers, building modellers, quantity surveyors, builders, project managers, landscape architects and the client/developer, to sustainable building principles and outcomes from the macro to the micro including:

- site selection
- orientation and massing
- internal planning
- façade treatment
- materials selection
- building services
- implementation, commissioning and aftercare
- energy modelling.

5.5 Timing

Sustainability must be considered as early as possible in a building project and must continue to be considered at every step of design and construction.

A well thought-out and considered building is likely to include sustainable design within its numerous attributes. As the design process is more complex, it generally requires more time and higher fees. However, this should be viewed as a sound investment, as the additional costs and project durations are very small in relation to the overall end-out costs and life of the building.

5.6 Budgeting

It is important to recognise, from the outset, sustainable building as an integral briefing requirement rather than as an as added extra. This requires:

- including sustainable goals in the brief
- aligning the budget with the brief
- staying on track during design and construction
- ensuring quantity surveyors are providing realistic, rather than inflated, figures for sustainable features.

Simply choosing to add a premium to the budget for sustainable building is not enough, as there is no standard answer for each individual project. Benchmarking with other comparable projects can be useful but is not necessarily productive. Any assessment of the cost of sustainable building must be project-specific.

5.7 Measurement

Measurement is an important element in the implementation of sustainable building, especially as sustainable building becomes more mainstream, and particularly for commercial offices.

Rating tools or systems can help determine how sustainable a building is in relation to a benchmarking standard normally expressed in terms of stars, metals or grades. Rating schemes can also easily communicate the relative level of sustainability to clients and the market.

New Zealand currently has no rating scheme. Australia has two schemes suitable for adaptation to New Zealand conditions – Greenstar and the less commercially driven National Australian Built Environment Rating System (NABERS). Greenstar currently covers only offices and office interiors. NABERS covers all building types generically. Building Research Association of New Zealand (BRANZ) has also prepared a pilot version of an office-rating scheme. The development or adaptation of a New Zealand rating scheme is a priority.

Using thermal, daylight and energy modelling, and three-dimensional massing model tools to refine, test and benchmark sustainable design strategies is also important. Although not routine in New Zealand this software is widely used overseas. Energy modelling in particular is useful in quantifying the relative cost benefits and sensitivities of differing sustainable strategies, as building investors need accurate figures on which to base their investment returns.

Measuring the building energy and water consumption on completion of the project and reconciling these with design stage estimates is also important.

5.8 Post-occupancy evaluation

Post-occupancy evaluation (POE) should become part of the sustainable building culture. Sustainable building has started to raise our consciousness about discovering what works and what goes wrong. Many people view sustainable building as a risky venture, so we need to ensure we meet expectations and projected goals without compromising internal comfort and usability.

5.9 Skills

The initial uptake of sustainable building in New Zealand has, to some extent, been limited by the available expertise and skills of consultants, architects, builders, modellers, engineers etc. To date it has been very much a niche market. Availability of skills has widened to meet the increasing demand for sustainable building but there are still inadequate resources and skills for its widespread application, as seen in the current upturn in interest and demand for skills from a limited range of practitioners. There is also inadequate education and development of an indigenous New Zealand resource in this area and an over-reliance on recruiting staff from overseas to meet this demand. As educators and as a construction industry, we urgently need to fill this gap.

5.10 Further information

Sources of further information on sustainable building in New Zealand are given in Appendix 4.

Appendix 1: International Trends in Sustainable Buildings

Overseas trends show that investors are increasingly diversifying their portfolios to include ethical or socially responsible funds. Ethical investment in the USA and UK has increased by 50% per annum over the past 10 years. In Australia, Socially Responsible Investment (SRI) managed funds grew by 41% in the year to date to June 2004, more than twice as fast as the overall Australian retail and wholesale investment market, which grew by 18% during the same period.

Commercial building developers in the US identify real financial benefits that come from sustainable building, including:

- lower operating costs for energy, water and waste
- increased rental rates
- marketing advantage due to point of difference
- a faster lease-up period
- higher tenant retention rates due to increased comfort and productivity
- lower liability and risk leading to lower insurance rates
- higher loan value and lower equity requirements
- higher building value upon sale and appraisal
- overall greater return on investment.

A survey (Green Building Workshops, 2003–2004) of 10 major Australian property investors' thinking and attitudes towards green building found that:

- most agreed that sustainable building credentials were well regarded
- most rated and benchmarked their buildings for energy efficiency
- most expected energy costs to increase beyond the rate of inflation
- all did not fully understand the differing rating schemes for sustainable building
- all believed that tenant requirements for sustainable building credentials would be the single major cause of growth in the industry
- all agreed that the lack of sustainable building credentials would be a contributing factor for building obsolescence
- all had empathy for the cause of sustainable building
- most believed they could not afford to pay extra for sustainable buildings unless there was a direct and compensating financial return
- all agreed that tenant demand for sustainable buildings would be a principal driver for investment in green buildings.

Central and local governments in the UK, the US and Australia are also increasingly making sustainable building a requirement for their properties.

Costs

Costs for sustainable buildings internationally show a relatively marginal cost increase for sustainable building.

Davis Langdon states that significant environmental measures can be incorporated, leading to long term recurrent cost reductions, potential increased asset valuation and a more attractive home for tenants for as little as 2–4% additional capital cost (Davis Langdon Australia, 2004).

The Californian Sustainable Building Task Force identified an average capital cost premium of 2% for sustainable building. It is notable that a similar study just a few years earlier in the US estimated extra costs of 5–15%. The rapid drop in extra costs has been attributed to the normalisation of the market (ie, growth in industry experience and availability of materials and technologies) (Kats, 2003).

Davis Langdon states that significant elements of best practice, low energy and low embodied energy design can be adopted with a premium of about 10% (Davis Langdon and Everest, Matthiessen et al, 2004, Kats, 2003, Gottfried, 2003, McDonald, 2004 and Greater Vancouver Regional District, 2004).

Tenant-driven requirements

In the commercial office market, two client surveys, by Richard Ellis and Stanhope Plc in the UK, showed environmental issues to be the second most important factor for tenants after location.

Similarly, a recent survey by BOMA/ULI of US and Canadian tenants looked at the relative importance and satisfaction of over 60 building features, amenities and services. Environmentally-friendly building systems and materials were rated as important by 90% of the respondents. The survey also found there was a gap between the relative importance to building users of indoor environmental quality (temperature, indoor air quality, acoustics/noise control etc) and their satisfaction with standards in conventional office buildings. Similarly, rental and operational cost issues were also very important with only a moderate degree of user satisfaction.

Contrary to accepted wisdom, aesthetic features were, however, considered less important and there was an established degree of satisfaction with conventional buildings. This survey reinforces the importance of building interior design and indoor environmental quality, which is an integral part of sustainable building design. It also confirms tenant pressure on total occupation costs and the need to add value in these areas of sustainable building if continued growth in rentals is to be realised.

Green leases

The Australian Government, through the Australian Greenhouse Office, is developing a model green lease that will apply to all government tenancies (Power, 2004). The green lease will be linked to the Government's new Energy Efficiency Policy, which, among other things, will set minimum building energy performance standards. The following are some of the key features of the policy:

- all new and sustainably refurbished buildings, whether Commonwealth owned or where the Commonwealth is the majority tenant, must meet a minimum energy performance standard
- funding for building construction and refurbishing will be conditional on certification, by suitably qualified persons, that the building will meet required energy standards
- new lease agreements for buildings are also likely to exclude any provision permitting building owners to recover from the tenant the cost of energy used by building central services during normal working hours. This would ensure that building owners have an incentive to improve the energy efficiency of building central services.

The following are the key concepts under the green lease schedule being finalised:

- a mutually agreed management mechanism to implement energy efficiency and environmental obligations through an Energy Management Plan (EMP)
- establishing a building management committee to develop and manage the EMP
- defining the respective obligations of tenants and landlords in relation to occupational health and safety and other relevant statutory requirements, if energy efficiency measures are implemented
- monitoring and reporting mutually agreed outcomes in relation to energy efficiency and sustainable obligations (eg, such as agreeing energy intensity targets and/or savings)
- identifying opportunities to achieve energy efficiency initiatives on lease renewal (if applicable) and/or major refurbishments
- requiring the landlord to establish a water usage target for central service plant and set a reduction in percentage terms per annum.

Incentives

As an incentive to investment in sustainable building in the UK, the Finance Act 2003 introduced first-year allowances for capital expenditure on environmentally beneficial plant or machinery meeting strict water and energy efficiency criteria.

Australia also has some incentives, particularly with regard to uptake of renewable energy technologies.

Appendix 2: Short and Medium Term Sustainable Building Options

Table 7: Commonly considered and potential short/medium term payback sustainable building options

List of potential attributes	Potential operating cost improvement	Potential for productivity improvement	Symbolic ESD impact	Potential greenstar credits	Capital cost $/m^2 range		Typical payback range (years)		Advantage where no financial payback
Management category									
Independent commissioning agent	•	•		1	1	2	0	3	RR
Environmental management plan	•	•		3	0	2	Nil	Nil	MEI
Indoor environmental quality category									
Central atria – increasing natural light penetration	•	•	•	2	19	48	PS	PS	
Increased daylight penetration (through effective glazing design and sunshelves)	•	•	•	3	4	14	PS	PS	
External shading devices to north façade (on low rise buildings)	•	•	•	1	4	12	10	15	
Displacement ventilation	•	•		2	10	40+	5	15+	
Low volatile organic compound containing paints		•		1	0	5	Nil	Nil	IIAQ
Low volatile organic compound containing carpet (wool or specific solution dyed products)		•		1	0	10	Nil	Nil	IIAQ
Energy category		•							
Optimise glazing type	•	•		C	16	24	10	18	
Increased wall, floor and roof insulation rating	•			C	2	6	5	10+	
Advanced air conditioning options	•		•	C	50	75+	5	8+	
High efficiency electric motors	•			C	1	2	5	10	
Super pipework and ductwork insulation	•			C	3	7	5	10	
Night purging through use of BAS controls	•			C	0	1	0	10	IIAQ
Occupancy sensors (selected areas) / lighting zoning	•			1	2	4	4	8	
Lighting control system (selected areas)	•			C	2	4	4	10	
Photovoltaic cells	•		•	C	8	14+	10	25+	
Transport category									
Provision of bicycle storage and change facilities for ease of use by employees		•	•	3	2	6	Nil	Nil	RE
Water category									
Greywater collection, treatment, storage and use	•		•	5	15	30	12	25+	
Materials category									
Concrete with recycled content (green concrete)				3	3	6	Nil	Nil	MW
PVC reduction				2	1	3	Nil	Nil	MEI
Land use and ecology category									
Minimise ecological impact and maximise enhancement of site for new and existing buildings			•	4	PS	PS	Nil	Nil	MEI
Emissions category									
Minimise neighbourhood light pollution				1	0	1	Nil	NIl	MEI

Notes:

1. The figures stated are taken from various projects, both in sizes and locations. They represent an average cost for the attributes stated, taking into account all associated works required.
2. The costs and payback periods are provided as a guide only. Any business case must be reviewed on its own merits.
3. The figures have been compiled from a number of projects to provide a general overview of the likely ecologically sustainable development (ESD) opportunities available to clients considering new developments.
4. It should be noted that the operating cost saving has been calculated on an individual basis, and that the cumulative effect of incorporating ESD attributed may be less than the sum of the individual parts calculated.
5. The Greenstar credits are provided as on indication only and would be assessed by an accredited Greenstar Assessor on a project-by-project basis.
6. The items are those which have been considered repeatedly in the early design stages of projects.
7. The table examines each of these attributes in terms of potential operating cost improvements, potential productivity gains, impact on symbolic ESD, and the indicative Greenstar credit available. Anticipated capex ($/m^2) and typical payback periods (years) are also provided for each item.
8. It is noted that some ESD initiatives naturally fit together and frequently support the case for other attributes.

Legend:

RR = Reduced risk IIAQ = improved indoor air quality MW = minimises waste MEI = minimises environmental impact

PS = Project specific C = contributes to energy improvement / greenhouse reduction with potential of 15 credits

Appendix 3: Residual Land Value Calculation

For the purpose of this report, the valuation of both a conventional 10,000m^2 gross floor area (GFA) commercial office and a similarly sized sustainable office building have been analysed. The analysis is on the basis of the concept of 'worth', which properly reflects the benefits of sustainable building in terms of:

- corporate tenant identification with environmental issues
- improved rental values
- better technical performance
- improvements in productivity and other building occupant advantages.

The analysis depends on a rearrangement of the normal developer's equations as follows:

$$Value\ (V) = \frac{Gross\ Income - Outgoings}{Capitalisation\ Rate}$$

$$Costs = Land\ (L) + Buildings\ (B) + Finance\ (F) + Marketing\ (M) + Profit\ (P)$$

These equations are often rearranged in order to calculate the land value for a development. This is known as residual analysis or residual valuation. Thus, the residual land value is found as follows.

In the example in Table 3 the following assumptions have been made:

1 Building type

10,000m^2, Grade A city commercial office building in Wellington, 8,500m^2 net lettable area.

2 Developer returns

A 5% rental premium is allocated for the sustainable building to reflect the improved internal environment.

An allowance is also made for improved productivity. A productivity improvement of 2.5% has been assumed, giving an annual staff cost saving of \$75 per m^2 for the sustainable building.

Outgoings include operating and maintenance costs. The outgoings for the sustainable building have been reduced from \$80/m^2 to \$70/m^2 to reflect energy cost savings.

The net operating income is capitalised at 8% for the conventional building and at 7.75% for the sustainable building, which reflects its improved market potential.

Sales commissions and costs are assumed to be 1.5% of the capitalised building value.

Letting commissions and costs are assumed to be 15% of the net capitalised building value.

3 Development costs

The developer's allowance for risk and return is treated as a development cost in the residual analysis. Feasibility studies are often undertaken to establish potential profitability.

Ten percent is assumed for the conventional building and 15% for the sustainable building. This reflects an additional risk for the latter despite the improved returns listed above.

The building costs are allowed at $1,800/m^2 for the conventional building and $2,000/m^2 for the sustainable building to allow for potential premium costs for sustainable features.

Professional fees are allowed at 10% for the conventional building and 12% for the sustainable building to allow for the premium costs of sustainable design.

Construction financing costs have been assumed at 8% for both the conventional and sustainable buildings. The same construction period of 24 months is also used for both the conventional and sustainable buildings. The interest is assumed to be charged on the total construction cost for half the development period (ie, 12 months, assuming constant capital expenditure progress payments for building construction).

4 Gross residual land value

Rates includes local authority and water rates.

Holding charges and financing have been assumed at 8% for both the conventional and sustainable buildings. This rate has been charged for the full development period including a pre-construction period of six months and the construction period of 24 months.

The results of this residual analysis are illustrated in Table 3, which shows that the land value for the sustainable building is approximately 40% higher than for a conventional building, and the worth of the sustainable building is approximately 45% higher than for a conventional building.

Table 8: Residual value comparison between conventional and sustainable buildings

			Conventional building			Sustainable building		
		m^2	Rent/sqm	Net rental		Rent/sqm	Net rental	
Development returns								
Gross rental value			380			399		
Staff savings			–			75		
			380			474		
Outgoings			80			70		
Net rental value	Net lettable area	8,500	300	2,550,000		404	3,434,000	
Net income					2,550,000			3,434,000
Capitalisation rate					8.00%			7.75%
					31,875,000			44,309,677
Less sales commissions and costs			1.50%		478,125	1.50%		664,645
					31,396,875			43,645,032
Less vacancies								
	Pre-let		100.00%			100.00%		
	Letting up period		0.00%			0.00%		
Rent lost					–			–
					31,396,875			43,645,032
Less letting commissions and costs			15.00%		382,500	15.00%		5,692,830
					31,014,375			37,952,202
Development costs								
Developer's allowance for profit and risk				10%	2,819,489		15.00%	4,950,287
					28,194,886			33,001,915
Building cost	Gross floor area	10,000	1,800	18,000,000		2,000	20,000,000	
Consultants' fees			10.00%	1,800,000		12.00%	2,400,000	
				19,800,000			22,400,000	
Construction finance	Interest		8.00%			8.00%		
	Construction period		24			24		
				1,584,000			1,792,000	
Total construction costs					21,384,000			24,192,000
Gross residual land value					6,810,886			8,809,915
Less rate and taxes					100,000			100,000
					6,710,886			8,709,915
Less holding costs	Interest		8.00%			8.00%		
	Pre-construction period		6			6		
					1,118,481			1,451,652
					5,592,405			7,258,262
			6.00%		316,551	6.00%		410,845
Net residual land value					5,275,854			6,847,417

Appendix 4: New Zealand Sources of Information on Sustainable Building

Climate

- www.niwa.cri.nz National Institute of Water and Atmospheric Research
- www.climatechange.govt.nz Climate Change (NZ)

Education and Advocacy

- www.nzaee.org.nz New Zealand Association for Environmental Education
- www.eds.org.nz Environmental Defence Society
- www.nzgbc.org.nz New Zealand Green Building Council

Energy

- www.eeca.govt.nz Energy Efficiency and Conservation Authority
- www.ema.org.nz Energy Management Association of New Zealand
- www.energyfed.org.nz New Zealand Energy Federation
- www.windenergy.org.nz New Zealand Wind Energy Association
- www.photovoltaics.org.nz New Zealand Photovoltaic Association
- www.solarindustries.org.nz New Zealand Solar Industries Association
- www.bioenergy.org.nz Bio-energy Association of New Zealand
- www.sef.org.nz Sustainable Energy Forum (SEF)

Government

- www.mfe.govt.nz/issues/sustainable-industry/govt3/topic-areas/ Ministry for the Environment
- www.pce.govt.nz Parliamentary Commissioner for the Environment
- www.biodiversity.govt.nz Biodiversity Information Online
- www.dbh.govt.nz Department of Building and Housing

Materials

- www.cca.org.nz/toplevel_files/welcome.htm Cement and Concrete Association of New Zealand
- www.branz.co.nz Building Research Association in New Zealand
- www.enviro-choice.org.nz Environment Choice NZ
- www.ipenz.co.nz New Zealand Institute of Professional Engineers
- www.nzia.co.nz New Zealand Institute of Architecture

Recycling

- www.ronz.org.nz Recycling Operators of New Zealand Inc
- www.wasteminz.org.nz Waste Management Institute of New Zealand (includes links to other waste-related sites)
- www.zerowaste.co.nz Zero Waste New Zealand

Regional and city councils

- www.ecan.govt.nz/home/ Environment Canterbury
- www.ccc.govt.nz/environment/ Environment Christchurch
- www.waitakere.govt.nz Waitakere City Council

Research

- www.beaconpathway.co.nz BEACON
- www.waitakere.govt.nz/AbtCit/ec/bldsus/betterbuilding.asp Waitakere City Council Better Building Site
- www.branz.co.nz Building Research Association in New Zealand
- www.vuw.ac.nz/cbpr/ Centre for Building Performance Research

Standards

- www.standards.co.nz/default.htm New Zealand Standards

Sustainable business networks

- www.sustainable.org.nz Sustainable Business Network
- www.nzbcsd.org.nz New Zealand Business Council for Sustainable Development

Water

- www.nzwwa.org.nz New Zealand Water and Wastes Association
- www.waternz.co.nz Water New Zealand – a gateway to the New Zealand water industry
- www.arc.govt.nz Auckland Regional City Council

Appendix 5: Glossary

Agenda 21: Programme of action adopted by the 1992 United Nations Conference on Environment and Development.

BOMA: Building Owners and Managers Association UK. New Zealand equivalent known as the Property Council of New Zealand.

Californian Sustainable Building Task Force: A partnership of 40 governmental agencies working towards incorporating sustainable building principles into California's capital outlay process.

Capitalisation rate: The rate of return a property will produce on the owner's investment.

Carbon tax: A charge or tax levy on fossil fuels (oil, natural gas) based on their carbon content. When burned, the carbon in these fuels becomes carbon dioxide in the atmosphere, the chief greenhouse gas.

Crown loans: Investments in energy efficient technologies or loans available through the Energy Efficiency and Conservation Authority to government departments, district health boards, Crown owned companies, territorial authorities, regional councils, universities, polytechnics, schools and crown entities for energy efficient projects. These organisations have a collective energy spend of around $200 million pa. A review of 10 audits in the public sector over the past two years indicates a total saving potential of around 14%. Of that, 8% are low-cost savings and are generally able to be funded internally. The remaining 6% require capital investment.

Discount rate: The interest rate used in calculating the present value of future cashflows.

EECA: Energy Efficiency and Conservation Authority. EECA's role is to encourage, promote, and support the uptake of energy efficient initiatives and new renewable energy.

ESD: Ecologically Sustainable Development. ESD is a concept that recognises the need to integrate short and long term economic, social and environmental aspects into the management of all of our activities including the building environment.

Global warming: An increase in the near surface temperature of the earth. Global warming occurred in the distant past as a result of natural influences, but the term is most often used to refer to the warming predicted to occur as a result of increased man-made emissions of greenhouse gases.

Green Building Council of Australia and Green Building Council of New Zealand (GBCA): An international body of councils committed to promotion and education of sustainable buildings. Six councils exist around the world including Australia and eight councils are emerging around the world including New Zealand.

Green leases: A 'green lease' is a lease between the landlord and tenant of a 'green building' or a conventional building that is proposed to be refurbished as a 'green building'. It incorporates ecologically sustainable development principles that ensure the ongoing use and operation of that building to minimise environmental impacts, by establishing targets for energy and water use and obligation on the tenant for the sustainable use of buildings.

Greenstar: An Australian office building environmental rating scheme developed and administered by the Australian Green Building Council.

Govt^3: A Ministry for the Environment programme for agencies to improve the sustainability of their activities. The 'Govt' in Govt^3 stands for government and the '3' stands for the 'three pillars of sustainability': environmental, social and economic.

IRR: Internal rate of return. The discount rate at which the present value of the future cash flows of an investment equals the cost of the investment. The discount rate with a net present value of 0.

Infrastructure Auckland: A defunct infrastructure asset-holding authority responsible for planning and funding infrastructure projects in Auckland. Now a disestablished part of the Auckland Regional Council.

LNG: Liquefied natural gas. Natural gas liquefied by reducing its temperature to -162 degrees Celsius at atmospheric pressure. It remains a liquid at -82°C and 4.64 MPa. In volume, it occupies 1/600 of that of the vapour at standard conditions.

Marginal cost: The changes in total cost that arise when the quantity produced (or purchased) changes by one unit. For example, if a firm wants to produce more, it might find that it has to employ people on overtime, so additional units of output cost more to produce.

NABERS: National Australian Built Environment Rating System. NABERS is a performance-based rating system that measures an existing building's overall environmental performance during operation. NABERS will rate a building on the basis of its measured operational impacts – including energy, refrigerants (greenhouse and ozone depletion potential), water, stormwater runoff and pollution, sewage, landscape diversity, transport, indoor air quality, occupant satisfaction, waste and toxic materials.

NEECS: The National Energy Efficiency and Conservation Strategy. Prepared as a requirement of the Energy Efficiency and Conservation Act 2000. As required by the Act, the Strategy is organised around policies, objectives and targets, supported by a set of means (or measures). The Strategy's purpose is to promote energy efficiency, energy conservation and renewable energy and move New Zealand towards a sustainable energy future.

Non-residential building: Area that provides commercial, industrial and public facilities.

NPV: Net present value. The future stream of benefits and costs converted into equivalent values today. This is done by assigning monetary values to benefits and costs, discounting future benefits and costs using an appropriate discount rate, and subtracting the sum total of discounted costs from the sum total of discounted benefits.

Performance-based leases: Leases that include provisions for meeting agreed benchmarks for energy and water consumption.

Present value (PV): The current value or worth of an amount to be received in the future. In the case of an annuity, present value is the current worth of a series of equal payments or savings to be made in the future.

Post-occupancy evaluation: Post-occupancy evaluation involves systematic evaluation of opinion about buildings in use, from the perspective of the people who use them. It assesses how well buildings match users' needs, and identifies ways to improve building design, performance and fitness for purpose.

Property Council: A professional association that represents members with a vested interest in commercial property, including building owners, developers, agents, construction companies, investment companies, asset managers and service suppliers.

PROBE: UK post-occupancy evaluation method for buildings.

Resource Management Act (RMA): An Act of Parliament passed in 1991, it is New Zealand's principal environmental legislation. Its objective is to promote sustainable management of New Zealand's natural and physical resources. It is designed to deliver superior environmental protection with greater economic efficiency and public accountability.

Renewable: Energy sources that are, within a short timeframe relative to the Earth's natural cycles, sustainable, and include non-carbon technologies such as solar energy, hydropower and wind as well as carbon-neutral technologies such as biomass.

Simple payback: An energy investment's simple payback period is the amount of time it will take to recover the initial investment in energy savings, dividing initial installed cost by the annual energy cost savings. For example, an energy-saving measure that costs $5,000 and saves $2,500 per year has a simple payback of 5000 divided by 2500, or two years. While simple payback is easy to compute, it fails to factor in the time value of money, inflation, project lifetime or operation and maintenance costs. To take these factors into account, a more detailed life-cycle cost analysis must be performed. Simple payback is useful for making ballpark estimates of how long it will take to recoup an initial investment.

Socially responsible investment (SRI): A process that takes social, environmental and ethical criteria into account when investing in companies.

Sustainable building: The term sustainable building is used interchangeably with green building. Its purpose is to reduce the adverse human impacts on the natural environment, while improving our quality of life and economic well-being.

Tenancy lifetime care: The management of a tenanted commercial building by a building owner to ensure outcomes in terms of operating costs, environmental and user satisfaction outcomes are maintained over the life of the tenancy.

Total occupancy cost neutral: By considering the total occupancy costs, including rental and operating cost over the lease period, a higher rental cost can be cost neutral if it is offset by lower operating costs.

Whole-of-life cost: A whole-of-life approach takes account of the initial costs of building and also of the full costs of operating the building. Taken a stage further, it takes into account costs that might otherwise be excluded, such as raw materials extraction and processing, packaging and disposal of the building materials when the buildings useful life is at an end. It includes service maintenance and repairs, energy and other running costs, security of supply etc.

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