



Green Buildings



Beca ESD is a unique centre of excellence within the Beca Group* comprising specialist building services and structural engineers, and planners with expertise in environmentally sustainable design (ESD) for buildings, and the application and delivery of Green Building Technologies as well as strategic sustainable business planning. We are a well-established team with proven and award winning success across a variety of markets and geographic environments.

Beca ESD offers a totally integrated suite of consultancy, design and commissioning services to wide range of clients including building owners, developers, tenants and regulatory institutions. We apply 'whole building' environmental engineering techniques, integrating the engineering with the architecture during design and with operators at completion with the aim of achieving efficient and commercially sound outcomes where environmental performance can be benchmarked.

Beca ESD brings an open mind and an inventive and positive attitude to projects. We enjoy working as an integral part of the project team to research, evaluate, benchmark and agree the most appropriate integrated ESD solutions for the project.

* For more information about the Beca Group please visit www.beca.com

SERVICES

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Beca is a leader in developing the holistic design briefs that target building owners, users, and other stakeholders of the built environment. Key factors inherent in the design process that Beca has developed is the use of staged “Design Features Reporting” together with understandable technical descriptions for the options and potential solutions. Beca is particularly mindful of the need to integrate the solutions into a “Whole of Building” design, but also the take great care in considering the long term management and maintenance, energy costs and potential churn related to various type of buildings.

We believe that sustainable design is “front-loaded.” Early decisions have the greatest impact, and our integrated approach from the briefing stage through to hand over is underpinned by a thorough understanding of building performance and client and building stakeholder needs.

Our award winning buildings are testament to our desire and ability to deliver holistic sound engineering solutions, which are sympathetic to the environment, harnessing natural resources to minimise the environmental impact and maximise overall building performance.

ENVIRONMENTAL SITE MANAGEMENT

Beca specialises in developing environmental solutions with the aim of adding value to our clients’ projects and businesses. We provide these solutions through the preparation and implementation of site-specific management plans, follow-up monitoring and auditing, and assessment of environmental effects for the industrial, commercial and construction industries.

Beca’s approach is to address environmental considerations early in the project life cycle. Our experience has shown that a ‘front-end’ approach to issues such as public consultation and consenting processes can result in improved project timing and reduced costs. Beca can augment our specialist environmental services with our broader engineering services as and when required. Together with our other core services, our environmental services include:

Environmental construction management on both small and large projects. We can help monitor performance against compliance standards, minimise impacts to stakeholders and deliver potential gains in both project timing and costs. Our team can also develop tailored environmental education programmes for construction teams to help projects reach best practice benchmarks.

Compliance auditing for industrial and commercial sites or construction projects. Our team has Quality Society of Australasia qualified auditors who can lead or assist with compliance audits and environmental systems development.

Preparation and implementation of environmental management plans and systems that incorporate environmental considerations into a design, construction or regulatory process. The successful implementation of environmental management plans and systems can deliver significant environmental, economic and public relations gains and minimise the need for remedial works. We can

help define our clients’ environmental goals and find the best practicable engineering solutions to achieve them.

Environmental monitoring that aim to achieve environmental objectives, whether they be short-term goals (such as managing the quality and quantity of sediment runoff from a construction site), long-term goals (such as developing a strategic approach to stormwater management), or goals aimed at reducing a particular risk (such as flooding or erosion) or preserving a specific natural feature (such as fish passages or wildlife habitats).

Assessment of environmental effects, including follow-up advice on site management, issue resolution, remediation, engineering design, consenting, development of mitigation and/or project enhancement and public consultation.

Environmental feature design that can enhance the aesthetics of projects and business by including creative designs and artworks. Beca’s successful approach to urban/ environmental projects puts key considerations such as constructability, robustness of material, cost efficiency and safety at the forefront. Beca has been responsible for the development of vegetation strategies, feature relief on retaining walls and roadside barriers, and the development of heritage markers and public artworks along strategic routes.



WE RECOGNISE THOSE CLIENTS THAT HAVE INVESTED IN SUSTAINABILITY AND WILL CONTINUE TO HONOUR THEIR SUCCESS.

SUSTAINABILITY CONSULTANCY AND AUDIT SERVICES

Sustainability Policy and Strategy Consultancy

Strategic ESD planning helps define an organisation's environmental and sustainability vision and the detailed objectives and actions necessary to achieve that vision. Policy planning relates to the recording of the policy and implementation to achieve specific objectives or outcomes within the legislative environment. Beca ESD planning's approach is based on:

1. Having a thorough understanding of our clients' business drivers and the outcomes they are trying to achieve.
2. Sound understanding of the operating environment, including being at the leading edge of planning practices and changes to the legislative environment.
3. Achieving integrated, well-considered and practical outcomes that are sustainable long-term.
4. Taking a leading role in project management and engaging with a broad team to get the best results.
5. Using our mix of skills and experience to successfully deliver a diverse range of projects.

Our experience in running strategic ESD studies and policy development services includes:

1. Strategic studies and policy development for central, federal, regional and local government.
2. Strategic sustainability planning for business, including advice on investment decisions and project feasibility.
3. Master planning for sustainable environments.
4. Developing action plans, monitoring and risk strategies for achieving specific sustainability goals.
5. Industry specific strategy studies, such as for commercial office, education facilities, retail etc.

We use environmental rating and bench marking systems wherever appropriate and have BREEAM (UK), LEEDS™*, GreenStar Australia, and GreenStar New Zealand accredited professionals.

* LEEDS is a registered trademark of the US Green Building Council

Tenancy Work Place Standards and Representation

The environmental impact of building developments is under increasing world-wide scrutiny, and leading corporate clients are demanding office space, which is sympathetic to the environment and supports increasing visible Corporate Social Responsibility mandates. In the growing war for talent, corporations show casing their environmental objectives in ESD buildings are driving market expectations significantly altering the commercial office landscape in recent times.

As such, Beca are at the forefront of this charge, providing ESD advice to tenants, assisting with base building reviews, setting environmental benchmarks and providing options to enhance the ESD performance of end user developments.

Advise at the outset of a project, can result in significant improvements in not only the environmental performance, but also the quality of the internal environment, which can result in significant improvement on the indoor environmental conditions and staff productivity.

Key services include:

- Early ESD advice to tenants during lease and development agreement negotiations;
- Analysis and optimisation of base build ESD opportunities, to maximise tenant benefit;
- Interiors GreenStar bench marking reviews;
- Natural day lighting studies;
- Energy modelling services;
- Comfort modelling reviews and system advice;
- Specialist CFD modelling of Comms room and critical areas (such as dealing rooms, call centres, internal atria).

Beca are involved in the development of the NZ Green Building Council, "Office Fit out" GreenStar tool, and Commercial Office environmental rating tools which will provide an industry benchmark for Environmental impacts of buildings.





Energy Audit Services

An energy audit can help a company understand more about the way energy is used in the organisation and help control energy costs by identifying areas where waste can occur and where scope for improvement may be possible. Beca energy audits follow the Australian and New Zealand Standard AS/NZS 3598:2000 Energy Audits. An energy use investigation can be worthwhile to determine if operating costs can be reduced. A Beca energy use investigation can be selected from the following standard services or tailored to meet specific needs:

- On-line energy use monitoring;
- Comparative energy use (kWh) assessment;
- Comparative energy cost (\$) assessment;
- Annual energy use predictions;
- Component efficiency assessment;
- Opportunities for improvement;
- Design for improvement.

The Beca energy audit employs a rigorous process in order to gain a comprehensive picture of the company's current energy and utility usage. The audit report forms an ideal starting point for a journey towards cost-effective energy

management and achieving performance goals. From the audit conclusions, appropriate business solutions can be developed and cost-benefit analyses are carried out on each viable option. Beca can offer a wealth of practical experience to clients as many of our employees have previously held energy management roles within industry. As a multi-disciplined company, Beca also has a number of specialist departments that can be called upon to help resolve any areas requiring expert analysis. Energy and utility analyses considered within a typical energy audit include:

- Electricity;
- Refrigeration;
- Compressed Air;
- Boiler House;
- Water;
- Process Gases;
- Effluent.

The environmental impact of building developments is under increasing world-wide scrutiny, as society recognizes the global connection between human activity/development and our environment. Issues surrounding Climate change, Ozone depletion, Air quality and Water use are being addressed on the global stage, and International protocols /agreements are being implemented to reduce our impact on our natural environment.

Globally, buildings consume 40% of the world's raw resources, 15% of fresh water, 50% of timber and up to 40% of global energy. 40% of solid land-fill waste, 40% of harmful air emissions and 35% of the worlds CO² emissions are produced by buildings. Environmentally Sustainable Design (ESD) seeks to address these issues, and promote development, which minimises our impact on the environment in the building, operation and decommissioning processes.

WE DON'T NEED TO TELL OUR CLIENTS ABOUT THE IMPORTANCE OF SUSTAINABILITY. THAT GENIE HAS BEEN OUT OF THE BOTTLE FOR YEARS. OUR JOB IS TO DELIVER NEW IDEAS AND THINKING TO HELP THEM ACHIEVE THEIR SUSTAINABILITY OBJECTIVES ACROSS ALL ASPECTS OF THEIR BUSINESS.



GREEN BUILDING DESIGN AND COMMISSIONING

Building Envelope Analysis

We work on a collaborative basis within the overall design team to develop the building form and fabric to perform as an integral part of the environmental servicing strategy working as the primary climate modifier to provide the following main environmental design functions to allow:

- Optimum use of natural daylight;
- Optimum use of natural ventilation;
- Minimisation of unwanted solar heat gain;
- Use of solar energy to reduce heating requirements;
- The benefits of natural resources (wind, rain, solar, etc) where appropriate.

Computer Simulation

Wherever appropriate, computer simulation modelling is used to aid the environmental engineering of the project. In the early stages site layouts and building form and orientation are evaluated to take best advantage of available natural energies – sun, wind, light and rain – offered by the site. The ESD performance study will use 3D computer analysis software to review the comparative performance to different building envelope specifications.

Our in-house 3D dynamic simulation modelling software allows evaluation and comparison of the effects of different building and window specifications, thermal performance, solar shading, natural ventilation performance and control strategies and HVAC system performance on occupant comfort, system requirements and annual energy use. Our 3D evaluation of natural ventilation and cooling requirements has been shown to offer significant performance improvements and optimise HVAC plant capacity operating efficiencies, for occupant comfort and energy use.

Beca uses 3D computer simulation of buildings to evaluate:

- Façade efficiency;
- Solar shading design and analysis;
- Low energy design;
- Natural ventilation performance;
- Comparisons of HVAC strategies;
- Passive heating/cooling techniques;
- Ventilated facades;
- Chilled ceilings and beams;
- Thermal comfort analysis;
- Energy targeting and energy use analysis;
- Plant sizing;
- R-value analysis;
- Innovative solution analysis.



WE ENCOURAGE OUR CLIENTS TO AIM HIGH WITH THEIR SUSTAINABILITY OBJECTIVES.
IT GIVES US SOMETHING CHALLENGING TO SHOOT FOR.



Ventilation

Natural Ventilation

Wherever appropriate we design for natural ventilation with opening windows, utilising carefully designed windows with simple operating mechanisms together with solar shading and passive elements of the building structure to provide the primary environmental control. This provides an inherently robust and flexible solution with the building dampening diurnal and seasonal swings in internal temperature to produce an internal environment which conforms to comfort expectations. Thermal analysis software is used where appropriate to verify the predicted performance of natural ventilation options and operating modes.

Ventilation and Cooling Systems

The evaluation of different HVAC systems will also form part of the TBP scope, to compare the performance of HVAC options for the development based on comfort, energy efficiency, emissions and local environmental impacts. The performance of HVAC system options will be evaluated based on comfort, energy efficiency, emissions and local environmental impacts.

Mixed Mode

Where it is not appropriate to use natural ventilation, a mixed mode strategy can be investigated to operate parts of the building in mechanical mode during hot and cold periods, using efficient and effective mechanical systems for optimum ventilation effectiveness.

Lighting

Day Lighting

Wherever appropriate we design for natural lighting, with windows provided and designed to provide views and allow optimum utilisation of natural light while controlling glare and any unwanted solar gains. Daylight control devices will be utilised wherever practical to enhance daylight availability. Efficient artificial lighting systems are provided with user-friendly controls to optimise daylight usage when available.

Lighting Control

Appropriate lighting design can add significantly to the overall energy efficiency of a building. And Beca has full time specialist lighting engineers with close contacts with lighting research being undertaken throughout the world. The building must operate effectively both when adequate daylight is available, at times where artificial lighting is used to either supplement daylight or for full artificial lighting.

We work closely with the architect/façade designer to ensure the correct selection and location of fittings and implementation of intelligent lighting control systems will produce a building that occupants enjoy working and studying in at all times of the day and throughout the year. Beca has uses 3D modelling of the lighting system design utilising both AGI32 or Lightscape lighting analysis software.





Energy

Active Energy Usage Control

Energy rationing is going to be a factor in business planning for the foreseeable future. The design of an electrical system that allows loads to be shed in a controlled manner whilst minimising the impact on operational functionality is a key to business success. Beca played a major role in maintaining business operations for many clients throughout the world. From these experiences we have developed a number of design options, for clients to select from based on their risk assessments and individual needs.

Low Energy Design

A low energy design process involves close communication with the designers of the various elements of architecture, structure and building services. It also requires a detailed understanding of the client and users operational and functional requirements. The consultation process would develop appropriate targets / guidelines for thermal comfort, air quality, energy use, acoustic performance,

manual vs automatic control, and the extent of individual user control.

Opportunities will be identified for passive heating, cooling and ventilation, and areas where mixed mode systems will provide the best results. The use of daylight will be maximised by integrating lighting control systems with a façade that provides good light let through whilst limiting solar heat gain. The performance of low energy options would be bench marked against typical mechanical building services systems to enable value-engineering decisions to be made.

The analysis of comparative benefits and assessment of risks is particularly important where passive solutions are being considered. With conventional mechanical systems there is generally sufficient "installed capacity" to address changed or even misunderstood expectations by the adjustment of control set points. Passive systems do not allow the user to simply "dial up" more or less capacity to meet changed demands/expectations.

Renewable Energy

Our specialists will also review and report on building integrated renewable and low carbon energy generation technologies which may be considered for the project, using in-house models for technologies such as solar electric, wind power, fuel cells, etc.

Solar Energy

We seek to take maximum advantage of available passive solar energy to reduce heating energy consumption. Active solar techniques are also evaluated wherever appropriate.

Thermal Energy Storage

Beca's experience in the design and procurement of thermal energy storage systems has enabled a range of international clients to take advantage of the reliability benefits and operational cost savings these systems can deliver. Thermal energy storage systems make use of low-cost electricity to generate chilled water or ice at night time for use in process or air-conditioning during the daytime, thereby avoiding peak energy and demand costs for electricity. They can also utilise smaller plant capacities to meet peak demands and manage peaky cooling loads. Thermal energy storage systems, when employed for straight air-conditioning, can be economical in countries where there are multi-tiered electricity tariffs and where night-time electrical charges are more than 50% cheaper than daytime.

These systems need be designed with many constraints in mind. Space, capacity and performance are critical criteria, and the choice of technology will sometimes be determined by the energy or back-up strategy used. Beca can help to select the appropriate technology and with our experience in this area determine a procurement strategy to suit the project. As most technologies are proprietary, efficient integration with existing systems is vital. Beca understands the strengths and weaknesses of different technologies and can provide advice on how best to integrate technologies and systems.

Water

Water Efficiency

We employ water use models developed in-house for the water use analysis part of the design review, using historical local rainfall data to optimise the size of the rainwater collection tank to suit the local climate and the project requirements for best value. Freshwater use is reduced by implementing water efficient sanitary ware specification measures when evaluating sanitary ware, and rainwater collection and recycling systems. The tap ware and sanitary ware will be assessed with a view to minimising water use. The additional benefits provided by rainwater collection and recycling for toilet flushing and irrigation uses will form part of the evaluation.

Hot Water Heating

By selection of water efficient shower and taps the benefits of solar hot water heating can be considerably enhanced. The benefits of solar hot water heating will be evaluated and reported on, again using programmes using the local climate conditions to optimise the solar benefits.

Green Roofs

The addition of earth and plants to a roof is old as civilization. Traditionally, turf and stones held down the weathering layer on exposed coastal roofs. The midday sun was kept out of a cool interior by layers of clay and sand in desert strongholds.

WE NEVER FORGET THE COMMERCIAL DRIVERS THAT MUST BE SATISFIED IN OUR CLIENT'S BUSINESS. WE MUST ALWAYS SEEK PROOF THAT OUR ESD THINKING TRANSLATES TO OUR CLIENTS BEING MORE PROFITABLE AND MORE EFFICIENT.

In a high technology building context, major benefits can be gained for building users and owners by the addition of planting to roof areas. The combined Beca Group expertise in engineering and architecture give a wide range of options to suit the location, and strike that crucial balance between amenity and cost. A planted roof can serve as the fifth elevation in a tight urban context, or act as the disguise for infrastructure buildings in sites of great landscape importance.

The structure, finishes, irrigation and maintenance of such a roof require no more care than a conventional roof, but can offer climate mitigation, sound attenuation, amenity areas; even storm water runoff can be delayed. Potential problems of thermal stress and creep in the roof finishes can be eliminated through the insulation and evapotranspiration of a planted surface. These are valuable points for the GreenStar ratings of all types of buildings.

Early in the building design process, a building envelope analysis can indicate and quantify the advantages of specifying a green roof. Energy and water efficiency, ventilation, shade and amenity value can be gained by thinking of your roof as an extension of your site, rather than just an umbrella.





Sustainable Structural Design

Consideration of both energy cost of material and the volume of materials used has gained significant currency in Sustainable building design. Structural engineers have a responsibility to their clients to design cost effective structures making efficient use of natural resources. The greatest benefits are realized through a multi-disciplinary approach, which combines the skills of the structural engineer with those of the architect, buildings services engineer and other disciplines. Beca structural engineers are able to draw on a wealth of experience gained on an extensive range of significant projects, which have involved a multi disciplinary approach to problem solving.

Work has included:

- development of innovative techniques for creating floor and wall finishes utilizing structural concrete with the elimination of additional finish material;
- use of hollow core flooring to act as passive 'building cooling'; and
- utilization of structural elements to provide shading, reducing cooling demands on buildings.

Beca has developed significant expertise in the reuse of existing structure for redevelopment rather than complete demolition and rebuild. The recently completed Pacific Place project in Jakarta utilized 5 levels of existing basement significantly reducing waste generation and material demand for the redevelopment. These integrated engineering solutions have resulted in significant reductions in both energy cost and volume of material used on projects.

Commissioning Management

Our philosophy at Beca is that if a system cannot be commissioned correctly then the effort and expense of design and installation has been wasted, especially where the building design includes a mix of passive and active systems. We believe commissioning is vital to achieving a fully functioning building and one that maintains the correct environmental conditions. The commissioning process needs to be managed diligently to deliver to the client a fully commissioned building with the associated documentation record. Beca provides a comprehensive Commissioning Management service that can be tailored to each client's needs, from off-site reviews through to a fully manned project team. We can provide the following services:

- Design Review;
- Create and Manage Independent Database;
- Integrated Programming;
- Method Statement Review;
- Monitoring During Installation;
- Witness Testing;
- Integrated Systems Testing;
- Client Training;
- Ongoing Commissioning Reviews.

WE ARE NOT A CLOSED SHOP AND ACKNOWLEDGE THAT THERE IS ALWAYS MORE TO LEARN. WE ENCOURAGE DEBATE, REWARD RESEARCH AND FOSTER RELATIONSHIPS WITH OTHER KINDRED PRACTITIONERS OF SUSTAINABLE DESIGN IN ORDER TO FIND NEW BREAKTHROUGHS.



ESD PROJECTS



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REPUBLIC POLYTECHNIC

Client

Republic Polytechnic

Beca Environmentally Sustainable Design (ESD) work in Singapore was recognised when the Republic Polytechnic was awarded a Platinum Rating under the Singapore Government's Building Control Authority (BCA) Green Mark Awards. Republic Polytechnic is a 200,000m² campus, which opened to students in phases over 2006. From the outset Beca, in collaboration with the project architects, set low energy and sustainable targets for the competition stage design. Sustainable features were heavily influenced by an integrated design approach using the building form, external shading systems and landscaping to minimise energy requirements for lighting and cooling. A central energy centre provides campus-wide power and chilled water distribution, and is the first campus in Singapore to implement Thermal Energy Storage to

optimise the chiller operation. Other features include rain water harvesting, chemical free condenser water treatment systems, solar energy from Photo Voltaic (PV) cells for lighting, mixed mode ventilation systems for the sports halls and use of recycled materials.



SINGAPORE NATIONAL LIBRARY

Client

Singapore National Library Boards

A key challenge of the design for this \$203m (SGD) Singapore icon was the balance between natural daylight penetration and controlling heat gains and improving internal comfort for the high levels of public use for this building. Beca undertook extensive CFD modelling to maximize the user comfort. Some open spaces span up to 3 levels, therefore this aspect was critical to the architectural planning for these internal spaces. Beca also undertook thermal design and modelling of the facade, to achieve an optimal result for glassing selection. Other features include:

- High efficiency lighting system;
- Automatic sensing and lighting control;
- A energy saving 'variable outdoor air control strategy';
- Displacement air design for the National arts drama centre, creating an efficient energy system for the space;
- An energy efficiency index calculated at 178Wh/m² per year.



SINGAPORE MANAGEMENT UNIVERSITY

Client

Singapore Management University

Beca is proud to have been a key member of the engineering design team for this prestigious educational facility in Singapore. This building set the benchmark for sustainable engineering design features at the time it was constructed. Despite the tropical climate Beca was able to minimise the use of air conditioning, resulting in greater energy efficiency thanks to the optimised building fabric. Significant attention was paid to design integration between all disciplines to achieve a building of low energy consumption, which also included environmentally friendly features. The mechanical and

electrical systems Beca designed are still considered a benchmark for 100,000 m² facility. It spans five blocks of the central city and an administration building of 16,000 m². Integrating the design disciplines facilitated an environmentally sustainable design that minimises energy consumption and makes the most of passive systems and natural ventilation. Passive environmental controls and effective use of natural light were optimised by Beca's computational analysis systems.



PARAPARAUMU LIBRARY

Client

Kapiti District Council

Beca was commissioned to provide the design of heating, ventilation and air conditioning services for this \$5.8m (NZD) public library. The brief was to create a low energy building that provided best value over the life of the building. A major design intention was to keep the main library space comfortably cool without air conditioning. Extensive use of dynamic computer modelling to predict the performance of the low energy system in use allowed information on the performance of the system to be clearly conveyed to the client for informed decisions. The building cost no more to construct than a traditional solution but the low energy systems could potentially save \$280,000 over its economic lifetime. A Victoria University building use survey indicated

user satisfaction with the comfort conditions with a top score of 7/7. The features, which distinguish the building, include:

- External solar shading using sun louvres;
- A high level of insulation;
- Exposed structural elements;
- A double-layer ground floor slab as a supply air path and tempering element for incoming ventilation air;
- Overnight ventilation to pre-cool the structure;
- 100% outside air ventilation system to reduce fan power and improve internal air quality;
- Intelligent control systems.



UCi3 INNOVATION INSTITUTE (UNIVERSITY OF CANTERBURY)

Client

University of Canterbury

UCi3, the New Zealand ICT Innovation Institute, at the University of Canterbury is a centre for excellence in Information and Communications Technology (ICT).

The first teaching and research facility of its kind in NZ, it links academic and industry expertise to enhance high-tech capabilities and developments. Beca's ESD team have worked closely with the architects to develop the concept and incorporate numerous ESD features into the building design. The building is being designed to target a minimum 5-star equivalent GreenStar rating and operate in a 'mixed mode' including automated 'mixed mode' HVAC operation, and underfloor ventilation.

Extensive 3D computer simulation analysis has been carried out by Beca to inform and target the design including natural lighting, facade environmental performance, external solar shading, natural ventilation performance, heat recovery, thermal comfort modelling and annual energy and water use. A minimum 50% of construction waste will be targeted for recycling, and the option of going Carbon Neutral is being reviewed. Rain water recycling, solar water heating and environmentally preferable materials specification also form a key part of the project approach.



SOUTH CHRISTCHURCH LIBRARY

Client

Christchurch City Council

Using our 'whole building' ESD approach, Beca provided mechanical engineering services for this landmark ESD building project. Computer modelling was employed to evaluate options for building construction and associated passive and active environmental control strategies; evaluation of solar shading options; and to verify the predicted comfort performance and establish annual energy use target. Key passive features include:

- Increased thermal mass;
- High levels of insulation, offering greater thermal temperature control;
- High level of natural lighting;
- Natural ventilation;
- Effective solar control through building geometry and use of high-performance double glazing.

Zoned underfloor heating is supplied via a heat pump, using the high efficiency to achieve significant energy savings. The town water main serves as a heat source, and as a heat sink when cooling is required, with water reticulated through underfloor pipework via a heat exchanger. This cool water loop also supplies active chilled beams cooling elements to offer cooling in high-occupancy areas where natural ventilation could not meet requirements.

Other ESD features include high levels of daylight, rainwater recycling, waterless urinals, and environmentally preferable material selection. The project was the winner of the inaugural NZ Engineering Excellence award for "Sustainability/Clean Technology" in 2005.



PAPAMOA LIBRARY

Client

Tauranga City Council

Beca provided a total engineering package for this unique library and worked closely with the project architect to establish a smart ESD design. Key sustainable design features include a heatpump, underfloor heating and cooling, high thermal mass, automated window controls and rainwater recycling all feature in the innovative design. Beca ESD applied thermal modelling techniques from past low-energy projects for a result designed for this environment. Due to the thermal mass the heatpump is used only minimally and the lighting operates at vastly reduced levels during the day.

A challenge was to develop a cost-effective solution to meet the project budget. Life-cycle cost techniques identified building

energy saving measures and the lighting design provides for a practically glare-free environment for both staff and visitors, with adequate and appropriate lighting levels for different needs including selecting books, reading and relaxing.

The design brief to the Beca structural team included a large clear space for the library with glass walls on the north front, rooftop highlights to maximise natural light and a curved roof in line with the beach theme. The team provided a cost-effective design including insulated concrete wall panels for lateral load resistance, eliminating the need for wall-bracing.



BNZ TENANCY ADVICE (INCLUDING THE BNZ TOWER PROJECT)

Client

Bank of New Zealand

Beca have been involved, as tenant advisors to BNZ for the recent office portfolio consolidation project. The projects see BNZ consolidating operations into three main building in Auckland and Wellington, including

- 15,000m² office space on the Wellington waterfront (part of ~\$60m project);
- 7,500m² office space (sole tenancy) at Quay Street, Auckland City Fringe (Part of ~ \$20m project);
- 13,000m² office space (anchor tenant) in the BNZ tower, at 80 Queen Street, Auckland (part of ~ \$125m project).

Beca have been involved, providing ESD, and engineering advisory services through the inception, through to final implementation and integration of fitout specific design. Integral in acting as ESD advisor, is providing assistance to both tenants and developers in understanding and integrating BNZ ESD objectives into

base solutions, leading to commitment within the development agreements to deliver five GreenStar building designs, incorporating BNZ corporate policy.

Key advice includes:

- Beca involved developing brief for BNZ;
- Subsequent review of offers from the market;
- Development agreement negotiations;
- Review of design development in relation to DA commercial agreements;
- Design brief development for integrated fitout;
- Specialist comms, security and Lighting advice;
- Ongoing construction monitoring;
- Establishing and delivering consistency of approach for the corporate solutions across varying projects, developers and locations and delivery mechanisms.



SINGAPORE ZERO ENERGY BUILDING

Client

Building and Construction Authority Singapore

A recent project lead by the BCA in Singapore has pulled together experts to create a target zero energy building as a show case for other building in the region. As recently report, 'As clean energy still fulfills only a small percentage of the world's energy needs, the immediate solution is to make our buildings very energy-efficient,' said Professor Lee, director of the centre for Total building performance at the national University of Singapore. Beca is delighted to be asked to be part of the professional team to progress and undertake the design work. Beca's work will be in a collaborative team environment where international experts will contribute to the best available solutions. With two platinum awards for green mark buildings in Singapore and the international experience of the Beca Buildings global team, we will being a major contributor in this project.



SITE 7 KUMUTOTO

Client

Meridian Energy

Beca were commissioned to provide building services design to help achieve a 5-star GreenStar rating. This building sets ambitious goals for energy efficiency, water efficiency, and environmental performance which aim to set new best practice benchmarks, while providing a healthy and productive working environment. The project incorporates an active building envelope with automatic shading control, opening windows, and ventilated double skin façades – designed to react to best suit the climatic conditions to achieve the desired internal environment with reduced energy input. Using 3D computer simulation we evaluated performance aspects to help determine the best

balance of aesthetic and environmental performance drivers. A 'mixed mode' ventilation approach is provided, allowing the building to be operated using natural ventilation when suitable, with a low energy active chilled beam system to achieve flexibility, comfort and energy efficiency when required. The Building Management System controls the HVAC systems, and is interfaced with security, lighting, power, and façade systems to facilitate ongoing energy efficiency. Rain-water recycling, solar water heating and environmentally preferable materials specification also form a key part of the project goal to set new benchmarks for sustainable design.



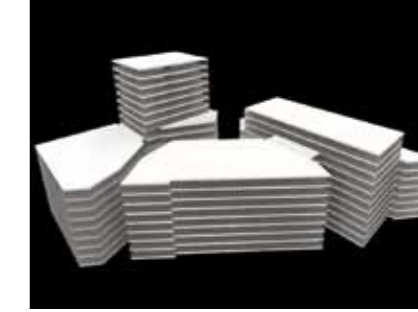
STATISTICS NZ BUILDING

Client

Statistics New Zealand

Beca was appointed as building services consultants, and used integrated ESD and energy efficient design approaches to achieve the project goals. 3D computer simulation modelling of energy use indicated a low-pressure variable air volume air conditioning system as the preferred option. 'Swirl' supply air diffusers were specified in the office areas, creating enhanced uniformity of air distribution, while providing improved comfort over conventional diffusers. Variable speed controls were provided on all main systems with demand control of heating and cooling systems. Dimmable ballasts are provided on office lighting, with a daylight control system to reduce the artificial lighting levels, and

to minimise energy use when natural lighting is available. The services were designed on a modular arrangement to assist future flexibility. At it's heart lies a fully distributed Building Management System (BMS), which monitors and controls the building services to balance comfort criteria and energy efficiency and also meters main energy uses. An independent design review carried out prior to completion bench marked the building design to be equivalent to a 4-star GreenStar rating and it subsequently won the Commercial Office Property Award at the prestigious Property Council of New Zealand Rider Hunt Property Awards.



BOWEN INTEGRATED CAMPUS

Client

AMP Capital Investors

The Bowen Integrated Campus project aims to regenerate the existing buildings in the Government precinct, using an environmentally sustainable approach. A roofed atrium is being added to connect the buildings providing a sheltered amenity area offering significant social benefits for building users and the local community. The refurbishment is being designed to target a 5-star "New Zealand Excellence" GreenStar rating and as such includes numerous GreenStar criteria to enhance management aspects, and to reduce energy and water use. The façade performance is designed using 3D computer simulation analysis to balance thermal and visual performance requirements,

and the largest active chilled beam HVAC system in Australasia is proposed offering lifecycle value and improved environmental quality, plus the ongoing benefit of reduced maintenance disruption to the tenants.

An addressable DALI daylight control is being incorporated offering significant lighting energy savings and enhanced visual quality and flexibility for tenant alterations. The project is expected to be used as a case study project by the New Zealand Green Building Council, to demonstrate the approach to 'greening' existing buildings.



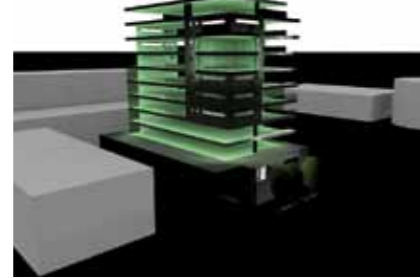
HARBOUR QUAYS F1/F2

Client

Bank of New Zealand

Landmark waterfront office project as part of the Harbour Quays development, with BNZ proposed as anchor tenant. The base building design is targeting a 5-star GreenStar rating. The central atrium spaces are a key aspect of the work place connectivity and the 'transparent' architectural concept for the building, and Beca's ESD team worked closely with architects Jasmox to design these spaces to perform as an integral part of the environmental engineering approach. 3D computer simulation analysis has been carried out by Beca to inform and target the design including natural lighting using the atrium spaces, façade environmental performance, external solar shading, thermal comfort modelling and annual energy use. Rain-water recycling, and environmentally

preferable materials specification also form a key part of the project goal to provide a flexible and adaptable office with good access to views and natural light while reducing adverse environmental impacts.



CLUB TOWER

Client

Canterbury Trust

Club Tower will be the first A-grade building constructed in Christchurch in almost 20 years and comprises 12 stories, including office and top floor penthouse apartments. The project design is targeting a 5 star GreenStar rating with particular emphasis on internal environmental quality, building services energy efficiency and water efficiency measures. Beca's ESD team used 3D computer simulation of the building façade performance to help determine the performance requirements of the insulated double-glazing units to offer the best balance of daylight, thermal performance, and energy efficiency drivers. A heat recovery HVAC system was indicated to offer energy efficiency for the project, with heat recovery

on the outside air ventilation also to further reduce energy use. Daylight compensation control is proposed for the low-energy lighting system, and a rainwater recycling system is incorporated to improve water efficiency. In addition to this commission, Beca were engaged early in the concept design to undertake the environmental sustainable design (ESD) modelling and provide design input to assist the architect. This included preparing the following reports and studies for consideration:

- ESD Rating Report;
- Energy Target Report;
- ESD Options Report;
- Water Efficiency Report;
- Daylight Availability Report.



TRUST'S STADIUM WAITAKERE

Client

The Waitakere Regional Sports Trust and Development Board

Beca provided ESD advice and mechanical and hydraulic building services consulting services for this state of the art indoor stadium. The multi-purpose sports and events stadium design incorporates a number of energy efficiency and environmentally sustainable design features, including passive natural ventilation of the main arena augmented by mechanical ventilation should conditions require. Water efficient fittings are used throughout, and stormwater is collected from the roof area and filtered and pumped to flush the toilets, and solar hot water preheat is included to reduce the energy requirements for generating hot water. The natural ventilation is controlled by the central Building Management System which opens and closes motorised louvres and windows depending on air temperatures, air quality, and ambient

wind speeds. Natural lighting is used where possible, backed with energy efficient artificial lighting systems. Beca utilized 3D computer simulation to inform the design process for the natural lighting availability, and to assess the likely peak temperatures using the passive design and natural ventilation approach.



WESTPAC CENTRE

Client

Christchurch City Council

Beca provided mechanical and electrical design services for this multipurpose arena that is host to concerts, trade fairs, exhibitions and a range of sporting events. The complex comprises a fully air-conditioned arena, with 7,200 seats for centre court spectator events and 8,800 seats in a concert configuration. The building design incorporated an innovative HVAC concept, which uses the arena air to also condition the concourse space. This concept removed the need to provide two separate ventilation systems, with associated capital cost savings for the client. Flexibility for the

ductwork and pipes between the two structures that could provide for this extent of movement, while still retaining integrity, was an integral part of the design. The air conditioning also utilises special motorised long throw air diffusers to provide high comfort levels with very low noise, while throwing air up to 16m. Extensive electrical systems were provided for sports, concert and trade events including structured data cabling and power to in-floor service pits, extensive video and audio way lines, sound reinforcement systems and sports lighting for televised events.



GENESIS RECREATION CENTRE

Client

Masterton District Council

Beca was engaged to provide structural, building services, pool water services, and fire engineering, surveying and geotechnical services for this sports and aquatic facility. The new and upgraded facilities at the Genesis Recreation Centre were designed to provide a good balance between on-going energy costs and project capital expenditure. The pool hall envelope has high value thermal insulation in the walls and roof, and double glazed windows and skylights located to provide a balance between good natural lighting and heat loss. The building services and pool water systems

were designed, and equipment selected to provide the necessary energy output and performance with the minimum input of energy. Heat pump technology was selected to ensure the maximum possible levels of heat recovery from the waste air streams exhausted from the pool facility. Masterton District Council commissioned an independent energy audit for all aspects of the project during the design phase. This audit supported all of the energy conserving features incorporated in the design.



Client

New Zealand Trade & Enterprise

Beca undertook the mechanical, electrical, fire, and structural design for the New Zealand at the Aichi World Expo pavilion. Environmentally Sustainable Design (ESD) was a key focus of the project. As the pavilion services consultant Beca was faced with a range of infrastructure challenges. An 'energy recovery wheel' was installed to recover heating energy from the air stream and presentation lighting, allowing efficiency and less reliance on the Exposition Authority's limited capacity infrastructure systems. A Low Velocity Displacement Ventilation System was also integrated within the architectural walls of the exhibition space. This minimised spatial demand on the constrained space and allowed the temperature of the air entering the exhibition space to be introduced at a higher

AICHI WORLD EXPO PAVILION

temperature than a traditional high level air conditioning system, thereby reducing the load on the infrastructure. Beca's ability to work closely with the architect and project manager in all engineering facets helped to complete the design ahead of schedule.



ST JAMES THEATRE

Client

St James Charitable Trust

Beca was commissioned for the ventilation and lighting design for this conservation-sensitive upgrade and was requested to provide an efficient, cost-effective system compatible with the theatre's heritage features. The design considered the theatre's function by enhancing the acoustic performance, accurately compensating for heat emission from lights and occupants and controlling draughts on the stage and throughout the auditorium. Using a computerised 3D fluid model to simulate a range of conditions, Beca

analysed potential 'hotspots', draughts, noise levels and the effects of scenery movement and incorporated this information into the design. The resulting fan-assisted displacement ventilation system made innovative use of the large area beneath the floor of the stalls combined with high-level air extraction to assist the natural flow of air through the theatre. By basing the ventilation system on natural processes and using modelling to predict difficulties, Beca provided an economic solution that would require little or no retrospective adaptation.



EMBASSY THEATRE

Client

Embassy Theatre Trust

Beca provided mechanical, electrical, and plumbing and drainage services design and construction monitoring for the extensive redevelopment of the historic Embassy Theatre in preparation for the world premiere of "The Lord of The Rings, Return of The King". The technical design included creating a displacement ventilation system, integrated with seats via a plenum that had minimal effect on the heritage aspects of the building; the provision of new power supply and lighting; and new heating and ventilation. The mechanical system also allowed

maximum 'free' outdoor air-cooling, since limited budget did not provide for chilling equipment. The theatrical lighting system was designed to be sympathetic to the heritage features. The project time frame was extremely short, warranting concurrent design and construction. Beca delivered the project on time and within budget, complying with a very short time frame. The cost-effective design was developed while still retaining the heritage features of the structure.



HORNBY MALL

Client

Southway Properties Ltd

Hornby Mall was transformed into a modern retail facility through this \$6 million project. Beca was appointed as the mechanical and electrical services engineer responsible for the design and construction monitoring. The mall remained operational throughout the re-development. This was acknowledged in the design, including appropriate staging and re-use of existing plant where economic. The mechanical services design concept had a two-fold approach to energy conservation – a low energy design concept enhanced with sophisticated environmental controls to maintain space conditions. A key feature

of the mechanical design included an innovative energy efficient environmental control system comprising evaporative cooling coupled with displacement ventilation provided a very cost effective HVAC system. The benefits of this system design included:

- Reduced capital cost by some 20%;
- Lowered ongoing energy costs by some 40-50%;
- High average indoor air quality;
- Reduced maintenance costs;
- Lower ratio of refrigerants, providing environmental benefits.



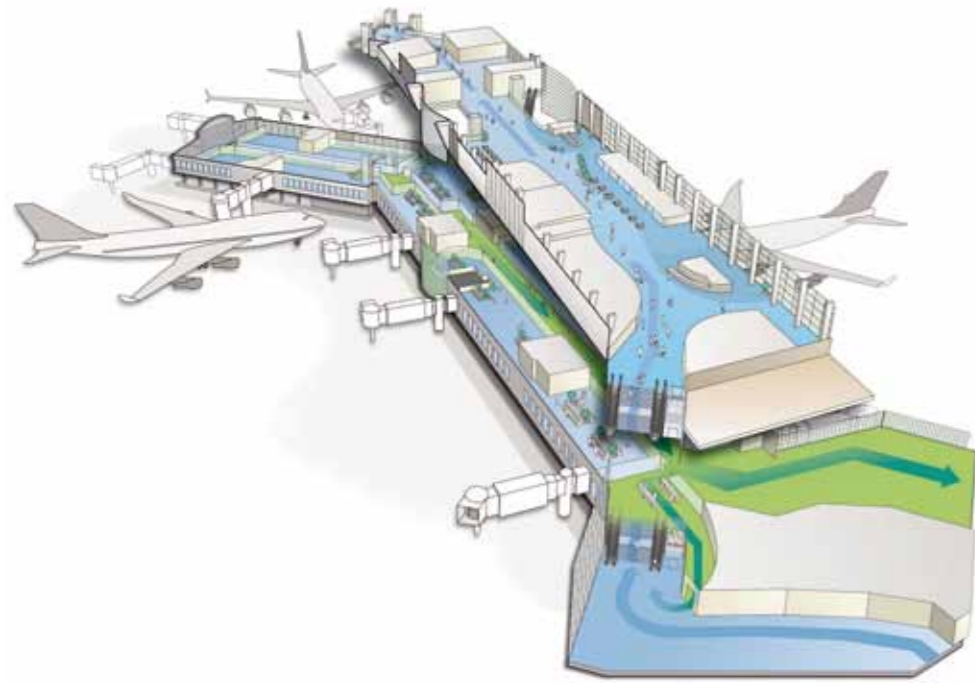
ANG MO KIO (AMK) HUB

Client

SLF AMK PTE LTD / NTUC Income Insurance Co-operative Ltd / NTUC Fairprice Co-operative Ltd

The site is located at the junction of Ang MoKio Avenue, a busy and prosperous area of Singapore. The project links the MRT train system with a 7 level retail and car parking building. To reduce the effect of the local environment, innovative design and construction techniques were employed. These include top down excavation system with internal braced system for the deep 3 level basement. The bus interchange area required significant detailed design coordination to keep pre described site boundaries. A system of post tensioned slab-beam structural design was studied

to reduce the material cost, and resulted in a construction system that minimized the disruption to stakeholders and the immediate environment.



AUCKLAND INTERNATIONAL AIRPORT PROJECTS

Client

Auckland International Airport

As New Zealand's largest and busiest airport Auckland International Airport Limited is well aware of its role in maintaining and in some cases improving and restoring its immediate environment. As a major development partner Beca has collaborated closely with the AIAL engineering team contributing to many major initiatives in recent years. Beca has identified initiatives contributing to energy conservation and the enhancement of the life cycle of buildings for on a number of projects including the Domestic Terminal Building Refurbishment project, International Terminal Building Arrivals Expansion project and Pier B project. Key ESD features include:

- Photovoltaic cells on the roof to provide power from the sun;
- Intelligent lighting control system;
- Use of high efficiency modern light sources;

- Escalators and Travelators include presence detection and variable speed start/stop controls;
- High efficiency condensing boilers used for hot water to air handling plant;
- Variable speed high efficiency centrifugal chillers;
- Main baggage hall ventilation systems are controlled via CO sensors;
- Building Management System controls main HVAC plant, and monitor energy consumption;
- Rainwater reclaim reuses the roof stormwater for non-potable use in HVAC cooling towers;
- Solar hot water panels provide hot water to toilets.



AUCKLAND REGIONAL WOMENS CORRECTION FACILITY

Client

Department of Corrections

Beca provided building services design for the new Auckland Region Women's Correction Facility at Manukau. In collaboration with the security contractor and designer, Beca also provided an integrated mechanical and electrical design for the site which includes an IT infrastructure and integrated security management access control system, smoke control system and building management system. Service and maintenance costs were reduced through employing a high quality central heating and cooling plant comprising high efficiency boilers with flue gas condensing capability. High efficiency air cooled chillers (EER 3.0) have been located outside the secure prison perimeter. The cell blocks are heated by an energy efficient hot water based under floor heating system which results in heating energy saving of about 20% over traditional heated air systems. The lighting

system includes high efficiency luminaries and extensive use of high quality daylight sensing and infrared occupancy detection systems. Domestic hot water is heated via calorifiers using distributed heating hot water heated from the central gas fired boilers. Cell water supply is strictly controlled with an electronic water control system that limits the duration of flow from taps and showers.



RESIDENCES @ EVELYN

Client

City Development Ltd

Residences @ Evelyn is a condominium with 208 apartments housed in two high rise blocks of 33 storey high, with full club house and swimming pool facilities. Each apartment is served by private lift, opening into apartment. Careful and extensive planning at the initial stage was required to divert the services out of the site, in particular where the services are serving the other nearby developments. The Client is a strong advocate for green features building, and this green movement lead to Beca having to work very closely with the Client to achieve their green objective. Several green features were studied and some were eventually implemented such as:

- Inverter split air-conditioning units, with varying refrigerant volume;
- Pneumatic refuse waste collection system;

- Acoustic treatment for noise control of the pneumatic refuse waste collection plant room;
- Natural vents openings to the basement carpark for fresh air supply to the basement carpark;
- CO sensors to control the running of the exhaust mechanical ventilation for basement carpark;
- Solar lamps for common area light fittings.

The green features result in lower energy consumption and a more environmentally friendly atmosphere for the residents.

BECA ENVIRONMENTAL

www.beca.com



Beca Environmental offers specialist environmental management advice to a wide range of private and public sector clients. We take pride in the knowledge that our consultancy advice assists our clients to achieve their objectives in an environmentally sustainable manner. In developing environmental solutions, our aim is to provide advice that is targeted, cost-effective, practical, innovative, creative and able to add value. Part of our success relies on the emphasis that we place on the local execution and management of projects and the establishment of close working relationships with our clients. Our established and growing environmental team is able to provide assistance across a wide range of disciplines.

- Air quality and odour (including monitoring, modelling and impact assessment, greenhouse gas emissions).
- Land contamination investigation and risk management.
- Stormwater, erosion and sediment control.
- Water resource management (including water quality and hydrogeological assessments).

WE CONTINUALLY INVEST IN THE ONGOING DEVELOPMENT OF OUR PEOPLE'S KNOWLEDGE AND SKILLS; AND PROVIDE THE BEST TOOLS TO THEM IN ORDER TO STAY AHEAD OF OUR COMPETITION.

- Environmental audit and due-diligence.
- Integrated monitoring, testing and interpretation service.
- Environmental management/monitoring plans and systems.
- Strategic environmental assessment (SEA).
- Assessments of environmental effects (AEEs).
- Applications for resource consent and consenting support (including preparation and presentation of evidence at court hearings).
- Management and integration of environmental inputs for large-scale multi-disciplinary commissions.

We have developed a multi-disciplinary team of specialists – many of whom are at the forefront of their professions. This means that we are able to give our clients informed, and authoritative advice on a wide range of issues. With the skills available to us, we are now engaged in the widest possible range of commissions, from the development of strategic guidance for national, regional and local government, through to assisting clients with the design, construction and management of an individual development.



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Sydney
Adelaide
Brisbane
Wollongong

Brazil

Sao Paolo

China

Suzhou

Beijing

India

New Delhi

Indonesia

Jakarta

Malaysia

Kuala Lumpur

New Caledonia

Papua New Guinea

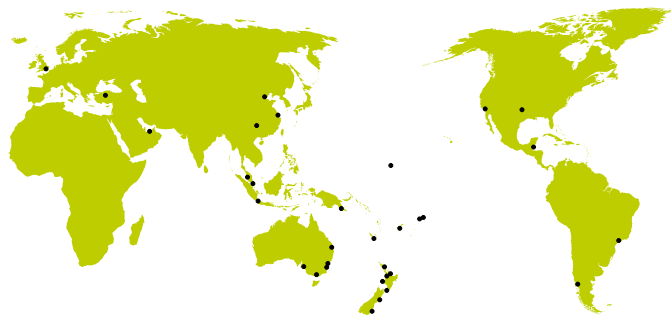
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BECA ESD AND ENVIRONMENTAL AWARDS

Beca has a specific centre of excellence comprising specialists with expertise in Sustainable Building design, and have won a number of awards related to this subject. These include:

ESD AWARDS

Singapore National Library

BCA Best Buildable Design Award 2006
BCA Green Mark Platinum Award 2005

The Trusts Stadium Waitakere

NZ Property Council of New Zealand - EECA Energy Efficiency Award 2006

Republic Polytechnic

BCA Green Mark Platinum Award 2006

Parliament Building, Executive Wing, Banquet Hall & Foyer, Wellington, New Zealand

Excellence Energy Efficiency and Conservation Authority Award, IESANZ Lighting Awards 2006

Residences@Evelyn

BCA Green Mark Gold Award 2005

South Christchurch Library

NZ Engineering Excellence Award (Sustainability and Clean Technology) 2005
Excellence Award ACENZ 2005

Royal Plaza On Scotts, Singapore

BCA Energy Efficiency Buildings Award 2004
M&E Consultant: Retro fitted category 1st position

AUT B Block

New Zealand Energy Wise Award, IES New Zealand 2003

Paraparaumu Library

ACENZ Excellence Award 2004

Gul Circle District Centre Singapore

Certificate of Merit for Best Build Ability Design Awards. Industrial category 2000

Hornby Mall, Christchurch

EECA Energy Wise Award, EECA New Zealand 2002

Derceto: Energy Minimisation for Wellington City Council

ACENZ Gold Award 2002

ENVIRONMENTAL AWARDS

Waiatarua Wetland Project

IPENZ Arthur Mead Environmental Award 2006

Freeflow – Auckland Central Motorway Junction

International Road Federation Global Achievement Award: Environmental Mitigation 2005

Grafton Gully Motorway

Arthur Mead Environmental Award 2004

Manukau Foreshore Restoration

IPENZ Environmental Award 2004

Manukau Harbour Foreshore Restoration

Arthur Mead Environmental Award, Institute of Professional Engineers, New Zealand 2003

Otira Viaduct

IPENZ Environmental Award 2001

ALPURT Sector A

IPENZ Environmental Merit Award 2001

