ENERGY WISE

BEFORE THE FIRST pour

Design guide for energy-efficient commercial building fit-outs

These Notes bring together the knowledge of professionals in various disciplines of design and construction. You can use the text in full as a complete and self-contained design brief, or as a guide in developing your own brief.

This document on fit-outs is from a developing series that currently includes introductory notes and specific briefs on both large and small/medium new commercial buildings and retrofits.

Copies of these other briefs and more information on the work of the Energy Efficiency and Conservation Authority (EECA) in commercial construction, including funding for design audits are available by contacting buildings@eeca.govt.nz

Financial assistance for energy-efficient design

Energy-efficient buildings cost less to heat and cool, and because they don't need complicated and expensive air conditioning systems they are cheaper to build, easier to maintain and simpler to retrofit.

Energy-efficient buildings are also more attractive to potential tenants and occupants. Users generally have more control over their working environment, and systems are less likely to be affected by variations in the price and availability of power.

Everyone gains from energy efficiency in building, which is why EECA provides financial assistance to encourage it at a crucial stage – in an energy design audit. Undertaken early in the process, an energy design audit helps ensure a project incorporates the latest energy best-practice. It may even help you reduce upfront construction costs.

To find out how easy it is commission an energy audit and share the costs with EECA, contact Dan Coffey by emailing dan.coffey@eeca.govt.nz

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Overview

A new context for building design

Without significant energy efficiency improvements, New Zealand's energy consumption is forecast to rise by 33% between 2001 and 2012. The costs to the economy and the impact on our rivers and lakes to resource of such an increase would be enormous.

Global warming from CO_2 emissions is another major issue. It has the potential to dramatically change our temperature, wind and rainfall patterns, affecting agriculture and lifestyle, and significantly raising sea levels – by up to 17cm in 2025, and up to 35cm by 2050.

These are real threats, and unlike the oil shocks of the 1970's, they are permanent changes. Efficiency is a key part of the solution. If it is not embraced voluntarily by the construction industry, further regulation is the inevitable prospect, particularly if the Government is to meet its Kyoto Protocol commitments.

Energy efficiency. The new imperative

Commercial and industrial buildings account for around 8% of New Zealand's total energy consumption a year, and 5% of total CO_2 emissions.

Field studies have shown there can be a ten-fold difference in energy consumption between similar buildings and that construction-related issues are the single biggest contributor to the differences.

Clearly, there is plenty of scope to significantly reduce consumption through energy-aware design. Given the issues that face our country, energy efficiency is therefore going to be a key criterion in future commercial developments.

Efficiency optimises lifetime costs

Designing energy-efficient buildings makes sense on all sorts of levels – not the least of which is the overall economics.

Costs relative to initial construction costs over the life of a typical building

Environmental consultant fees	0.03
Professional fees	0.10
Construction costs	1.00
Energy, operating and maintenance costs	3.00
Business costs (salaries, rental/space)	200.00

As the table shows, even taken together the design fees and costs of construction are only a tiny portion of total lifetime costs of a building. Focusing on these initial costs alone will almost certainly result in a project that does not optimise its lifetime costs.

The extra cost of letting the architects and engineers think through the design thoroughly and arrive at an energy-efficient solution is an investment that will repay itself many times over the life of the building.

Business costs are by far the most significant lifetime cost of a project, and to influence them, the effect of a building on the productivity and health of its users must be taken into account.

There is a growing body of research and case history which suggests demonstrable productivity and satisfaction gains can be realised by providing better built environments.

Based on measured and anecdotal evidence, the potential gains in productivity and reduced absenteeism could be between 5-15%.

It has also been estimated that a 3% improvement in productivity could pay the full cost of a new building.

Energy-efficient design has a significant role in providing healthier, more productive environments. For example:

- External shading to lower peak cooling loads in summer also cuts down uncomfortable direct radiant gain for building occupants. Shading also means users don't need to use their blinds as much, making them feel less cut off and more in contact with the exterior environment
- Energy-efficient lighting provides better colour rendering and eliminates headache-producing flicker
- Making better use of thermal mass lowers peak cooling loads and energy requirements, and also gives occupants more and more comfortable radiant cooling.

These are just a few of the ways an energy-efficient building can improve productivity.

Efficiency adds value

All stakeholders in the building stand to gain from more energy-efficient design.

Owners/occupiers and tenants enjoy lower operating costs, greater operational flexibility and an environment that encourages greater productivity.

These attributes all help to make the building a more marketable commodity for developers, helping them attract a suitable margin with less risk. The benefits also add to the long-term value of the asset for owners and portfolio holders.

Initially, the demand for energy efficiency will be driven by tenants and owner occupiers, who will in turn influence real estate agents, owners and developers over time.

The benefits of energy efficiency will become more obvious and more valuable as energy costs rise, employees' pressure for healthier environments increases, regulation becomes a more distinct possibility and overall environmental awareness improves.

Before the first pour

The greatest gains in energy efficiency come from integrated building design early in the project's development – well before work on the ground begins.

Design considerations must include the building, its systems and the people that will use it.

Integrating these issues involves team work between all the design disciplines. It also requires a commitment to minimising life cycle costs for the whole building – not just minimising the capital costs for an individual component.

Integrated energy-aware design progresses from the macro to the micro, including:

- Site selection and utilisation
- Orientation and massing
- Efficient facades
- Internal planning
- High efficiency lighting and electrical services
- High efficiency mechanical services
- Alternative energy sources.

After the hand-over

Realising and maintaining energy efficiency doesn't end when the building is built. Energy efficiency is a process of continuous improvement throughout the recurring cycle of construction, use and renewal.

Ensuring everyone is briefed

A fit out may involve the skill of professionals from many disciplines – there may also be a parallel design team working on the base building.

Everyone involved should receive a Design Brief and Guidelines like those presented in this document. This will ensure they're aware of the tenant's desire for energy efficiency and the need to incorporate that in their offer of service.

They should be aware of the implications and how they may relate to:

- Reviewing existing tenant facilities
- Reviewing proposed new tenancy space
- Input into capital expenditure (CAPEX) and operating expenditure (OPEX)
- Design
- Fit-out monitoring
- Testing and hand-over
- Building tuning
- End of defects/hand-over.

Working with a base design

Much of the energy efficiency of a building is determined by the base design, and in a fit-out situation there is often little that can be done.

Choosing the right building is the key. Energy efficiency should be included in the selection criteria and energy issues including usage (as part of the operating costs) and working environment should be given reasonable weight in the decision.

If the fit-out is in a new development however, there will often be scope to vary the base design for specific requirements. This is an opportunity to make changes in the interest of energy efficiency.

Setting a benchmark

Before beginning the search process, a tenant should review their existing facilities. This 'needs analysis' provides the benchmark that potential new space can be compared to.

The review should consider:

- What standard of environment is required – for example, air conditioned, non-air conditioned or a mixed mode
- What degree of operational flexibility required by each department – for example, after hours or weekends
- What facilities are required, such as office space, meeting rooms, training facilities, café/restaurant etc.
- Particular operational requirements, such as specific pieces of office equipment, occupancy density, glare control

- Existing energy use and operating costs
- Location relative to business needs, staff residences and public transport.

Assessing options

Tenants should explore the market thoroughly before making a commitment, comparing the spaces available with the facilities they already have. Attributes should be weighted with location, energy efficiency, operating costs, building and system features and flexibility being key concerns.

If the proposed tenancy is in an existing building, it should be surveyed and drawings and documentation checked. If the building is yet to be constructed, the specification should be reviewed. Key issues to consider in terms of energy efficiency include:

- Design criteria - temperatures, humidities
- Design loadings - W/m^2 power, lighting, and people
- Occupancy density - persons/m^2
- Zoning: air conditioning (where appropriate) and lighting
- Controls: air conditioning (where appropriate) and lighting
- Provisions for out of hours use
- Provisions for cleaning and security
- Façade provisions - glass type, external shading, internal blinds
- System provisions - natural ventilation, air conditioning, lighting, small power and IT, security, domestic water services, standby power
- Building and system condition (for existing buildings only)
- Fit in relation to tenant needs
- Operating cost budgets or recorded costs for comparison to energy targets and OPEX benchmarks.

Including efficiency in the budget

Budgets for the project will need to allow for energy efficiency measures. The figures should cover design costs, capital costs and recurrent costs of energy efficiency measures, such as those identified in the Design Guidance notes and Checklist included in this brief.

Budget figures should be reviewed in term of the investment criteria set by the tenant, including length of the proposed tenancy and CAPEX ceilings, and take into account the tenant's discount or interest rate and any financial incentives for energy efficiency measures.

Taking opportunities in the design phase

As discussed above, energy efficiency opportunities may be less in a fit-out than in a new or refurbished building. The building enclosure and central plant arrangements are probably 'givens', so that the tenant's influence is limited to the design of building finishes and fixtures and 'on floor' services.

However, the Guidance Notes and Checklist in this brief offer suggest some opportunities the design team should consider.

If a Design Features report is going to be prepared during the design stage, it should confirm the arrangements for energy efficiency and their economics. Alternatively, you can use the Checklist in this document to confirm which measures are to be implemented.

Guarding efficiency through the tender

Contractors often offer cost saving options to make their tender more attractive. Energy saving initiatives are particularly vulnerable at this stage, as they're often seen by contractors as opportunities to cut capital costs.

Unless the project is significantly over-budget, energy-aware tenants and advisors should be aware of this tendency and resist it as a short-term expedient which will detract from the ultimate value of the tenancy.

Monitoring efficiency implementation

The fit-out should be inspected regularly to ensure that approved energy-saving measures are being implemented. As a guideline, the IPENZ/ACENZ documents specify appropriate levels of inspection in relation to building size and complexity.

Testing, commissioning and hand-over

Proper testing and commissioning is always important in ensuring energy-efficient buildings. It should be carried out by suitably trained personnel, fully documented and certified as being correctly completed.

Providing proper Operating and Maintenance Instructions along with Record Drawings of the building is also important. The Contractor should supply these for the users or tenants with simple instructions for energy-efficient day-to-day operation.

Maintaining efficiency in tuning

Design assumptions and control settings of energy efficiency systems will need to be fine tuned for the realities of the tenancy.

After-hours or weekend inspections are a good idea, to ensure that services start and stop when required, that security and cleaning arrangements aren't affecting efficiency and that staff are being responsible in terms of switching off lights and computers and setting up power saving routines.

Tenants and their staff will need to be educated in how to use the building's systems correctly for energy efficiency. They also need to know how to deal with problems promptly, or the systems may revert to a default setting which may not be efficient. All this should preferably involve some structured training.

In the first year's operation, direct metered energy use and operating charges associated with the base building should be checked against targets and budgets at least monthly.

The final opportunity to check

At the end of defects/final hand-over, there should be a final inspection to identify any defective works and residual issues. A full year's operating costs should be reviewed and anomalies against targets and budgets examined and corrected.

Design Brief Briefing Checklist

To be completed by Designer/Project manager)

Location (climatic zone):		
Energy target:		kWh/m²
Energy efficiency incentive:	☐ Yes	☐ No

Investment criteria:

Max capital cost	$	
Max operating cost p.a.	$	
Energy	$	
Operation and maintenance	$	
Max payback period for energy efficiency measures		yrs
Discount rate to be applied		%

Design Brief Guidance Notes

The designers shall take the following considerations into account in designing the building. Any initial design report is to comment on the degree of compliance with these guidelines.

Internal environment

Key issues

- Select appropriate temperature levels for the activity in the space
- Establish minimum ventilation requirements for the proposed activity
- Choose appropriate lighting levels to optimise the energy required in achieving the desired visual standards
- Determine periods when the building will only be in partial use. Ensure plant and system operation have flexibility to accommodate these
- Identify any particular activities or processes which will require specific environmental conditions, particularly cleanliness or humidity control
- Design naturally ventilated buildings not to exceed a dry resultant temperature of 28°C for more than 1% of the year and 25°C for more than 5% of the year. Air movement may be used to offset higher dry bulb temperatures, but the air velocity should not exceed 0.8m/s. If the moving air is cooler than the bulk air conditioned supply, air movement should be limited to 0.2m/s. For winter, design the building so it is not less than 20°C for more than 1% of the year.

Infiltration, ventilation and air conditioning

Key issues

- Keep ventilation rates to the minimum required to provide satisfactory environment for the occupants while removing excess moisture or pollutants. Consider partial re-circulation as appropriate, unless 'free cooling' is available and required for comfort control
- Ensure ventilation levels are adequate to remove pollutants and excess moisture which could otherwise result in condensation problems
- Ventilate locally to cool specific heat emitting equipment or processes to keep overall mechanical ventilation and cooling requirements to a minimum.
- Base the design on realistic criteria and avoid over-provisioning
- Zone the system for differing user requirements (eg. low occupancy, variable occupancy, out of hours use, areas of high solar radiation) and generally minimise the need for reheating the building
- Minimise lighting and small power loads by specifying energy-efficient equipment
- Avoid using CFCs and HCFCs.

Lighting and daylight

Key issues

- Light landlocked areas such as internal corridors with borrowed light introduced from adjoining spaces or rooms with access to natural light
- Design lighting layouts and switching arrangements to take advantage of the available daylight without using artificial sources. Switch lighting in rows parallel to corridors. Where appropriate use local lighting in preference to overall illumination

- Use internal finishes with higher surface reflectiveness to reinforce the lighting system
- Carefully consider design illuminance/uniformity and how it is achieved
- Consider high efficiency and alternative light sources with high light output ratios and high frequency or low loss control gear to achieve a lighting installation with an average power density of $12W/m^2$
- Label all light switches clearly. Locate them where they intuitively relate to the zone switched to minimise the likelihood of switching on non-required areas by mistake
- Use occupancy sensors in areas of infrequent use like meeting/conference rooms, storerooms, toilets etc.
- Consider locally-initiated after hours overrides and circuit lighting to provide separate levels for cleaning and after hours security.

Controls

Key issues

- Fit good thermostatic and time controls to ensure spaces are not overheated or overcooled. Enable systems to allow for fortuitous gains from people, equipment, lighting or sun penetration through areas of glazing
- Allow for a wider control band than the conventional ± 1°C
- Install controls to allow individual occupied areas to achieve the required environmental conditions. In certain situations, consider local manual control for personnel, particularly where large spaces and low occupancy is a requirement
- Consider zoning environmental conditions to reflect different activities or orientation. Allow for current and future changes in occupancy pattern or function
- Ensure controls minimise simultaneous heating and cooling
- Control lighting to take advantage of day-lighting levels and to reflect occupancy patterns. Photoelectric controls and activity sensors are now widely available
- Organise switching to encourage lights to be turned off when not required
- Locate sensors in representative places - not in sunlight, draughts or above local sources of heat
- Match outdoor ventilation rate to occupancy by using CO_2 or air quality sensing, unless free cooling benefits overall energy consumption
- Design systems to be capable of 100% recirculation during pre-occupancy periods
- Allow for free cooling economiser cycle (enthalpy control) where RH control is not important.

Hot water supply

Key issues

- Ensure local storage units are appropriately insulated to reduce standing losses and generally in accordance with NZS 4305. Units to be time-clock controlled
- Minimise dead legs
- Fully insulate distribution pipework
- Consider use of low-flow fixtures, water flow restrictors and pressure reducing valves as appropriate to limit hot water demand
- Specify low-energy boiling water units, time-controlled to limit hours of operation.

The 'Before the First Pour' series has been developed from design briefs produced for EECA by Roger Feasey of Opus International Ltd. and David Fullbrook of Ove Arup & Partners New Zealand Ltd.