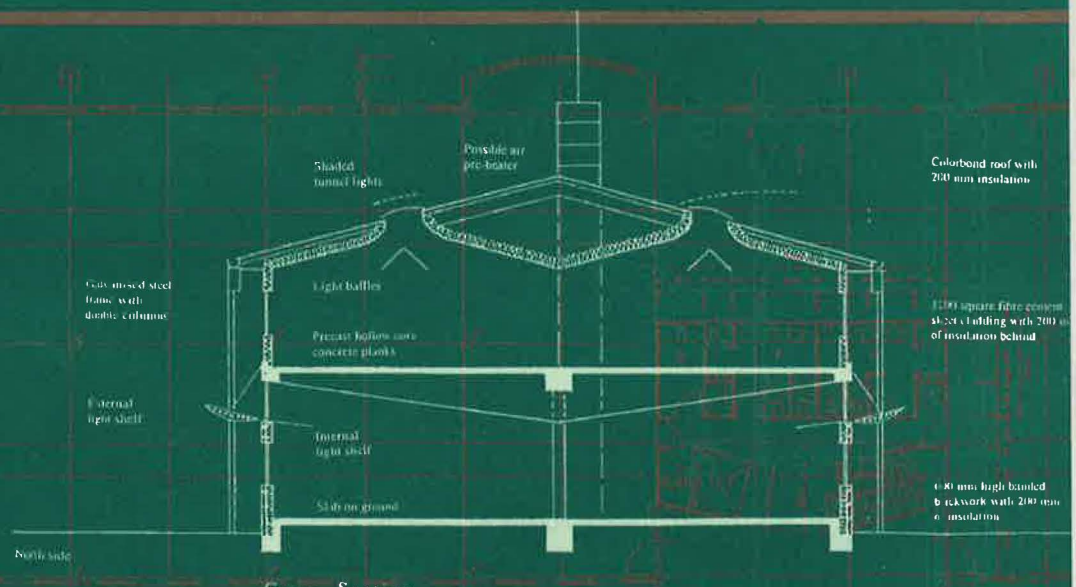
Issues in developing small energy efficient office buildings



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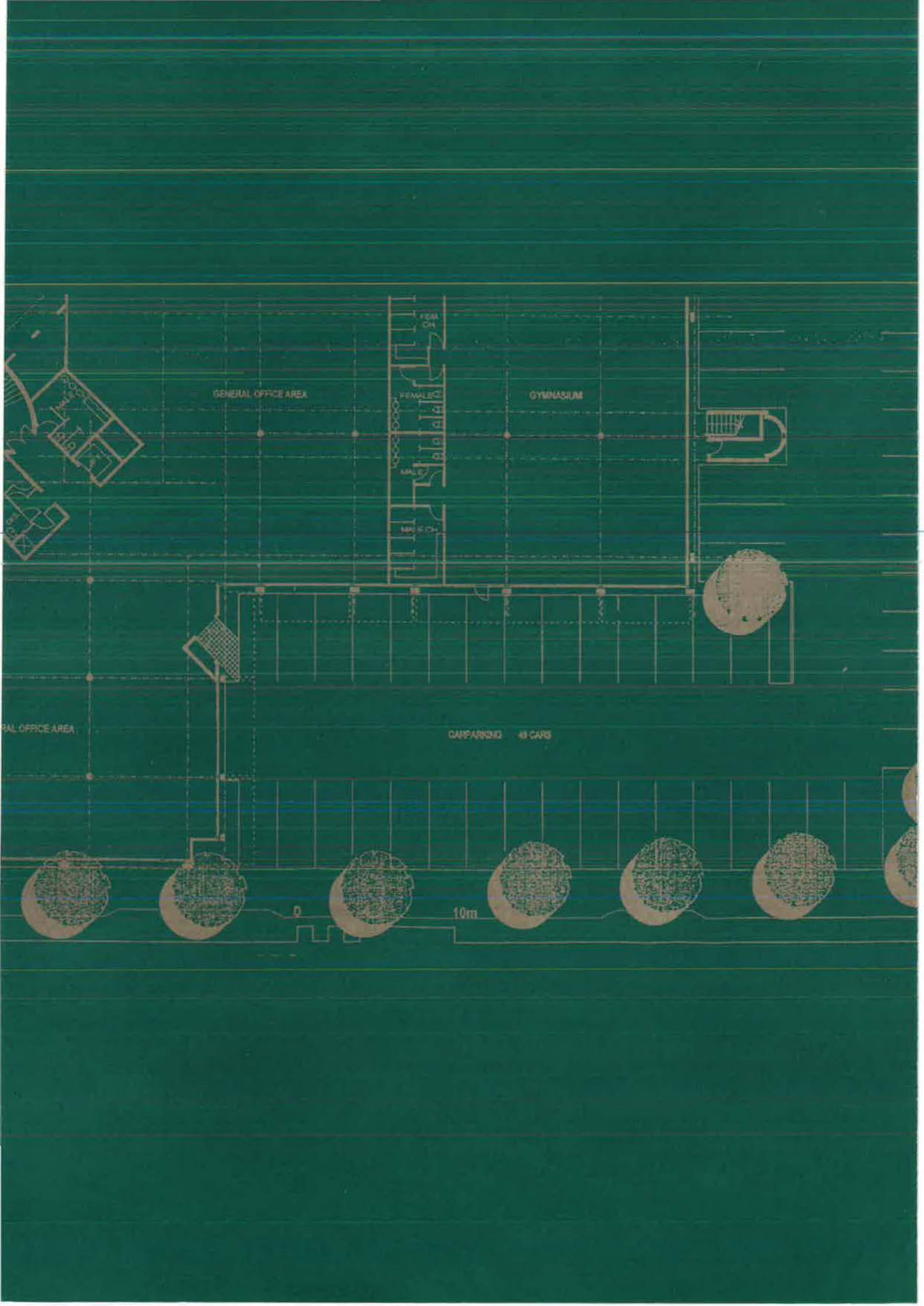
efficient (ERDC)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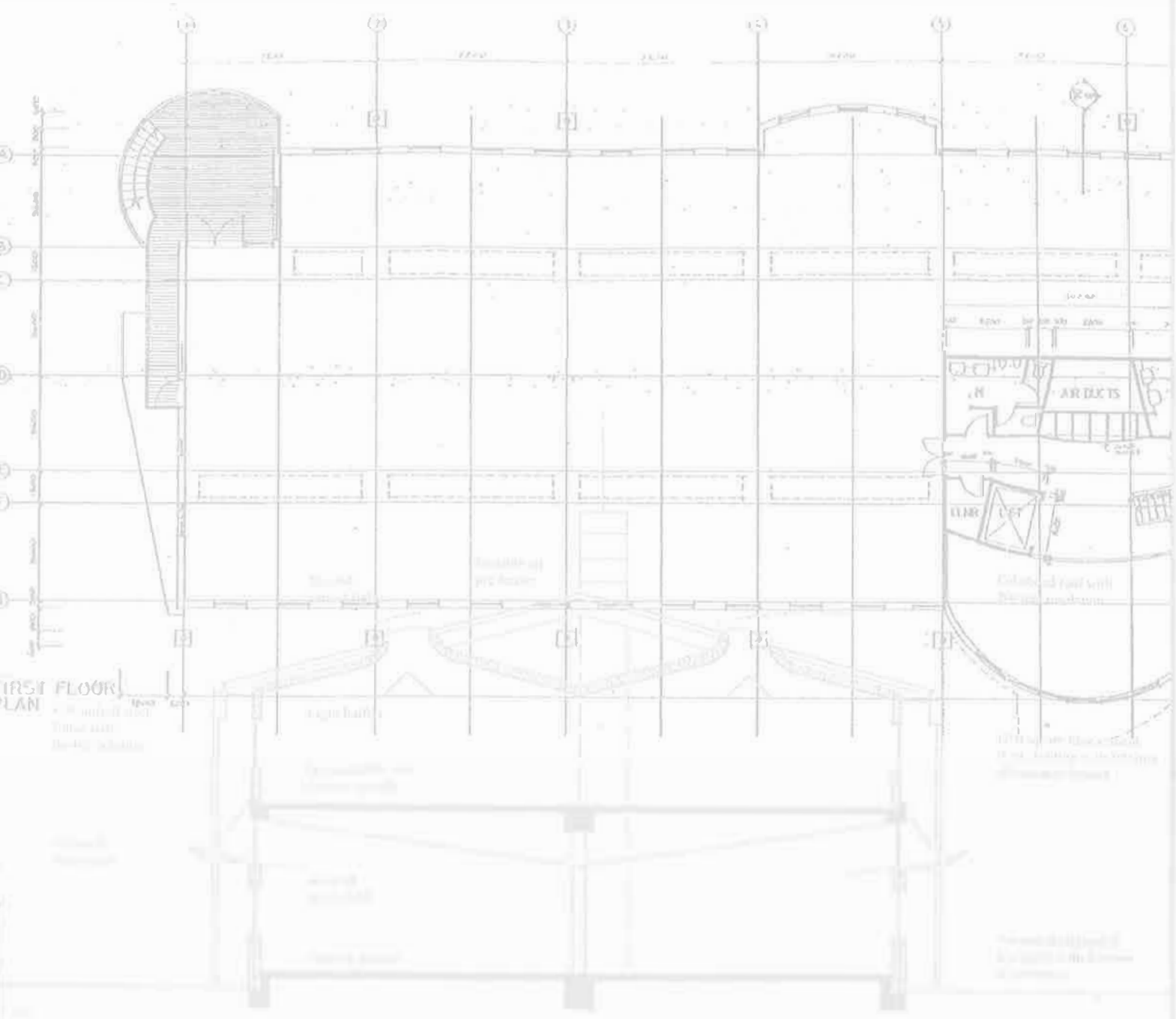
ARTIFACTS

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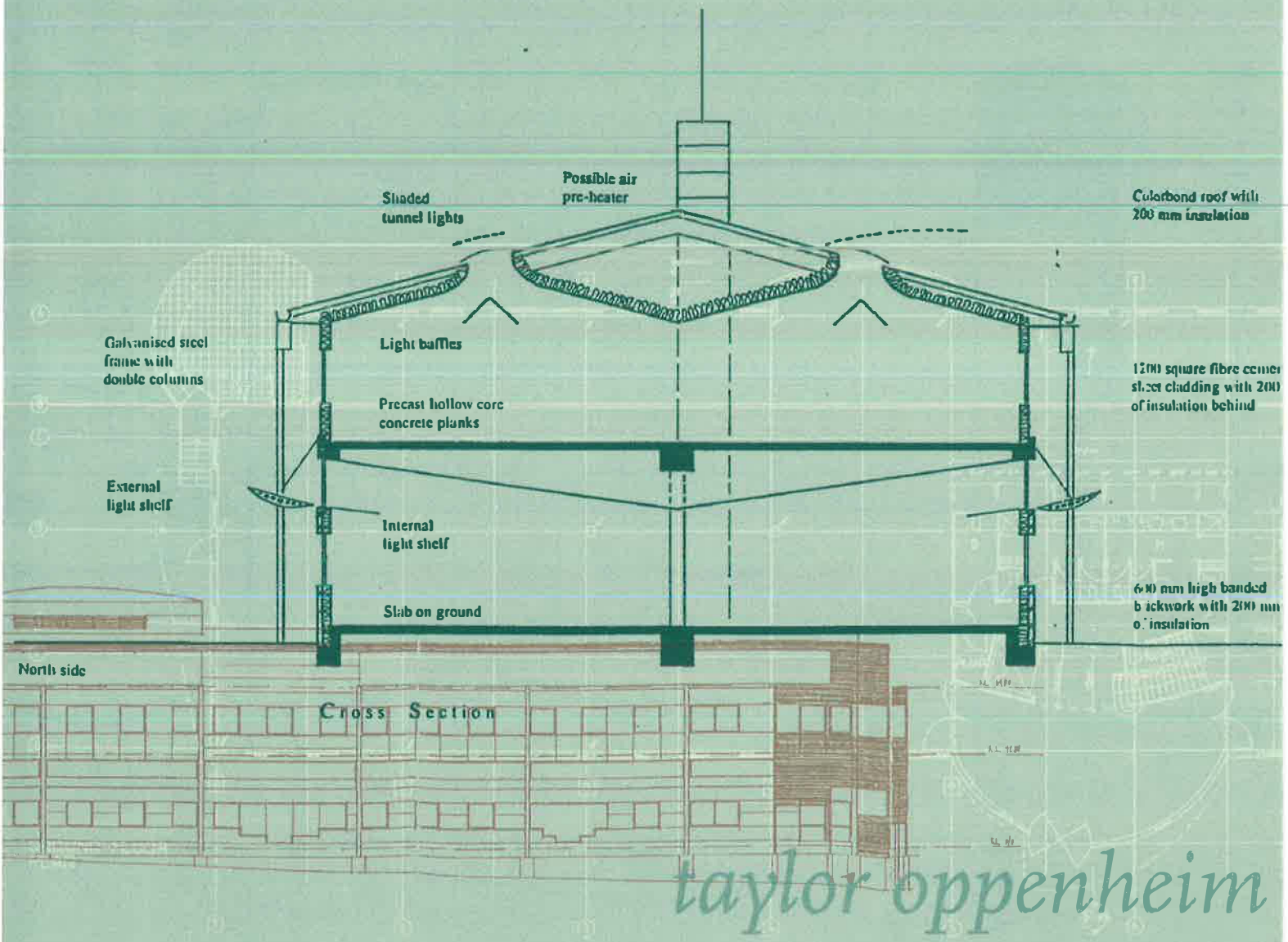


taylor oppenheim

The Australian building industry and architectural profession have been historically slow in their uptake of new design techniques and emerging technologies, especially those that can achieve energy savings for owners and operators of the buildings. Given that 2% of Australia's greenhouse gas emissions are produced by commercial buildings, there is a need for identifying real ways to achieve savings.

This document identifies the key issues to be managed if a small office building is to be developed to its energy efficient potential.

It seeks to outline how this outcome can be achieved, and identifies the potential danger zones along the way for those involved.

This document is based on the lessons learned and experiences gained during a project that was instigated and funded by the Energy Research and Development Corporation (ERDC).

David Oppenheim of Taylor Oppenheim Architects was a key player in the project. His firm was selected to act as architects for the project in March 1994 and continued until the project was finalised at the end of 1996. He has been involved in energy efficient buildings since 1976 and has won many awards for his work.

Although the project was stopped prior to the actual construction of the building, ERDC commissioned Taylor Oppenheim Architects to write this Guide so that the wider building community could learn from the projects experiences, and not waste time in the future re-inventing the wheel.

We believe the issues raised will play a key role in expediting the early adoption of new processes and technologies, which means two things:

- building owners will have a more attractive, energy efficient product to sell to their potential tenants, and
- tenants will be more interested in operating from a site that will cost them less to run.

A detailed End of Project Report has also been prepared by Taylor Oppenheim Architects and is available by contacting ERDC.

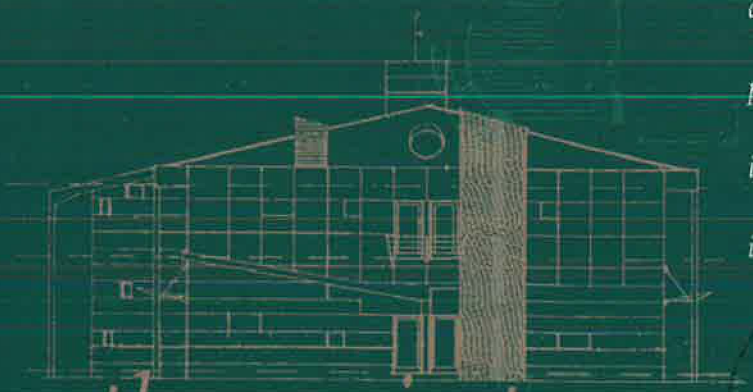
Merv Johnston
Acting Managing Director, ERDC
October 1997

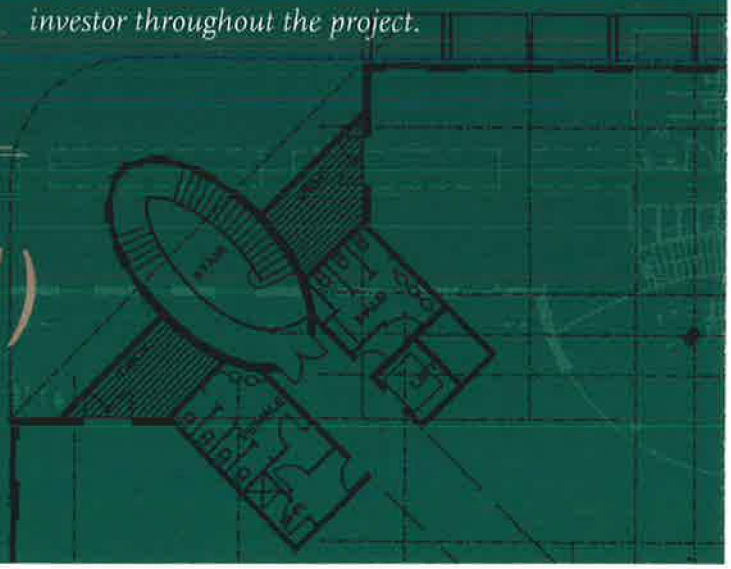
The Project

The project was undertaken between early 1993 and the middle of 1996 at the instigation of the Energy Research and Development Corporation (ERDC). The aim of the project was to construct a demonstration energy efficient small commercial building in Canberra.

At the time it was likely that ERDC would potentially be the main tenant of the building, taking approximately 600 m² of the 1500 m² office area.

ERDC initially acted as investor for the project and allocated $2,816,000 for its development. It was later decided that the project be sold off the plan to a third party investor, instead of ERDC remaining the investor throughout the project.





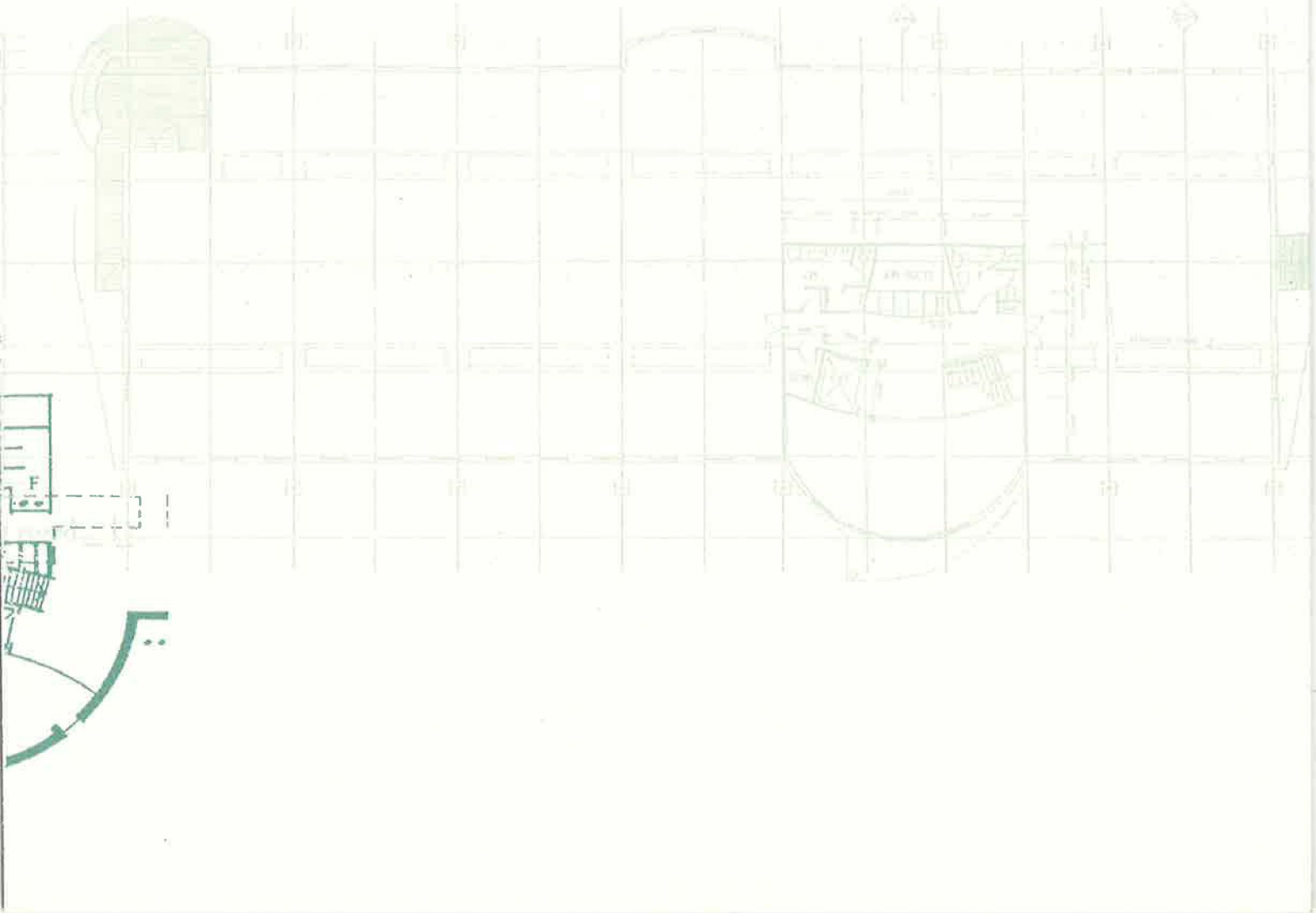
the project (ERDC)

The needs for the project were perceived as being:

- To demonstrate leading edge design strategies & technologies;
- To document the energy performance of energy efficient buildings;
- To demonstrate the cost-effectiveness of proposed strategies;
- To document the design process used to achieve energy efficient buildings;
- To investigate the likelihood of this demonstration building evolving from a commercial environment, rather than a research environment;
- To provide research opportunities for companies involved in the design process, since they were often limited by size and resources; and
- To field test the proposed technologies rather than have them tested over a limited period of time in a laboratory.

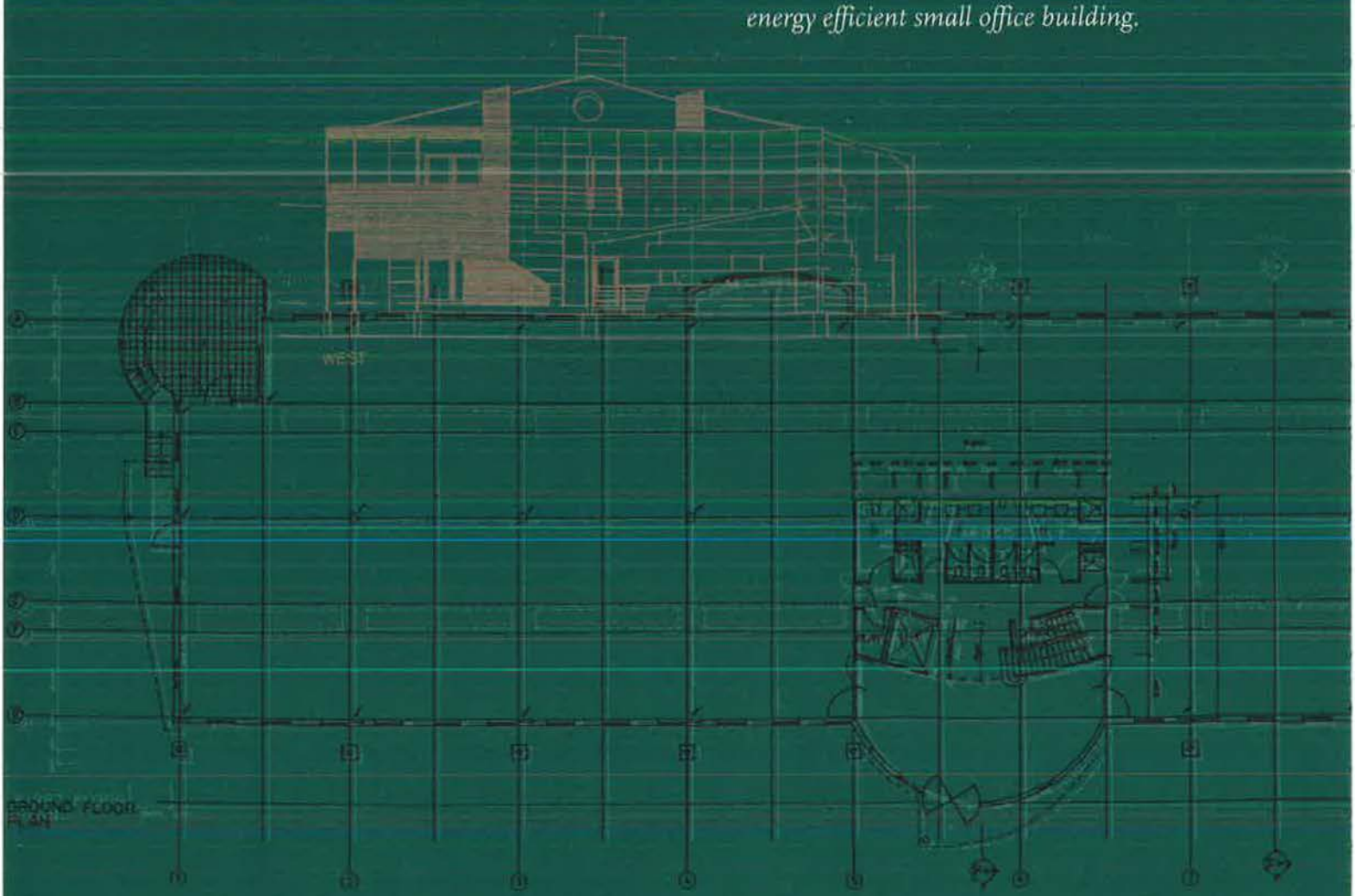
The benefits of the project were perceived as including:

- Enhanced export opportunities for Australian manufacturers & consultants;
- Reduced CO_2 emissions from commercial buildings;
- Reduced national energy bill;
- Development of standards and/or guidelines for low energy buildings;
- Greater market share for energy efficient equipment and design;
- Improved data base for future cost/benefit analysis that would be provided by data obtained from monitoring;
- Feedback on operational effectiveness of specific features that would have been provided by additional data obtained from monitoring of energy conservation features; and
- Market leader status would have been accorded to equipment suppliers and the buyer of the building and they would have been recognised as being leaders in the field.



Planning process for an energy efficient small office building

The project identified several factors to include in the planning process for an energy efficient small office building.



Financial Hero

The Financial Hero is a person or organisation that has two characteristics: firstly, the financial ability to drive the project, and secondly, the desire to produce an energy efficient building. In any project, choices have to be made between options. Information is provided by the project team to assist in the making of the final choice. The Financial Hero would make the final decision since it is their money that is at stake. If this person sees energy efficiency as one of their primary goals, then issues such as long term return on investment (ie. investing in lighting controls), and unusual building fabric options (ie. accepting narrow floor plates, external light shelves, and perhaps sloping ceilings) will be pushed through rather than pulled backed from.

Examples of past financial heroes have been:

a) environmentally involved owner /occupiers (ie. Greenpeace and their HQ in London, Audubon Society HQ in New York, World Wildlife Fund HQ in Zurich, SEDA HQ in Sydney);
b) enlightened developers (ie. John Knott on Dewees Island in South Carolina, Stanley Selengut with Harmony Resort at St John in the US Virgin Islands, Olympic Co-ordination Authority with the Homebush Bay developments for the Sydney 2000 Olympics); and
c) utilities (ie. Southern California Gas Company Energy Research Centre in Downey California).

Signed up tenant

Any commercial development seeks to secure a long term tenant to act as an anchor for the development. Energy efficient developments are no different. A ten year lease for the whole building would be ideal, but 6 years with an option for 6 more for 75% might be acceptable. How far off the ideal will depend on the developer. Thus an essential ingredient in the planning process is to secure a long term tenant.

Charette

A Charette is a meeting involving all stakeholders in the project. These are similar to Value Management meetings but differ in that they seek not only to obtain financial value but also environmental value. They typically run for half a day and a report is produced soon after that summarises the findings. The Charette occurs after a brief has been created, but before any design work occurs. A second Charette is then held which results in the creation of a schematic or concept design which is priced both financially and environmentally.

The two Charettes used in the development of a small office building are the zero resource charette, and the achievable charette.

The Zero Resources Charette sets its aim at designing a building that uses no external resources in its operation ie. is autonomous. It goes beyond energy efficiency and also addresses water, waste and transport. This might typically mean a high performance building fabric and internal equipment combined with photovoltaic cells to produce electricity, solar panels to produce heat, water

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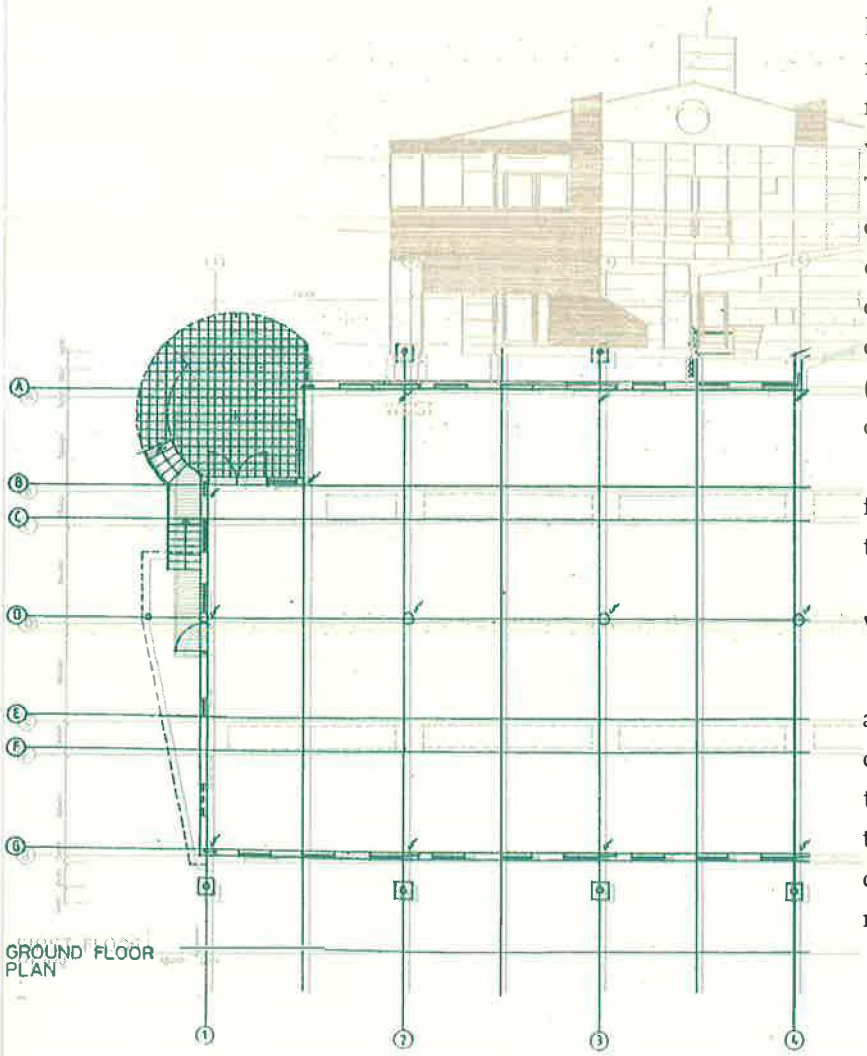
Planning process for an energy efficient small office building



collection and storage, as well as careful waste disposal. Outcomes are measured financially and environmentally. The result is a building normally way out beyond the economic reach of the developer.

A report summarising the findings of this Charette is produced and circulated to stakeholders for their consideration.

The Achievable Charette follows the Zero Resource Charette. The aim of this Charette is to create a project that can be realistically achieved. The starting point, however, is not current practice, but rather the Zero Resource Building. Justifications therefore need to be made by the project team as to why there is a move back from the zero position, rather than why there is a move up from current practice. Typically, reasons such as 'too expensive' (based on first up capital cost rather than life cycle costing), 'has not been done' (based on local experience rather than international experience), and 'fees will not cover it' (revealing lack of personal research) are cited as obstacles to moving up from current practice.

Once again a report is produced on the findings of this Charette. These findings form the Schematic Design.

Whole team committed to process

To maximise the energy efficient potential of a building, the whole project team must be committed to the process. Being committed to the ethos means they will not lose interest in the project. They will be keeping abreast of developments and attending conferences and meetings to continually update their knowledge.

The team members and their roles are described below:

Client/Financial Hero

As noted above, the Client/Financial Hero is a person or organisation that has two characteristics: firstly, the financial ability to drive the project, and secondly, the desire to produce an energy efficient building.

Developers

If a developer is involved in the project and is the financial driver of the project, he/she should be a financial hero as described above.

Architects

Architects must be able to cover all the energy efficient ground not only for the building fabric design but also for all the other services.

Services Engineers

Services engineers must be aware of all the current technologies that are emerging, and have tools to assess their efficiency.

Energy Engineers

The energy engineer is a new type of consultant who assess the use of energy in the building in the same way a quantity surveyor assesses the use of money. An energy budget is formed (as is a money budget), the first option is measured as to its energy performance (the first Cost Plan), and then variations to the design are assessed in terms of energy (as in subsequent Cost Plans). Differing technologies are examined individually (ie. daylighting) and together (ie. the impact of daylight on air conditioning).

Quantity Surveyors

Quantity surveyors play the normal role they play in any project of measuring the use of money.

Structural Engineers

Structural engineers play the normal role they play in any project, except that if the design requires the connection of the thermal mass of the structure to indoor air, then special design features may be required.

Civil Engineers

Civil engineers play the normal role they play in any project with respect to energy, but when conservation of water use is considered for the project, they will be required to exercise special skills.

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Danger Zones - identifying problems and solutions for energy efficient projects

Energy efficient projects have peculiar problems with some aspects of the building and development process. These are detailed in the body of the End of Project Report (available from ERDC), but are summarised below, along with some suggestions as to their respective remedies.

energy efficient projects

Differing processes

Energy efficient projects, because of their unusual nature, often highlight the diametrically opposed approaches and cultures used in research projects and commercial projects.

Research is undertaken by opening up problems, examining them, and reporting on the findings. Recommendations are then made as to the best course available. Monetary considerations are usually not part of the equation.

Development, on the other hand, is undertaken with the aim of gradually reducing, and hopefully eliminating, problems.

Projects should attempt to quarantine these two differing processes of research and commercial development. Areas where this may occur are daylighting and natural ventilation.

The Financial Hero can assist with this circumstance by a commitment to seeing the innovations through, rather than be caught up with existing concepts. The Financial Hero needs to be skilled enough to properly evaluate and direct the project.

Timing

The timing of an energy efficient project has some different considerations when compared to a traditional development. For example, the financing of such a project tends to coincide with a stable political environment when benefit can be seen in longer term planning of capital investment than would normally be supported during more turbulent political times.

However, energy efficient projects are similar to normal developments in trying to select a time when the economy is expanding rather than contracting to make the securing of a tenant easier. This may not, however, apply to owner occupiers.

Lack of information and examples of Australian case studies

There are very few examples of highly energy efficient buildings in Australia. New developments do not proceed because there are no precedents against which performance and costs can be measured, and there are no examples to provide these measurables because no-one is willing to finance an unknown proposition.

Involvement in the International Energy Agency tasks is one way Australian consultants can gain experience in innovative buildings. For each task, experts from OECD countries gather and deal with specific issues. For example, IEA Task 21 deals with Daylight in Buildings and Australian involvement has added to consultants knowledge of daylight monitoring and protocols, design aids, as well as daylight case studies.

When does energy efficiency lose priority?

The importance of energy efficiency is usually downgraded when:

- there is no Financial Hero to hold the position;
- cost cutting measures are required; capital investment for long term gains is often the first to go;
- tenants are not willing to compromise on temperature and humidity limits (ie. 21°C ± 2°C);
- energy performance modelling of the desired feature is slow and unwieldy (as in daylighting and natural ventilation); and
- energy costs are perceived as unimportant. With energy costs accounting for perhaps only 2% of tenant's total outgoings, there can be a perception that it did not matter. This attitude was reinforced by the fact that operating costs are usually not borne by the developer. A solution for this could be to seek out owner occupiers for such projects, or those organisations that are driven by environmental concerns rather than economic ones.

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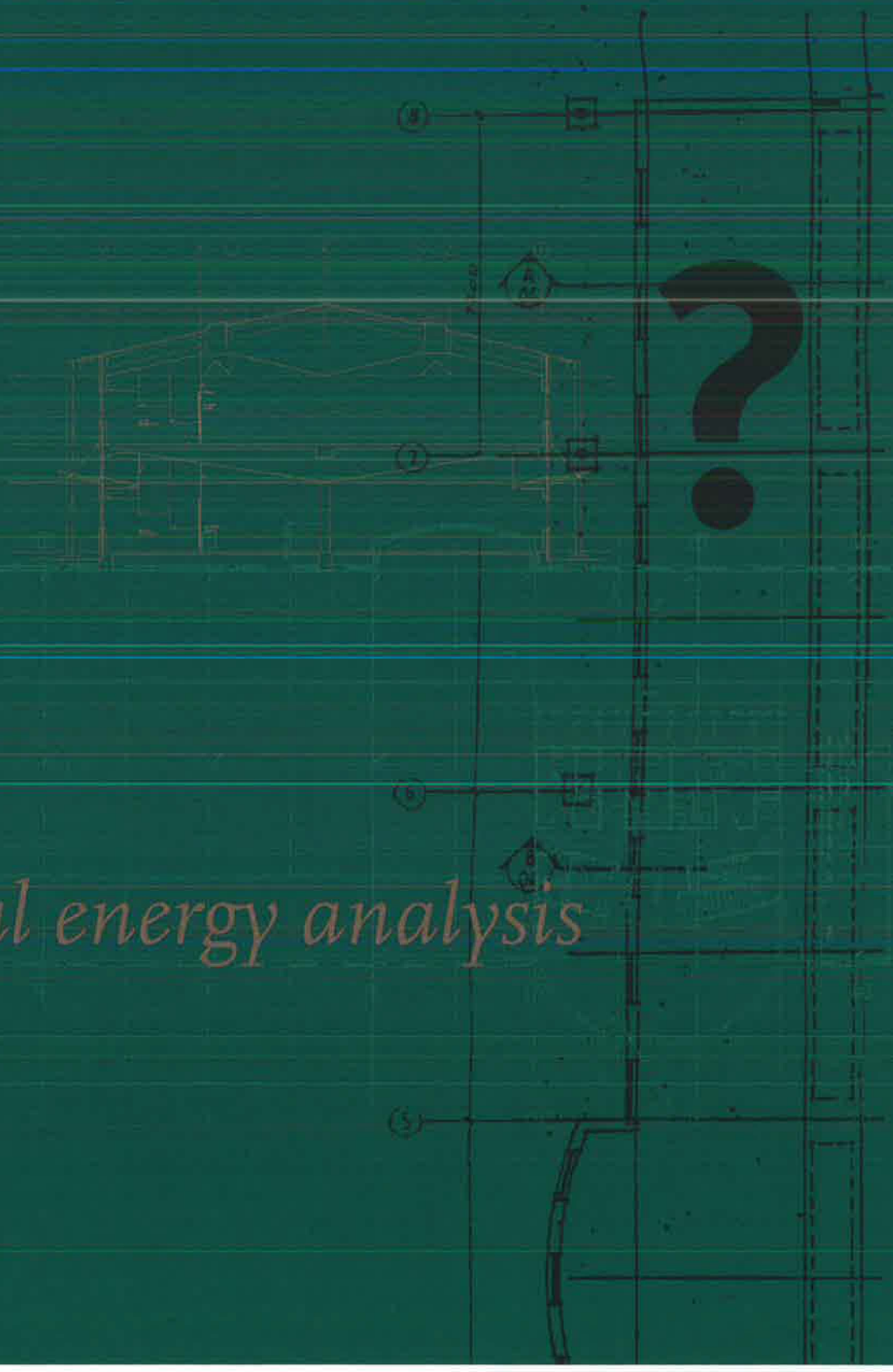
Things to consider when planning an energy efficient small commercial building



thermal energy analysis

Brief

The Brief is a key document in the design process. Because of the conflict between a research project and a commercial development, the brief needs to clarify the perceptions and intentions of the key participants. If a commercial development is planned, more emphasis needs to be accorded to the tenant and investor requirements.

Selection of consultants

Correct selection of appropriate consultants is essential for any project. In an energy efficient project, special attention needs to be paid to the experience and commitment of consultants.

Conducting proper research includes gathering information on past award winners in energy efficient building design and contacting, for example, the Royal Australian Institute of Architects or the Institute of Engineers.

Consultants specialising in energy efficiency may also be listed on the following sites:

- EnergySearch
http://www.energysearch.com.au

- the Federal Government's Department of Primary Industries and Energy - NetEnergy site
http://netenergy.dpie.gov.au/eelibrary/eehome.html.

Site

Greenfield sites such as office parks pose fewer restrictions than urban sites. A fuller range of possibilities can be considered on greenfield sites such as external light shelves, different floor plate designs, and fields for ground source heat pumps.

Engineering analysis

Engineering analysis needs to be undertaken to evaluate different energy efficient technologies. This needs to be not only in terms of energy use, but also in terms of capital cost increases and operating cost savings. Research will be needed to find the results of monitored built examples.

Thermal energy analysis is fairly straight forward except for calculating the thermal effects of daylight introduced into the building. Daylight analysis is, however, currently a slow process as well as lacking an emphasis on the financial viability of various options.

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Useful facts and figures

1 Project team members

CLIENT

Energy Research & Development Corporation
Contact: Karen Jackson (Canberra)
Tel: 02 6274 4800

ARCHITECTS

Taylor Oppenheim Architects P/L
Contact: David Oppenheim (Melbourne)
Tel: 03 9859 7811

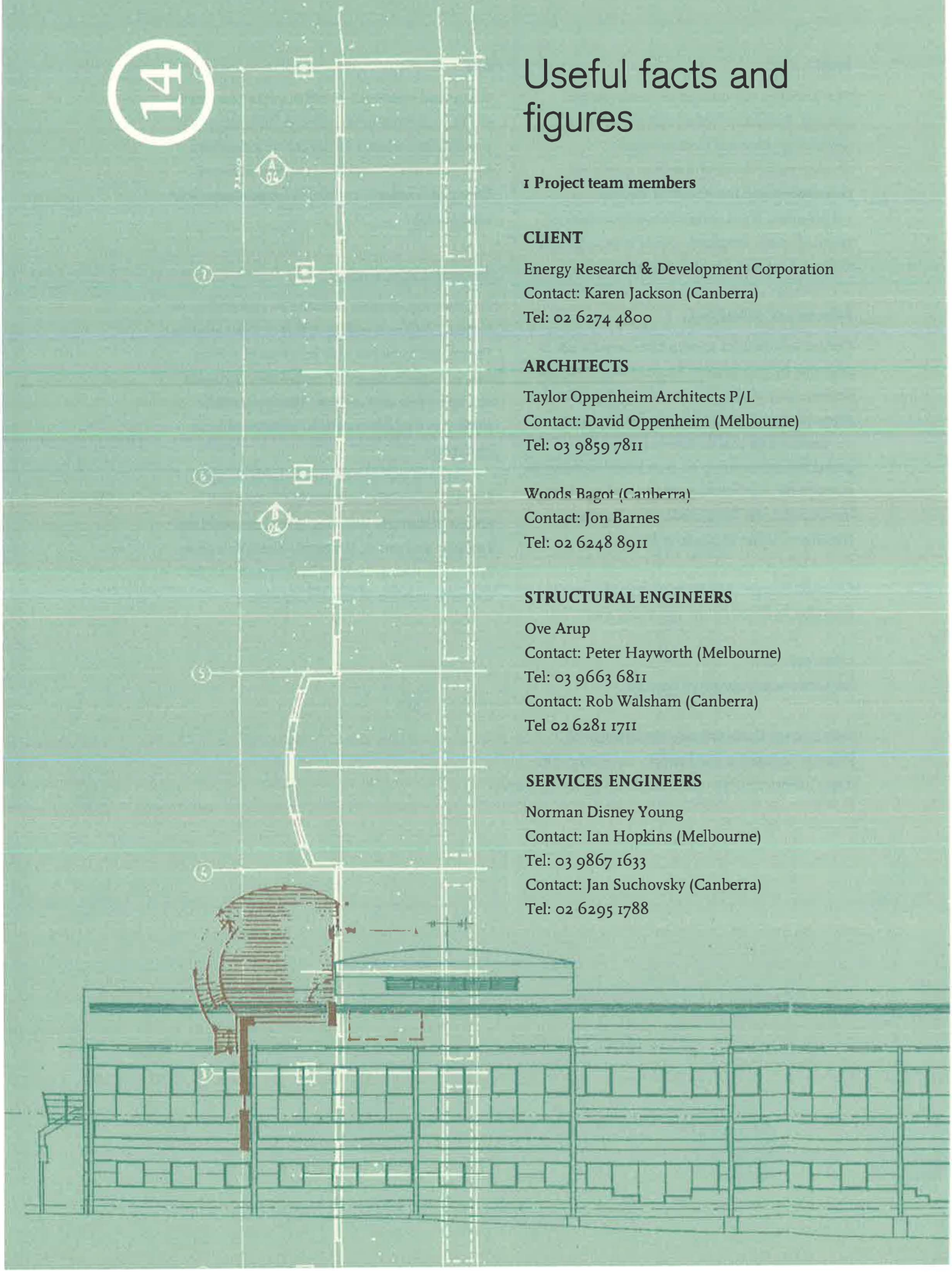
Woods Bagot (Canberra)
Contact: Jon Barnes
Tel: 02 6248 8911

STRUCTURAL ENGINEERS

Ove Arup
Contact: Peter Hayworth (Melbourne)
Tel: 03 9663 6811
Contact: Rob Walsham (Canberra)
Tel 02 6281 1711

SERVICES ENGINEERS

Norman Disney Young
Contact: Ian Hopkins (Melbourne)
Tel: 03 9867 1633
Contact: Jan Suchovsky (Canberra)
Tel: 02 6295 1788



CIVIL ENGINEERS

Hughes Truman Ludlow
Contact: Brad Dobson (Canberra)
Tel: 02 6288 6103

ENERGY ENGINEERS

Enersonics
Contact: Rob Alexander (Melbourne)
Tel: 03 9819 1811

QUANTITY SURVEYORS

Slattery Australia
Contact: Steve Grimes (Melbourne)
Tel: 03 9602 1313

DEVELOPERS

Lend Lease
Contact: Mike Jubb (Canberra)
Tel: 02 6265 1690

Fletcher Constructions
(No longer operating in Canberra)

Ron Bell and Associates
Contact: Ron Bell
Tel: 02 6257 2388

2 Operating costs

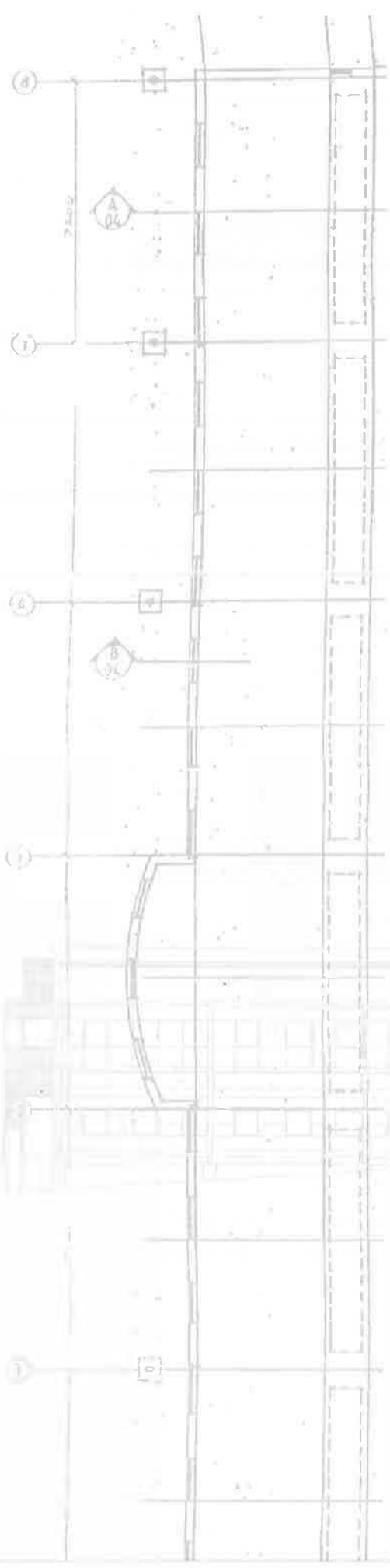
Typical operating costs for a tenant for a small 2000 m² commercial building over a fifteen year period, for a building that would have a capital cost of $3,000,000.

Item		Cost $
Rent	say 180/m²	5,500,000
Rates & taxes*		450,000
Insurance		45,000
Cleaning		38,000
Fire prot. maint.		15,000
Repairs & maint.		75,000
	sub total	**6,123,000**
Electricity	Heating	1,000
	Cooling	37,000
	Air Handling	90,000
	Lights	123,000
	Power	106,000
	Lifts	32,000
	Hot Water	0
	sub total	**389,000**
Gas	Heating	23,000
	Hot Water	6,000
	sub total	29,000
	Grand Total	6,541,000

*Varies markedly from State to State.

3 Tenant's mode of transport to work

Energy used to transport workers to and from their place of employment is approximately equal to the energy used at the office. This transport energy therefore needs to be considered if a change can be made upon it when considering the design of the building (for example, can the design encourage and promote bicycle usage).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