Submission to Productivity Commission

Improving the future performance of buildings

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Executive Summary

This submission concentrates on energy efficient technologies for buildings - the types of energy efficient technologies; the potential savings; impediments to their uptake; and various strategies which we see can assist in their uptake. The technologies discussed are primarily related to minimising building energy use for heating, cooling, ventilation and lighting as these form the focus of current ACRE activities in this area, and are the areas in which we have experience.

Examples are given of potential savings which could be achieved by implementing existing technologies in an appropriate manner, and going beyond current world's best practice. Further examples are given of the problem which are currently encountered in implementing energy efficient technologies in buildings, which largely arise owing to the structure of the building industry and the lack of understanding of technology, and communication between the different parties in most building projects. Two strategies to increase the uptake of energy efficient technologies in buildings are given in Section 7: development of improved design tools for energy efficient technologies and education and training. Both of these will require considerable industry, government and research input to develop.

1. Background

The Australian CRC for Renewable Energy (ACRE) has a program targeting building energy efficiency. Last year ACRE submitted an application for an extension to the current research program to expand the activities in this area, emphasising the development of enabling technologies to improve the energy sustainability of buildings. Many of these technologies are **input saving technologies**, and tools to enable design of buildings to include these input saving technologies in a straightforward manner.

The issues which were addressed in this proposal covered both operating energy consumption and energy embodied in construction processes. However, reductions in energy consumption are not the only benefits of many of the technologies. There are also reductions in building operating cost (arising from reduced heating, lighting and cooling loads), reductions in cost of capital plant (from reductions in peak capacity requirements), and improvements in the amenity of buildings for occupants. This last factor can be particularly significant for commercial buildings where the interior comfort (thermal, visual, air quality etc) affects overall worker productivity[1].

The application submitted by ACRE was unsuccessful, largely owing to the difficulty in bringing together a cohesive group of industry partners which could cover the broad spectrum of groups impacted by the proposed research.

2. Scope of Submission

This submission concentrates on energy-related input saving technologies, covering:

- the types of input saving technologies available to reduce energy consumption, or to assist in the design of buildings to reduce energy consumption;
- the impact of energy pricing and deregulation of the energy market on the uptake of energy saving technologies;
- impediments to the more widespread use of energy saving technologies;
- how the structure of the building industry affects the design of buildings; and
- some suggestions for increasing the uptake of energy saving technologies in buildings.

Two case studies are presented, one highlighting an advanced lighting design which suffered in implementation, and the other highlighting design problems, and effectively a lack of commitment from developers to good design which maximise function and performance of buildings.

3. Energy Efficient Input Saving Technologies

3.1 Technology areas

There are numerous existing energy efficient technologies which can be incorporated into buildings and lead to operating cost reductions in buildings. Some examples are:

Lighting

- energy efficient lighting (luminaires);
- advanced lighting control systems;
- use of daylighting (coupled with lighting controls to achieve maximum savings).

Heating/Cooling

- natural ventilation
- advanced window technologies
- increased efficiency motors (fans, chillers etc)
- appropriate insulation

Appliances

- high efficiency motors (especially in houses - ceiling fans, refrigerators)

While many of these technologies exist already, there are also developments in all these areas which will broaden the range of solutions available, both in terms of the range of buildings which can make use of the technologies and also in terms of initial cost. Australia is a world leader in many of these areas of research, such as advanced window technologies, daylighting technologies and energy efficient motor design, and new products will continue to come on to the market.

The potential savings from the inclusion of these types of technologies can be significant. In the Australian context, current lighting power levels in commercial buildings are approximately 16W/m^2 (BOMA Average). With daylighting technologies, energy efficient luminaires, and advanced control systems, it is estimated that this could be reduced to 5W/m^2 (in Sweden the current standard is 10W/m^2). For a 400m^2 floor of a building this translates to a saving of 8.7MWhr (220 days per year, 9 hours per day), or a cost saving of $800-900 (assuming is lighting is used when the building is not in use). There are also additional benefits (energy savings) arising from the reduced heat load.

3.2 Design Process and Design Tools

Many of these technologies can not be considered in isolation, either at the design stage or in the final building. As an example, the use of low shading coefficient glazing in a commercial building will reduce the solar heat load on the building[2,3], and may allow a smaller chiller unit to be installed[3]. In ref 3 reductions in chiller capacity of 40% were possible in several northern US locations when high performance advanced glazing systems were used. However, this may also result in increased requirements for powered interior lighting. In order to adequately design buildings to maximise the benefits from energy saving technologies, it is essential that appropriate design tools are available to the building design professions.

In addition, all participants in the design and construction process must have confidence in the results of the design process (and therefore these tools), so that the designs are correctly implemented. This is highlighted by the experience of the Energy Research and Development Corporation when they were planning construction of their offices, incorporating energy efficient design features. This is well documented in the report by David Oppenheim on this project[4]. Another example is given in Case Study 1 below.

One of the difficulties with the design tools is the complexity of these tools for most participants in the building industry. Programs like DOE2.1 (Thermal modelling of buildings - US Department of Energy), Radiance (Lighting modelling - US Department of Energy), ESP II (Thermal modelling of buildings - available in Australia from ACADS-BSG), and CHEETAH (thermal modelling - CSIRO) are extremely useful, but tend to require substantial input and require extensive technical knowledge to use effectively.

Transparency and simplicity (in presentation) are required to ensure that all participants in the construction process are aware of the process of arriving at the design, and trust this process.

CASE STUDY 1. A HERBARIUM USING DAYLIGHTING TECHNOLOGY
For this building, a government organisation commissioned the building, and requested QUT to design a daylighting system for the building. The system was designed specifically for the building, and extensive design calculations were performed to ensure adequate daylighting was delivered to the building.

The builder, when it came time to install the system, followed his normal procedure for double glazed windows and installed wide frames, rather than the specified narrow frames. This reduced the amount of light entering through the windows, which were externally covered with specially designed light-guiding shades. In addition, he insisted on installing a removable cover over the skylight (at considerable additional cost) as he was concerned with heat gain during the day and heat loss at night. This was considered in the design. Apparently the cover has never been used.

4. Input Pricing - Energy

During the process of preparing the Extension proposal for ACRE's building activities, it became clear that energy efficiency was not a high priority for most participants in the building and construction sector because of low energy prices. In the example used above, the reduction in lighting energy from $16W/m^2$ to $5W/m^2$ could save up to $900 for a $400m^2$ floor of a building with an energy unit cost of $0.10. However, the cost of retrofitting a comprehensive system to achieve this target would probably result in a long pay back period (perhaps 3-5 years). A simpler solution (perhaps just replacing the lights with high efficiency lights) could be achieved at lower cost (during routine maintenance - cost is only the globes/tubes) with a shorter payback period. The situation is exacerbated by the real falls in the price of electricity for commercial and industrial customers in recent years[5].

The deregulation of the electricity market appears to be partly responsible for driving the costs down in the short term. However, even at $0.10/kWhr, the return on the investment in the above case is likely to be small. One person from an electricity retailer commented that they could not even mount a business case for a $20 relay in an energy management system (which was no longer functioning because of a failed relay) because there was no return in energy efficiency.

The relatively low cost of electricity may not be a long term problem, but the pricing of all forms of energy to reflect the total cost (including externalities) would make all forms of energy efficiency more attractive to businesses and domestic energy users. The most appropriate mechanisms to achieve this full-cost pricing are not clear, but would clearly include such things as a carbon tax, a more general "waste" tax, or somehow charging for the "cost" of the raw materials. These issues are beyond the scope of this submission.

5. Demand for Energy Efficient Buildings

We are aware of some evidence of consumer demand for energy efficiency **measures** in commercial buildings, particularly the "high-end" buildings and buildings commissioned by Government.

Examples

1. G James Glass and Aluminium, based in Brisbane, have recently commissioned a glass coating line (the only one in Australia, and one of the few (two or three) in the southern hemisphere. This line is designed to manufacture energy efficient advanced glazings, and G James have invested in as they see sufficient existing market for product from this line with a probable growth.

2. QUT has been involved in the design aspects of several projects, giving advice on, and preparing detailed designs for advanced glazings and daylighting systems. The majority of these have been for Government, and include libraries and schools.

It is harder from our perspective to assess whether demand for energy efficient measures translates into demand for energy efficient buildings.

6. Impediments to widespread use of energy efficient technologies

From our experience there appear to be three principal impediments to greater uptake:

1. Energy costs (of the building) are only a small fraction of running costs of most commercial buildings;
2. There is a lack of understanding of how to design with energy efficient systems (or even to consider energy adequately), and a lack of understanding (or confidence) of builders in novel designs
3. The system of procurement of buildings often leaves the occupant (who pays energy bills) out of the design and construction phase.
4. Lack of communication (trust?) between parties in the construction process.