University of Technology, Sydney

Productivity Commission

Improving the future performance of buildings

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Input Saving Technologies

Introduction

Products and processes exist to achieve energy savings in excess of 50% in non residential buildings, often without an increase in construction costs. Various impediments exist which need to be addressed before this can be achieved on a wide scale. Extra effort and cost is needed in the design process but it can be recouped many times over in the reduced operating costs, enhanced growth in capital value and return on investment from tenants, because such buildings are in general considerably more attractive to occupy. Simple payback analyses, which focus exclusively on energy savings, have not really captured the real financial returns inherent in well designed, environmentally friendly buildings, relative to standard buildings. There has also been a piecemeal approach, in part due to separating out inputs, where individual technologies are assessed for returns rather than using an integrated strategic approach[1]. For example energy efficient lamps with controls to maximise daylight contributions to savings are commonly treated independently of other building functions. The same can be said of standards - they tend to defocus attention from *whole -of- building integrated performance* , onto components and hence establish a culture of "meeting standards" rather than achieving best global performance.

Design issues - the need for a change in process and methods

Bringing the environment into the Design process

Both the content and timing of energy analyses (if any) in design using conventional methods means that energy savings are rarely optimised and often well below expectation in practice. This stems from a philosophy in which the building is treated by and large as a separate entity to the environment whose impacts are studied once the building is designed whereas what is needed is one in which the building and the environment are treated in a fully integrated fashion at the outset. This can only be achieved if a quite new approach is adopted to design. Low energy strategies should be explored and evaluated at the pre-design stage . Likely strategies are identified , then changes as geometry evolves checked and strategies fine tuned at the preliminary design stage. IST inputs are diverse and interact, so comparisons and ranking according to savings and costs are needed at an early stage. Modern tools enable some of this to occur and scope is improving.

Dealing with physical complexity in buildings

Computing power at the desktop has opened up a new era for the designer as well as researchers on energy efficiency technologies and made the strategy just outlined viable. The researcher must deal with and describe the underlying physical processes and characterise how technologies link to different aspects of building performance and the local climate and environment. The designer benefits from this work, and they may need some feel for it, but mostly they cannot and do not need to deal with this mathematical complexity directly, but need tools which do. Without them there is just too much guesswork and potential for costly investments which do not work as expected. The new generation of programs is reducing this risk though there is further to go. Until two years ago only the more cumbersome research like tools were available and only the most dedicated architects used them or called upon the few consultants who did. But it is now possible using tools such as the QUT/ACRE/UTS GSL and LIGHTING[2] and the NREL package ENERGY-10 to make informed choices and carry out integrated design with energy considerations in and important at the outset. Other Australian programs such as NATHERS are useful but focus on standards and star ratings, and emphasise thermal performance. Being residentially focussed they do not provide much on the big saver lighting and daylighting - (see below). Their structure is not ideal from an optimisation viewpoint, for quickly fully assessing, including financially, a variety of strategies in any location. They use conventional design approaches, that is analyse the energy in the building after it is largely designed, and then modify or add-on components, if possible, to reduce energy consumption.

The extra design costs will gradually decrease with the advent of increasingly user friendly software tools in which most of the complexity is hidden within the core software - but some design premium will always be necessary to achieve good energy efficient results. The costs of this can be recouped by the designer in interesting new ways that will make it attractive to the developer or future owner/occupier (see below). The average designer needs training and support on these tools and confidence that the model's predictions are reliable and that they have at their disposal all necessary input data or algorithms to properly describe the technologies of interest. Currently there is a lot missing in this regard but it is improving . Provision of services to support this process including design oriented measurement and testing facilities , and computer model validation, are needed, and are available in some institutions including a joint effort between UTS and QUT and CSIRO, in part with assistance from ARC and ACRE.

Daylighting - the design issue for temperate and hot climate zones

A few dedicated scientists and architects in Australia and elsewhere have been promoting the importance of daylight as the pre-eminent factor in achieving major energy savings coupled with much increased occupant satisfaction and productivity. The emphasis has been conventionally on thermal restraints and negative aspects such as glare; which has meant, because it has not been understood how to handle all together, that the potential for savings in lighting and better aesthetics has been diminished greatly. Recent improvements in lighting controls and lamps themselves, can also greatly assist now but are often not used or used poorly. The daylighting resource is very complex and either poorly understood, taken for granted or treated in an overly simplistic manner. Glazing, shading and skylighting technologies that handle it best often appear simple but actually incorporate quite high technology, complex optical phenomena, and high level design concepts. Again with the right design tools, daylight and new daylight technology can be brought into the design process with confidence.

People have an inherent appreciation of daylighting which is why skylights are popular, but find it difficult to articulate its appeal or even consciously register that it is daylight that is giving them that enhanced sense of well being. Another example is Australia Stadium where daylighting has been introduced deliberately as a key feature. People like the Stadium but the reasons are not often given explicitly, but rather sensed or felt. We at UTS did much of the unique daylighting design and materials selection work for the large roofs and also studied impacts on interiors.

Australia has abundant resources of daylight which we can use without making interiors uncomfortable through good design and well chosen technology. The potential for energy savings in the near to short term is quite stunning- for example lowering average lighting requirements from well above 15 Wm^{-2} to well under 10 Wm^{-2} during the day in commercial buildings is not difficult. With good design and new technology it can go even lower plus there is a significant reduction in cooling load and hence size of chillers needed. The resulting potential for reductions in Greenhouse impacts is very big.

Design input- team make-up and incentives for energy efficiency

As well as the design tools and the point in the process where energy is considered, it is also important to adopt a more team oriented multi-disciplinary approach to design for best practice- especially in early discussions and evaluations of strategy. This helps in getting an integrated approach. Input from the owners or eventual occupiers as part of the team is also beneficial[3] and often European design teams include building physicists to help achieve their energy and comfort goals.

From the designers perspective some interesting incentive schemes have been established in the USA - called Savings by Design incentives[4] - in which incentive payments are linked to energy savings at various points ; say the design conclusion, at building commissioning, and over the life of the building. This is one way to defray the initial extra costs associated with good energy efficient design. The design team only gets part of the premium up front but can gain a lot more down the track if the designs achieve their goals in practice . Thus the design team will seek better solutions and become more aware of the technologies and techniques available. An ongoing return is linked to performance. They are then more likely to adopt new practices. This is in fact a form of intellectual property royalty, in recognising the intrinsic value in particular designs by the energy savings they produce and by sharing a portion of ongoing dividends from the design with the designer. If performance expectations are not met then incentive payments are reduced or not received.

Information, Training and Support

While the amount of information and case studies in this field is growing rapidly and is important, information alone is not enough. It is useful for stimulating ideas and needs to be kept up to date but potential users need some evaluation . Volume of information is large and varied in quality, with much developmental. Overseas information is often not suited to the Australian context or needs adaptation and even local developments need to be assessed for different climate zones within Australia.

The situation is similar for design tools - for instance locally suited or developed technologies and their data may need to be added to data bases or software libraries and a greater emphasis placed on daylighting than is common in colder climate zones. Sky conditions are also different.

Tailoring design tools and associated well run training courses and sessions both live and virtual, are needed for focussing on the new design techniques as outlined above, and introducing new technologies from a users and designers perspective. On going support to the building owners and occupiers may also be needed to maintain IST gains as well as to the engineering and design community in terms of keeping abreast of new developments. There are many aspects to support services for new energy efficiency, various providers and means of provision, but because much of this is new it is important that change occurs if acceleration of IST is to occur.

We are happy to elaborate further if requested.

References

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3. Harmony Library (Fort Collins) web site http://www.light-power.org/harmonylib/index3.htm
4. Energy Design Resources web site http://www.energydesignresources.com/