The Institution of Engineers, Australia

SYDNEY DIVISION

30 July 2003

Mr Kevin Greene MP
Chairman
Standing Committee on Public Works
Parliament House
Macquarie St
Sydney NSW 2001

Dear Mr Greene

Engineers Australia has over 70,000 members Australia wide, with over 21,000 members in NSW. Many work in the environmental and energy sectors. Sustainability is a major tenet of Engineers Australia's code of ethics and our members see energy efficiency and renewable energy as issues of significance to be addressed by governments, industry, the professions and the wider community.

The increase in urban development in New South Wales has made residential building a key area for energy efficiency and reducing greenhouse gas emissions. The New South Wales government has created a number of programs to assist residents and developers to improve their energy efficiency through energy rating systems, renewable energy assistance programs and a sustainable building development program and these are supported.

Engineers Australia welcomes the opportunity to make a submission to the New South Wales Legislative Assembly Standing Committee on Public Works *Inquiry into Energy Consumption in Residential Buildings*. This submission will discuss several issues relating to the inquiry including:

- Current NSW government sustainable energy in residential building development programs.
- Energy efficient residential building design.
- Other actions to improve energy efficiency in residential housing.

CURRENT NSW GOVERNMENT SUSTAINABLE ENERGY IN BUILDING DEVELOPMENT PROGRAMS

The NSW government provides a number of programs to assist with energy efficiency in residential building development. This includes the *Energy Smart* ratings system for residential housing, the Green Power program that provides consumers with the choice of buying their electricity from renewable sources and *Building Sustainability Index(BASIX)* which is an Internet based planning tool for councils and residential developers to assess the potential performance of their development against an agreed set of sustainability indices.

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Engineers Australia supports these programs and encourages the NSW government to further develop programs to reduce energy consumption, lower greenhouse gas emissions and increase in the use of renewable energy in residential developments.

ENERGY EFFICIENT RESIDENTIAL BUILDING DESIGN

Although the NSW Government has provided a number of programs to assist with energy efficiency further improvements in sustainable building development could be achieved. There are several examples of sustainable building design including the *Sustainable House* and the *Hot Humid House.*

- *The Sustainable House*- is a terrace house in inner city Sydney. A number of changes were made to help reduce energy consumption and greenhouse gas emissions including installation of photovoltaic and solar hot water systems on the roof, energy efficient lighting and special louvre windows to control ventilation. As a result of these changes, energy consumption has been reduced from 24kwh to10kwh electricity per day. This has cut the energy bill from $1600 per year to less than $200.

- *The Hot Humid House* located in Brisbane, reduces energy consumption by improving ventilation and insulation. It is based on a simple affordable design positioned towards the north to pick up sunlight and prevailing breezes. Air travels in and out of the house through a roof ventilator that takes excess heat out in summer. Specially designed awning windows further assist with circulating the air. The insulation inside the house consists of a concrete slab on the floor covered by linoleum that reduces cold. Polyester/cotton material is used to insulate the external walls and ceiling. This is a cheaper alternative than double glazing and helps keep the house at cool or warm if the windows are kept closed. Natural light in the house is improved by raising parts of the ceiling and using high windows. Significant savings were made with heating in cooling and greenhouse gas emissions were reduced. The house also reduced greenhouse gas emissions each year because of energy savings.

Engineers Australia believes that energy efficient housing designs such as the *Sustainable House* and the *Hot Humid House* need to be considered on a wider scale. The NSW government could establish standards for all new residential developments that incorporate significant reductions in energy consumption and the use of renewable energy. In particular, this could apply to all new public housing developments.

OTHER ACTIONS TO IMPROVE ENERGY EFFICIENCY IN NEW AND EXISTING RESIDENTIAL BUILDING

Engineers Australia's publication *Sustainable Energy Innovation in the Commercial Building Sector* makes several recommendations for improving energy efficiency that apply in residential developments, including:

- *Professional development*– The NSW government needs to provide funding for training programs for engineers and other professionals working in the building and energy sectors on sustainable development in residential housing. The aim of these programs is to assist with the development of procurement and building practices that take account of energy efficiency and greenhouse gas emissions throughout the process of residential building development.

- *Monitoring standards.* – The NSW government should ensure that standards set for energy efficiency in residential development through programs such as Energy Smart and BASIX are carefully monitored and reviewed. The NSW government should also lobby the Commonwealth government to provide national auditing of greenhouse gas emissions from residential buildings to determine the impact of energy saving programs

- *Funding for R&D* - The NSW government needs to increase funding for R&D for innovation in sustainable residential building design. This can help determine which sustainable housing designs could be affordable and appropriate for different NSW regions. R&D could also be conducted in energy efficient household appliances to help develop further innovation in this area.

- *Incentives for best practice* – The NSW government could provide incentives for best practice in sustainable building design such as special subsidies for building materials. Consideration could also be given for including sustainable building and energy efficiency in the NSW *Greenhouse Gas Abatement Scheme*, to allow the issue of abatement certificates for residential building developers who reduce greenhouse gas emissions.

- *Solar Hot Water Heating*- The NSW government could introduce mandatory installation of solar hot water systems for all new residential dwellings. Leichhardt Council has already enacted a similar measure for all new residential developments in its shire. Solar hot water is well established in Australia and is more energy efficient than electric or gas hot water systems.

A copy of the *Sustainable Energy Innovation in the Commercial Building Sector* is attached to this submission.

If you require further information on any aspect of our submission, please do not hesitate to contact me.

Yours sincerely

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Sydney Division
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SUSTAINABLE ENERGY INNOVATION IN THE COMMERCIAL BUILDING SECTOR

The Challenge of a New Energy Culture

The Institution of Engineers, Australia

Sustainable Energy Building and Construction Taskforce Report 2001

The Challenge

GHG emissions attributable to the built environment, particularly the commercial buildings sector, are rising rapidly and are forecast to continue to grow at significant levels.

Australia needs to take more direct, strategic action to achieve its goals for sustainable energy use and GHG emission reductions. Constraints in key policy, financial, taxation, regulatory and commercial regimes stand in the way of improved energy and greenhouse performance for the building sector, as do prevailing attitudes, market behaviour and knowledge.

There are many opportunities to reduce electricity demand via sustainable design, energy substitution and energy efficient initiatives. The technology and the know how to significantly reduce GHG emissions in the building sector are available. Current best practice confirms that the building engineering and design community can deliver dramatic improvements if supported by government, investors and the community. Both industry and government must more urgently address a range of policy, commercial and educational issues if Australia is to even begin to meet the challenge of halting growth in GHG emissions, let alone reducing them, in the commercial buildings sector.

There is an urgent need for government to commit to establishing mandatory energy performance objectives, practices and incentives, which will drive non-residential building stock toward this goal of 'greenhouse-energy neutrality'. Government, as client, owner and increasingly as a tenant, is in a unique position to lead in the realisation of this vision in its own building stock.

Barriers to Sustainable Building Practice

The integration of sustainable energy practice in buildings faces significant barriers. For instance, The interface between the commercial buildings sector and the energy marketplace is a major area of concern. Electricity market reform allows energy suppliers to offer their product to the market either at or below the marginal cost of production, which distorts customers' buying decisions in favour of the status quo.

The perception of commercial and technical risk impedes uptake of environmentally sustainable energy sourcing. Capital costs are often higher and investments need to be supported by full life costing to demonstrate value across a building's life cycle. At present, sustainable energy generated on-site, or locally from solar sources, cannot be sold back into the grid for green power rates of return. Incentives need to be provided to drive change.

Most State or local governments have building approvals processes in place for structural, fire and plumbing issues. However, few have similar requirements for energy or the achievement of ESD outcomes. A major challenge is to educate and encourage all those responsible for building approvals to apply the range of regulatory and technical tools that they can use in the approvals process. National coordination is required.

There is a lack of data for a designer, or purchaser or occupant, to assess how a building compares with some benchmark. There have been thousands of energy audits done over the past 10 years, but few attempts to make sense of the information. There is a need for comprehensive data collection, analysis and definition to develop guidelines for sustainable energy and model ESD outcomes. Australia needs case studies and demonstration of technologies.

Industry's Role and Directions

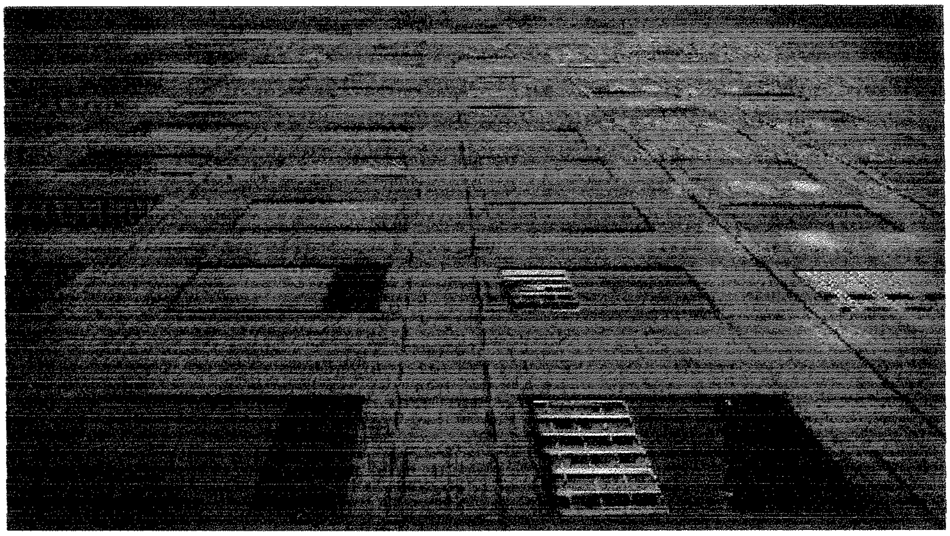
Industry is well positioned to drive energy innovation, provided it is given clear and coordinated policy directions and appropriate leadership and persuasion.

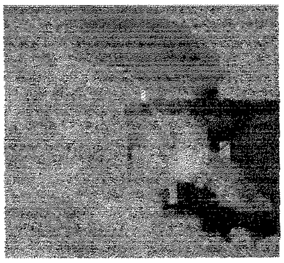
There is a growing number of tools, policy developments and resources that may encourage building owners to consider energy performance, to establish energy performance targets and reflect these in design and management decisions. However, an agreed national approach to measurement and rating of energy and greenhouse performance in commercial buildings is required. Australia needs to develop a rating system that embraces all environmentally sustainable aspects of design.

A copy of the report can be obtained from the Director, Engineering Practice, Institution of Engineers, Australia, 11 National Circuit Barton, ACT 2600, or contact (02) 6270 6525, e-mail mdwyer@ieaust.org.au. Alternatively, the report can be downloaded from www.ieaust.org.au/policy/publications.html

SUSTAINABLE ENERGY INNOVATION IN THE COMMERCIAL BUILDING SECTOR

The Challenge of a New Energy Culture



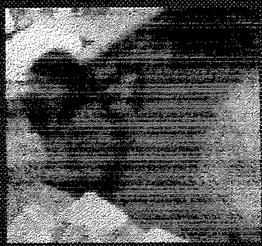


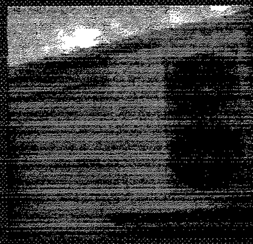
SUSTAINABLE ENERGY BUILDING AND CONSTRUCTION TASKFORCE REPORT
NOVEMBER 2001

REPORT SUMMARY

The Institution of Engineers, Australia

"Industry is well positioned to drive energy innovation, provided it is given clear and coordinated policy directions and appropriate leadership and persuasion."





Re-inventing the Building Design and Procurement Process

The delivery of more environmentally sustainable buildings requires a re-invention of the design and procurement process, both for new buildings and the retrofitting of existing ones. Developers take risks and expect returns, and investors too want a return - but traditional building development processes do not encourage life cycle assessment. Developers tend to focus design intent on outcomes that meet particular short-term market demands. Issues such as energy efficiency, occupant productivity and reduced GHG emissions do not receive proper attention. Mechanisms are needed that transfer the whole of life savings back into the market. Thus, increased market costs and savings can be distributed over a building's life cycle. Industry needs to adopt a life cycle cost approach instead of short term, 'development only' costing.

Governments must adopt the change mechanisms required for a reinvented process. Governments can and should lead by example. Performance-based contracting with financial incentives provided for one or more sustainability achievements should be normal government procurement practice. Government agencies should be directed to adopt environmentally sustainable design principles for all their building development and procurement, including public reporting, marketing and promotion of sustainable design.

Educating Building Sector Professionals

There is growing concern by educators about sustainability in the built environment. This is promising in light of anecdotal evidence from leading industry practitioners suggesting that many graduates have not been adequately exposed to energy efficient and sustainable design concepts and practices. Education and training for energy efficiency and GHG abatement in the building and construction industry are essential to the achievement of sustainable energy practice.

The Sustainable Energy Building and Construction Task Force of the Institution of Engineers, Australia has produced a report entitled "The Challenge of a New Energy Culture - Responding to the crisis in energy consumption and greenhouse gas emissions from non-residential buildings". The Taskforce was convened to explore avenues by which the building and construction sector might contribute to more sustainable energy practices and reduce greenhouse gas (GHG) emissions from this sector.

The Task Force recommends that the Commonwealth, State, Territory and local governments:

1) Improve awareness and understanding by applying increased emphasis and resources to educational and promotional programs, in order to alert all players in the building and construction industry to the rapid growth of GHG emissions attributable to the industry.

2) Accelerate the introduction of mandatory minimum energy performance standards into the Building Code of Australia, and introduce each energy-related component of a Code standard upon approval by the Australian Building Codes Board.

3) Ensure the initial minimum requirements in the BCA are not less than targets derived from the PCA Energy Guidelines for a particular location, and are, preferably, higher.

4) Articulate and implement a process to progressively and continuously increase the minimum mandatory energy performance requirements being incorporated into the BCA.

MORE RECOMMENDATIONS OVER

RECOMMENDATIONS CONTINUED

5) The Commonwealth to provide leadership and support for the development of an industry wide framework of mandatory and voluntary Codes of Practice, including
   a) investment in the development, coordination and promotion of a common and agreed national approach to energy and greenhouse performance ratings; and
   b) the industry Code of Practice to incorporate rating systems for energy, greenhouse and environmental performance.

6) Prior to the introduction of mandatory requirements in the BCA, all government agencies responsible for procurement and/or approval of development applications to require that:
   a) New buildings subject to approval from 1 January 2003, be designed, constructed and operated to deliver energy performance not less than the then accepted standard.
   b) All existing buildings to achieve nominated operating energy improvements upon current performance within preferably five but no more than ten years.

7) Integrate the reduction of national GHG emissions and the inclusion of externality costs more systematically within energy market reform.

8) Fully address key supply side reforms, including review of market charges, use of bilateral contracts, increased gas-fired electricity generation, renewable energy targets and facilitation of renewable energy use.

9) Facilitate the immediate introduction of a national requirement for all commercial buildings to undertake energy and greenhouse audits and to provide biennial energy and greenhouse emission performance reports to a national data collection and industry database

10) Demonstrate leadership in energy efficient best practice in the procurement, commissioning and operation of buildings, which they own and/or occupy. The Commonwealth, in particular, to give attention to the following:
   a) Systematic implementation of recommendations of the Auditor General's energy efficiency performance audit (Report Number 47).
   b) Publish the updated energy guidelines for Commonwealth-owned and leased non-residential buildings, ensuring that both energy efficiency and GHG savings auditing and reporting mechanisms are consistent with those being developed by industry.
   c) More directly and explicitly demonstrate that all agencies are implementing its Energy Policy, particularly with respect to energy auditing.
   d) Continue to work with industry to further identify, develop and deliver those management processes, professional accreditation systems and commercial documentation arrangements that encourage sustainable energy practice.
   e) Incorporate Qualification Based Selection, with energy and greenhouse performance criteria explicitly documented and prioritised in the selection processes for design and project management professionals on all government procurement projects.

11) Give due and immediate consideration to the introduction of a regime of financial incentives, 'ramped' over time, to encourage excellence in the pursuit of energy efficiency and GHG emissions abatement at the upper levels of performance in the built environment.

12) Allocate specific funding to professional and educational organisations to facilitate investment R&D of learning models and curricula materials for educators.

13) The Commonwealth to further enhance the AGO funding programs to provide support for the commercialisation and showcasing of innovative energy efficiency technologies, and for the development of educational resources and programs.

14) Support the implementation of information and training programs aimed at decision makers and market intermediaries, and training incentives for tenants and end-users to enhance awareness and assist these stakeholders to reduce energy needs and costs.

15) Resources to be made available to support research, documentation and promotion of financial modeling and assessment methodologies for commercial application.

A copy of the report can be obtained from the Director, Engineering Practice, Institution of Engineers, Australia, 11 National Circuit Barton, ACT 2600, or contact (02) 6270 6525, e-mail mdwyer@ieaust.org.au. Alternatively, the report can be downloaded from www.ieaust.org.au/policy/publications.html

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ENVIRONMENT DESIGN GUIDE

RESIDENTIAL SITE DEVELOPMENT – FOR ENERGY EFFICIENCY AND SUSTAINABILITY

Steve King and David Rudder

This is the companion Note to Residential Site Analysis and considers ways of maximising energy efficiency through layout of lots, roads and vegetation, and through manipulating housing densities to achieve maximum lot yield without compromising suburban quality.

1.0 DEVELOPMENT STRATEGIES FOR ENERGY EFFICIENCY

One of the principal areas in which energy savings can be achieved in the residential environment is through the use of the sun's energy for space and water heating. A well designed subdivision will maximise the number of lots which have good solar access.

1.1 Solar access

Solar access usually refers to the amount of sunshine penetrating north facing windows between 9 am and 3 pm in midwinter. Protecting the solar access of houses has important implications for overall site design.

In Australia's temperate regions, where the majority of the population lives, good solar access means '. . . *plenty of unobstructed sunlight available to north facing windows in winter*' (Energy Victoria 1994). In the tropical far north, however, good solar access might best be described as *no* solar access.

1.2 Street and Lot orientation

The orientation of lots is an important factor in designing an energy efficient subdivision, and directly relates to street orientation.

East–west streets provide the best orientation of lots for solar access to passive design dwellings. Because the long axis of the lot runs north–south, there is little danger of overshadowing from a house to the north, although this depends on the gradient and orientation of any slope.

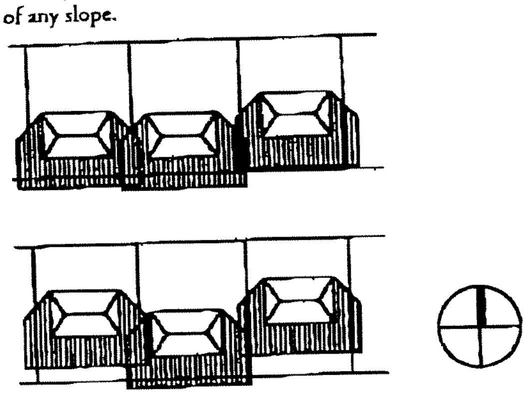

Figure 1. East-west streets
N.B. Houses on north side of the street may have reduced setback.

In comparison, lots on north–south streets may need to be of increased width, to prevent overshadowing and to create a useable and private north facing yard.

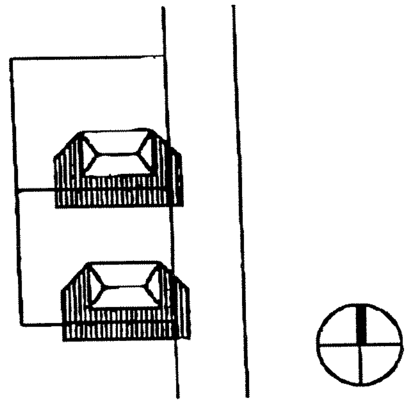

Figure 2. North-south streets
N.B. Lots may need to be widened.

In all cases, the house type should be matched to the lot in order to maximise the energy savings of the house.

1.3 Allotment shape

Most subdivisions will contain a range of lot shapes. A preponderance of rectangular lots has been found to give the best solar access to the greatest number of lots in a subdivision. Rectangular lots are also most suitable for maximising lot yield and are a good shape for small lots.

1.4 Allotment size and density

The sizing of lots for solar access must be considered in conjunction with the effect on density. If density is drastically decreased by the desire to achieve solar access then the *overall* energy efficiency of the site may be compromised.

Allotments between 450 m^2 and 500 m^2 are considered to be adequate for low density development. However, these dimensions should relate to the shadows cast by dwellings in different situations, and on different slopes.

1.5 Reducing allotment size

Simply reducing allotment size can lead to energy savings from shorter roads and services, and from increased site yield. There are a number of approaches to reducing allotment size.

The BDP Environment Design Guide is published by The Royal Australian Institute of Architects

reliance on air conditioning, and markedly improve outdoor comfort. Landscaping provides an important opportunity to control solar gain by shading buildings and ground surfaces.

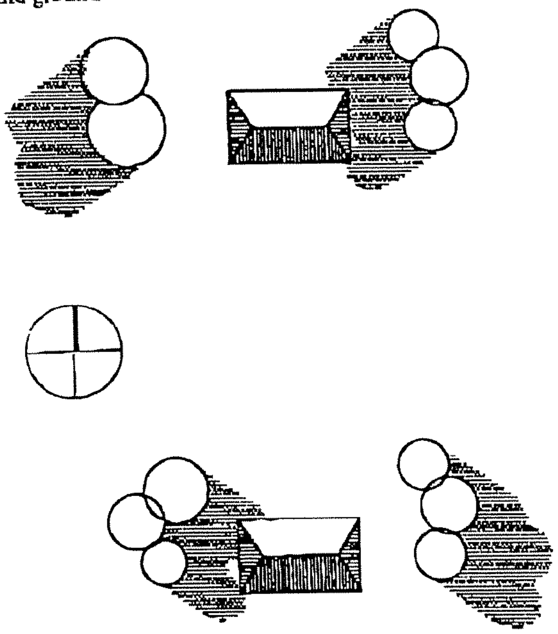

Figure 4 . Shading from morning and afternoon sun

Plants and grasses also reduce the heat load on exposed surfaces by locally obstructing the passage of solar radiation. By reducing the amount of solar radiation reflected from such surfaces, they further reduce the solar load on adjacent buildings.

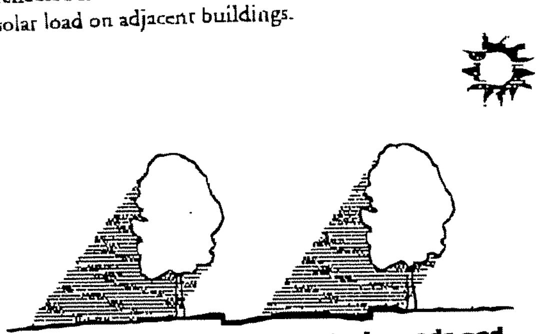

Figure 5. Dense canopies shade roads and pathways

Vegetation also helps lower the surrounding air temperature by evaporative cooling as a result of transpiration.

1.8 Planning for air movement

In temperate and warm arid regions, hot winds during summer can create a need for energy intensive means of cooling and increased water usage. In winter, cold winds can increase heat loss from houses and consequently raise the demand for energy intensive heating.

Air movement affects the perceived temperature and greatly influences comfort. In the warm humid climate of Australia's tropical and subtropical regions, subdivision design which provides cooling breezes can often eliminate the requirement for air conditioning for much of the year.

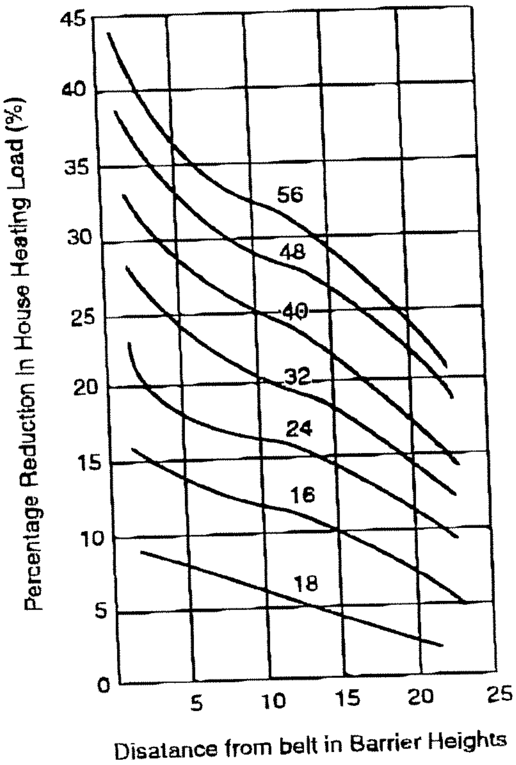

Figure 6. The influence of a shelterbelt on heating loads, Robinette

The graph below shows the percentage reduction in heating loads for varying distances from the shelterbelt in different windspeed conditions.

In most locations the predominant winter winds come from a different direction to those of the predominant summer winds, so that blocking the winter winds does not conflict with the funnelling of cooling breezes.

Shelterbelts consisting of trees, shrubs and other vegetation appear to provide the most effective form of wind protection for groups of dwellings and large sites. Shelterbelts in general should be located perpendicular to prevailing winds but can still be effective at a 45° angle to the wind direction.

1.9 Street layout

The layout of streets within a subdivision must reconcile the need to maximise the number of lots having good orientation with the need to respect the rights of the pedestrian. Within residential subdivisions, the pedestrian and the cyclist should be given priority in the planning of transport networks.

Routes which link residential areas with schools, shops and other community services along easy gradients should be identified early on, and dedicated for use by pedestrians and cyclists. Depending on traffic volumes, parts of these routes may be used for both cars and pedestrians as shared roadways.

frequency of morning fogs, a slight easterly orientation may be preferred in order to let some sun in for an early warm-up in winter. East and west orientations may also be desirable, but only if suitably placed vegetation or other structures are used to screen unwanted summer heat gain. South windows should generally be designed for daylight or ventilation requirements, and rarely constrain adjacent development except on privacy grounds.

A generally accepted measure of solar access for energy efficiency is the period between 9 am and 3 pm in mid-winter. For example, in Sydney (latitude 34° S) the azimuth of the sun in midwinter is approximately 45° at 9 am and 3 pm, and the altitude of the sun at noon is approximately 30°. These limits define a *solar access cone* which should not be obstructed by buildings or vegetation.

There are two fairly well documented ways of protecting solar access: *solar envelopes*, and *shadow masks* used in conjunction with a *solar access butterfly*.

2.3 Solar envelopes

A *solar envelope* defines the limiting volume for development of a site, to provide nominated levels of guaranteed solar access to adjacent sites, and is defined as:

> *The largest volumetric container over a land parcel that allows solar access to all adjacent neighbours within useful time constraints.*

Such an envelope is generated using the altitude angles of the sun at nominated times to establish imaginary planes sloping inwards from their base on the boundaries of the site.

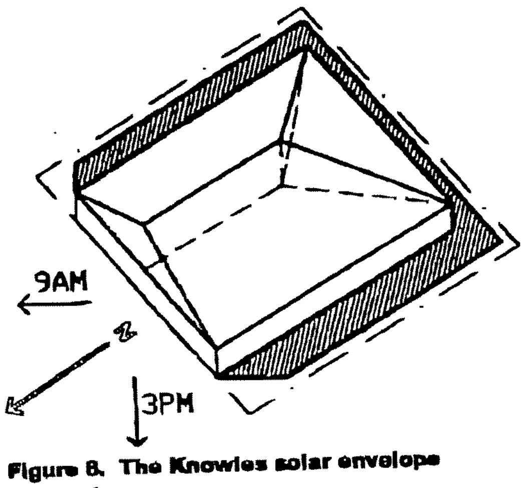

Figure 8. The Knowles solar envelope concept

The envelope thus obtained is designed for whole site solar access. Differing levels of solar access can be achieved using the solar envelope concept, by raising or lowering the height of the base plane from which sloping planes are generated.

The *solar fence* concept is a modification of the solar envelope approach. The allowable building envelope is regulated by an indirect method: no development may take place on a site which casts greater shadows onto adjacent blocks than imaginary fences of given heights, placed on the boundaries of the site.

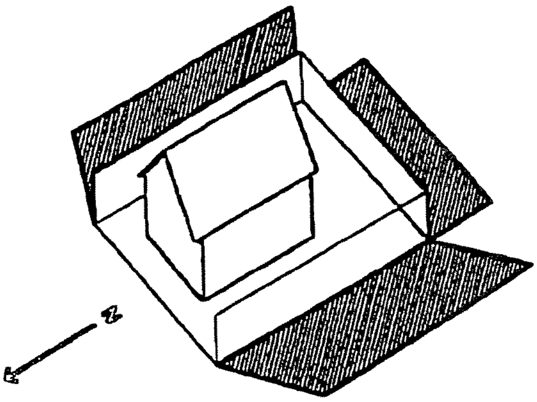

Figure 9. The solar fence concept

2.4 Shadow masks

In order to consider topography and house orientation simultaneously, *shadow masks* and *solar access butterflies* can be used. Using the shadow mask and butterfly principles, it is possible to design large housing estates in plan to ensure solar access to each dwelling.

The shadow mask is a composite of the shadows cast by a known or likely building volume, at 9 am, noon and 3 pm at the winter solstice (22 June), taking into account corrections for the slope of the site. A mask is established for each dwelling in turn for the likely position in which it is to be located. The limits of this shadow envelope determine how close buildings may be placed together on any given slope, without casting shadows on each other at any time of year.

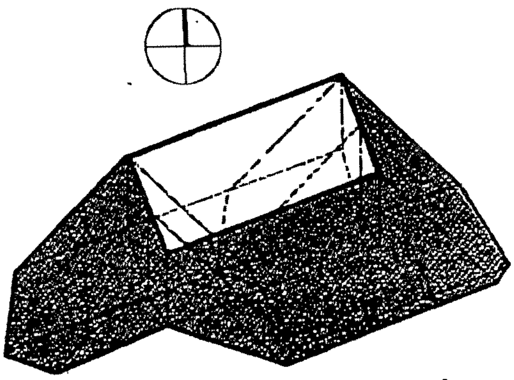

Figure 10. The developed shadow mask

2.5 Solar access butterfly

The solar access butterfly is a method which enables vegetation or other structures to be positioned around a house without shading the north wall in winter. The butterfly identifies zones where obstructions may not be taller than a nominated height for that distance from the north wall.

Water

- Allow for early construction of temporary sedimentation basins. See also *Multiple-use drainage systems*.
- Seek out natural features which could be included in a natural on-site stormwater treatment system: creeks, natural depressions or drainage lines, wetlands, floodways. Plot the relationship of these to the proposed development area.
- Investigate drainage connections upstream and downstream of the development area.
- Calculate the scale of the natural drainage regime in relation to proposed population density and the catchment development feeding the system.
- Where possible, design a multiple-use drainage and treatment system, including gross pollutant traps (GPTs) and detention basins which incorporates natural site features and which only modifies them where necessary to enable the system to operate under the full range of loads.

Bushfires

- Commission a bushfire management plan for sites adjoining urban bushland, national parks and other hazards. Consider allocation of buffer zones, perimeter formed roads and increased lot sizes where appropriate.

Winds

- Use tree shelterbelts to protect from unfavourable winds. Place perpendicular to wind direction.
- Avoid orientating streets in the direction of unfavourable winds.
- Design streets and broad planting to funnel cooling breezes. In warm humid climates, avoid 'checkerboard' layout of houses to minimise 'wind shadows'.
- If houses in cool climates must be located in exposed areas, consider use of attached dwellings, which have reduced surface areas.

Density

- Consider cluster housing, building to the boundary, and attached dwellings as strategies for increasing dwelling density.
- Maximise number of near-rectangular blocks for detached housing.

Solar access

- Nominate the standard of solar access to be achieved for individual allotments: *whole site, north wall or roof access*.
- Maximise east-west streets to enable favourable allotment design for solar access.
- Identify opportunities for higher density housing on north facing slopes.
- Lay out allotments to prevent shading of north facade of dwellings between 9 am and 3 pm in midwinter in temperate regions.
- Increase allotment sizes on south facing slopes, and allotment widths on north-south streets, to maximise solar access.
- Establish shadow masks of typical houses.
- Establish controls on shading by vegetation, using solar access butterfly.

Roads and pathways

- Consider location and type of street trees for summer shading of pedestrians, and paved areas generally.
- Identify routes with easy gradients for dedicated pedestrian and cyclist use.
- Establish a hierarchy of street reservation and pavement widths to minimise paved areas. Incorporate appropriate controls over vehicle speeds to encourage shared use of pavements and reservations.
- Minimise impervious areas through reduced width roadways, compact house forms and elevated housing in tropical, sloping sites.
- Reduce vehicular pavements. Use hammerheads instead of conventional cul-de-sac roadway terminations. Maximise the number of shared driveways.
- Design services for common trenching. Incorporate one way falls and central stormwater designs in roadways wherever practicable.
- Maximise use of porous pavements.

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