

Australian methodologies for successful implementation of building energy efficiencies

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Abstract

This paper outlines Australian energy initiatives such as the GGAP (Greenhouse Gas Abatement Program), NFEE (National Framework for Energy Efficiency), ABGR (Australian Building Greenhouse Rating Scheme), Green Star, NABERS (National Australian Built Environment Rating System), and MRET (Mandatory Renewable Energy Targets). This paper will not compare the Australian and the European Union's energy directives but will give the reader who is familiar with the EU directives another perspective and a view of what initiatives are being implemented in Australia.

Case studies are presented that will highlight the successes of various implementation methodologies into public and private buildings and how sustainability programs and ratings tools have influenced building designs and efficiencies. One particular case study will show how thirty nine energy efficiency and sustainability projects were rolled into one with a guaranteed outcome that delivered a risk free solution to a large city council whilst achieving their community and greenhouse obligations.

The case studies will demonstrate the use of new energy efficiency technologies, passive technologies, water initiatives and innovative building fabric designs. Measurement and verification techniques and reference to the Australasian Energy Performance Contracting Association (AEPCHA)

best practice guide to measurement and verification of energy savings will show how different energy conservation measures can be monitored for energy use, efficiency, guaranteed outcomes and achievement of particular Australian energy efficiency initiatives.

Introduction

As in all parts of the world, energy consumption in Australia is growing rapidly. Although Australian greenhouse gas emissions are about 1.6 per cent of world emissions and are too small for Australia to make a difference on its own, Australia is committed to pursuing effective strategies to reduce climate change.

Projections by the Australian Bureau of Agriculture and Resource Economics (ABARE) show that electricity consumption alone is expected to grow by 52 per cent by 2020¹. Commercial electricity consumption is growing at a faster rate than the average at approximately 57 per cent. According to the Green Building Council of Australia, commercial buildings produce 8.8% of Australia's greenhouse gas emissions, with office buildings and hospitals using 40% of that total.

Australians spend the equivalent of 29.5 billion Euro on energy each year. Demand for energy in Australia is projected to increase by 50 per cent by 2020, and the energy industry has estimated that at least the equivalent of 22 billion Euro in energy investments will be required by 2020 to meet the nation's energy needs.² Current electricity

1. "Spotlight on Energy Efficiency" – EcoGeneration Magazine, April/May 2004

generating capacity is waning, hence the need for demand management, energy efficiency and abatement programs.

Australia is the world's fourth largest producer, and largest exporter, of coal. Australia supplies 8 per cent of the world trade for liquefied natural gas, and possesses 40 per cent of the world's low-cost uranium reserves. Our known oil reserves are significant, but are projected to decline in the absence of new discoveries. Australia has significant wind and solar resources, and limited large hydro resources. Fossil fuels are Australia's major energy sources: oil, black coal, natural gas and brown coal provide 35, 28, 19 and 13 per cent respectively of primary energy needs. Renewable sources currently supply 5 per cent.³

It is estimated that commercial buildings will double their energy use and greenhouse emissions from 1990 to 2010 from 32 Mt in 1990 to 62 Mt by 2010 (AGO 1999). Current projections are for this to reach 67 Mt by 2010. The Energy White Paper (Securing Australia's Energy Future 2004) predicts 21 billion Euro in infrastructure investment is required by 2020 to meet Australia's growing energy requirements.

Australia is divided into five States and two territories and, apart from Federal Government programs, the approach to our sustainable future is driven on a State by State approach rather than a national integrated solution. All of the different States are developing and implementing different approaches to energy efficiency and sustainability. Apart from Federal Government initiatives there is no uniformity in relation to energy efficiency, sustainability and programmes throughout Australia. Each State has an "energy authority" that is responsible for developing programs and initiatives for sustainability within that respective State. There is very little dialogue between these State energy authorities and this causes a huge diversity of programs and duplication of development. No consistency of purpose exists between the States and, because of interstate rivalry, successful programs in one State are not adopted in another. The key aspect to be gained from the Australian individual State agency structure is that a cohesive approach with effective communications, cross pollination and multiple program ownership is essential for widespread success in sustainable effectiveness.

The Federal Government is committed to energy conservation and sustainability and has set up an Australian Greenhouse Office. As an indication of the Government's conviction to reduce greenhouse gas emissions the Australian Government has allocated more than 0.59 billion Euro for greenhouse gas abatement. Major elements are detailed later in this paper.

The Australian Government's 2004-05 Budget included programmes and policy amendments to further assist in the greenhouse area. The budget release will assist Australians in reducing their greenhouse gas emissions, develop global responses to greenhouse issues, actions and policies to climate change and help expand the opportunities for abatement.

The new energy efficiency regulations in the Building Code of Australia will define minimum energy efficiency

standards for all new buildings from 2006. These cover all aspects of building including the buildings itself and the services.

Australian Government Initiatives and Programmes

The Australian Federal Government has many programs outlined to reduce energy usage and improve its greenhouse gas abatement position. It is impossible to detail all programs in this paper, but some of the major programs are outlined below.

GREENHOUSE CHALLENGE

The Greenhouse Challenge was launched in 1995 and is a joint initiative between the Commonwealth Government, commerce and industry to abate greenhouse gas emissions. Participating organisations sign agreements with the Government that provide a framework for undertaking and reporting on actions to reduce emissions.

A high percentage of Australian organizations have signed up to the greenhouse challenge. These include Australia's largest businesses down to very small private companies. The Greenhouse Challenge has excellent coverage of emissions in some key areas including 100 per cent coverage of aluminium and cement production, 98 per cent of oil and gas and 91 per cent of coal mining.

An independent evaluation of the voluntary program has demonstrated that the Challenge has been highly effective in achieving greenhouse gas emissions abatement, and in building the capacity of both Government and industry to identify, monitor, manage and report greenhouse gas emissions. Many, many Australian and International companies are instigating energy efficiency and sustainability projects as a result of their direct involvement in the Greenhouse Challenge.

GREENHOUSE GAS ABATEMENT PROGRAM GGAP

GGAP is a major Commonwealth Government program and is expected to help Australia meet its long term greenhouse and environmental targets. An equivalent of 236 million Euro has been allocated to progressing and implementing the program. GGAP is reducing Australia's greenhouse emissions and has an immediate target for large scale and cost effective sustainable projects.

GGAP is a bidding program and is available for projects that will be expected to result in quantifiable reductions and additional abatement that would not be expected to occur without GGAP funding. Priority is given to projects that will deliver abatement exceeding 250 000 tonnes of carbon dioxide per annum. Projects that do not meet this threshold but meet other criteria to a high degree may be selected.

GGAP projects with a low cost for each tonne of emissions that is reduced or avoided are prospective funding recipients. GGAP utilizes a competitive selection process based on tonnes of reasonably assured and additional carbon dioxide estimated to be abated

2. Australian Government White Paper "Securing Australia's Energy Future"

3. Source: Data from ABARE Australian energy: National and state projections to 2019-20, 2003

Projects funded under GGAP are expected to provide complementary benefits, for example, opportunities for rural and regional Australia, ecologically sustainable development, employment growth, the use of new technologies and innovative processes, and non-government investment.

GGAP is targeted to deliver over 10.3 Mt of abatement prior to the year 2012.

FEDERAL MANDATORY RENEWABLE ENERGY TARGET MRET

MRET is a key factor in the renewable energy industry in Australia. MRET was set by the Commonwealth Government in the year 2000 and places a legal liability on wholesale purchasers of electricity (retail electricity companies) to purchase an additional 9 500 GWh of renewable energy annually by 2010. This figure equates to 2% of national electricity consumption in 1997. This legislation has encouraged the development of renewable energy businesses in Australia and provides a guaranteed market for the sale of electricity generated through renewable sources.

A range of energy sources and technologies are eligible under the MRET including hydro, wind, solar and various biomass sources, with provision for emerging technologies not yet commercialised in Australia such as wave, tidal and geothermal energy. MRET involves the creation of a market based trading scheme for Renewable Energy Certificates.

After over three years of operation, an independent review panel found that MRET is meeting its objectives, with industry taking up the challenge of delivering new renewable energy projects. Under MRET, the interim targets for the first two years have been exceeded and the industry is well on the way to meeting targets for the third and fourth years. Around 190 power stations that run on renewable energy have been accredited across Australia. This is a significant investment that is not only delivering clean energy to Australians but also regional development and employment growth.

MRET is expected to deliver 6.5 Mt of abatement by the year 2010 and drive over 1.2 billion Euro in investment in new renewable energy generation. A review of the National Energy Markets recommended an increase in the MRET target from 2010 to 2020. While the Commonwealth has rejected the recommendation State Governments are currently considering State initiatives to increase these renewable energy targets.

CITIES FOR CLIMATE PROTECTION CCP

CCP Australia is a partnership between the Australian Greenhouse Office (AGO), the International Council for Local Environmental Initiatives (ICLEI), the founder of the CCP Campaign internationally, and local Australian Governments.

The program is funded through a government commitment of 7.5 million Euro over 5 years

Over 175 local councils which represent over 70% of Australia's population are participating in CCP Australia. According to Government sources, the Australian program has had the fastest uptake and largest participation of local governments anywhere in the world.

The CCP program has been extremely successful throughout Australia as a vast majority of council are participating in the plan. The councils are varied in their approach to energy efficiencies throughout their buildings as some are going down the traditional audit, design and implement path whilst many others are conducting energy performance contracts. Some councils are implementing only high return projects whilst many others are integrating projects, such as solar collection, that have extremely long payback periods. Quite often these long payback period projects are bundled in with short payback period projects under an energy performance contract to show the broader community that the councils are active in energy efficiency and sustainability.

GREEN POWER

Green Power is a scheme whereby customers voluntarily pay a surcharge on their power bills in order to source their electricity from accredited renewable energy sources. The Green Power scheme operates nationally, with participation by electricity retailers in Victoria, NSW, Western Australia, Queensland, South Australia and the ACT.

Electricity customers who wish to participate in the Green Power scheme can contact their electricity retailer and purchase the particular Green Power product offered by that retailer. Currently there are about 63 000 Green Power customers nationally, with approximately 20 000 of these in Victoria. The emissions abatement achieved through the national program provides savings of about 400 000 tonnes of CO₂ per annum.

Determination of eligibility of energy sources for Green Power is made by a national accreditation body. Electricity supplied under the Green Power scheme cannot be counted by retailers in meeting requirements under the Mandatory Renewable Energy Target (MRET).

NATIONAL FRAMEWORK FOR ENERGY EFFICIENCY NFEE

In November 2002 the Ministerial Council on Energy (MCE) endorsed a proposal for the development of a (NFEE) to determine future directions for energy efficiency policy and programs in Australia.⁴

- Nine energy efficiency policy packages included in Stage One of the National Framework are:
- Residential Buildings
- Commercial Buildings
- Commercial/industrial energy efficiency
- Government energy efficiency
- Appliance and equipment energy efficiency
- Trade and professional training and accreditation
- Commercial/industrial sector capacity building
- General consumer awareness
- Finance sector awareness.

The specific measures being considered in each of these policy packages are about improving the energy perform-

4. "Five Steps Towards Energy Efficiency" – Ecogeneration Magazine Oct/Nov 2004

ance of building stock; driving increased awareness among consumers, energy managers and the finance sector; and improving skills training, accreditation and standards. The policies are still being developed and finalised so it is too early to determine the success of the program but indications are that it will be widely accepted by both Government and private bodies.

GREEN STAR

Green Star is an energy and environmental rating tool suitable for new and refurbished commercial office buildings and was developed by the Green Building Council of Australia.⁵ Green star evaluates not only energy, but other environmental criteria:

- Energy Management
- Indoor Environment Quality
- Transport
- Water, Materials
- Landuse and Ecology
- Pollution and Innovation

Within each category, credits are awarded where specific levels of performance are achieved, or certain defined policies and procedures are adopted.

Once all the credits within each category have been assessed, a percentage score is calculated. Every category is weighted to arrive at a single score, which is then converted into a star rating. The weightings vary from state to state throughout Australia, to reflect differing environmental concerns across the Australian continent and were derived from a range of scientific and stakeholder opinions.

Only buildings that achieve a rating of four, five or six stars will receive official certification from the Green Building Council of Australia.

Experience has shown that this rating tool is very expensive and time intensive to use, very expensive and difficult to implement elements to achieve credits and is open to interpretation. The rating tool is measured against design elements of new and refurbished buildings and quite often it is possible for the finished building to differ substantially from the design concepts utilized in the evaluation process. Criticisms include a lack of actual measurement of energy performance as the suite of tools only model energy performance without verifying actual performance.

AUSTRALIAN BUILDING GREENHOUSE RATING SCHEME ABGR

ABGR is a nationwide accreditation scheme for office buildings and office tenancies that provides a star rating of the facility within a scale one to five. The higher the star rating the more energy efficient the facility will be. The rating is based on actual energy consumption over a one year period and inputs energy usage (electricity, gas and solid fuels), hours of operation, floor space (net lettable area), number of staff and number and type of computers. Where 12 months data is unavailable (in new buildings for example) a commitment

agreement is entered into and this allows a building owner to promote the star rating immediately.

The ABGR was developed by the Sustainable Energy Development Authority (SEDA) of New South Wales and has been expanded to operate nationally. It rates the actual performance of buildings, based on energy consumption data, and awards a star rating on a scale of one to five, where 2.5 stars is considered the current industry average and five stars is exceptional.

ABGR is a fee-based rating system and must be obtained from a trained, qualified and accredited ABGR provider. Once a building owner or tenant has had their facility rated by an accredited rater the owner can promote their ABGR rating and use the ABGR logo on advertising and marketing material.

Commonwealth Gov requirement for 4.5 star for new buildings and green leases for annual 4.5 star ABGR rating. ABGR is now the most widely used and recognised rating tool and is becoming extremely popular among building owners, tenants and facility managers.

NATIONAL AUSTRALIAN BUILT ENVIRONMENT RATING SYSTEM NABERS

NABERS is another environmental rating tool for commercial buildings and was designed to take into account the landlord/tenant split which can provide base building rating, tenancy rating or whole of building rating. The original development of NABERS considered existing tools such as the UK's BREEAM, the USA's LEED and Canada's Green Building Tools, as well as other systems that have been developed locally.

Nabers uses star ratings, set in half star bands between nought and five stars, where 2.5 stars represents current conventional practice, and five stars represents current best practice. The main point difference between NABERS and Green Star is that its ratings are based on actual measured performance, rather than prescriptive design parameters. NABERS rates the buildings not only on energy but also on environment factors such as indoor air quality, waste and toxic materials, sewage, transport, occupant satisfaction etc.

NABERS is not as widely used or recognised as ABGR and Green Star and is only used when a more holistic environmental approach is required. The star ratings of ABGR and Green Star have influenced building owners to use these more than NABERS mainly because of the marketing value and ease of comparison with other buildings.

Case Study – 40 Albert Road

The greening of 40 Albert Road will see a typical inner suburban Melbourne office block built in the 1980s transformed into an environmentally friendly and sustainable office complex. The building is a four storey office building with 2 levels of carpark and a ground floor reception area. The owner of the building is a member of the greenhouse challenge and as part of his commitment under the greenhouse challenge will transform the building to meet the highest standards of energy efficiency and sustainability. The project will be

5. www.gbcaus.org

benchmarked against Government rating tools. Greenstar, ABGR and NABERS are being used to rate the building.

The project will demonstrate minimum energy and water performance standards to minimise outgoings and running costs and demonstrate that *going green is commercially viable* and is expected to be completed by mid-2005. Work in progress can be followed on the building's web site.⁶

One of the prime aims in the renovation of 40 Albert Road is to achieve a 6 star Green Star rating (the highest available) and a 5 star ABGR rating (also the highest available). To achieve any Green Star rating the building must first have at least a 4 star ABGR rating. The ABGR rating is primarily energy focused whilst Green Star covers the design intent of the energy and environmental issues, and NABERS measures the actual performance of the energy and environmental issues. It is necessary to engage external and independent consultants to carry out the ratings and submit rating applications for approval. This is a costly exercise. Green Star consultancy and application costs were approximately 65 000 Euro whilst ABGR cost 8 000 Euro. NABERS will be completed after the building has been occupied for 12 months and it is expected to cost in the order of the 8 000 Euro.

Commercially, the criteria for selection of individual energy and environmental initiatives into the project was a 5 year payback or better. Other measures, such as the inclusion of a fuel cell, photovoltaics and rainwater harvesting produced much longer payback periods, but were included to show off the technology and add leading edge equipment to the building. It was felt that the marketing value from these measures would be beneficial and would offer returns in other areas such market exposure, image and publicity.

The initiatives included in the building are as follows.

ELECTRICAL ENERGY CONSERVATION MEASURES

The building is to be fitted out with extremely efficient lighting with high output luminaires, high frequency ballasts and a "world's best practice" lighting control system. The lighting control system has occupancy based switching and dimming, daylight dimming, internal dimming (to compensate for initial overdesign), zone and local control and communications to the HVAC system. When the lighting control system occupancy detectors deem an area to be vacant for a certain period of time the HVAC system will operate accordingly, thus saving large amounts of energy normally associated with heating or cooling empty spaces.

The building will have a very advanced monitoring, verification and metering system that will allow instant internet access to the building's energy usage at any point in time or historically. This system will interrogate energy usage down to individual lighting and power circuit level and will monitor detailed energy usage of all electrical circuits, HVAC operation by small zones, lighting usage by zones, photovoltaic energy feedback. The system will be used to verify the operation and effectiveness of all the energy initiatives throughout the building.



HEATING VENTILATION AND AIR CONDITIONING ENERGY CONSERVATION MEASURES

The building utilises a gas driven 3 pipe VRV air-conditioning system that is considerably more environmentally friendly (as it uses gas instead of electricity) than a normal electrically driven system together with liquid dessicant technology to pre-treat the outside air for humidity control which also reduces energy and airborne contaminants and particles entering the building. A dedicated tenant's general exhaust riser is provided to all tenancy printing/photocopying room/areas. Automatic natural ventilation louvers have been coupled up to the HVAC system and the building management system. The lift has been retrofitted with variable speed high frequency drives and an energy conscious microprocessor control system.

THE BUILDING ENVELOPE

The building renovation has included many building design features to reduce energy consumption. These include external shading with internal manual blinds, high performance glass and double glazing, automatic natural ventilation louvers, skylights on upper floors and a ducted vacuum cleaning system.

WATER

Although not directly linked to energy usage, except for hot water, many water initiatives have been included in the building design. These include rainwater collection and re-use, grey water re-use, solar hot water, waterless urinals and flow restrictors.

MONITORING AND VERIFICATION OF ENERGY SAVINGS

Energy usage for the building will be measured and monitored with a series of meters spread throughout the building that will allow instantaneous data readings and historical readings in 15 minute intervals of electrical, gas and water use. The metering data will be accessible over the internet (password protected) and will be accurate enough to allow on-selling of power usage to individual tenants in the build-

6. www.ourgreenoffice.com

ing. The metering system will also be used to verify the predicted energy savings calculated prior to commencing the project. This monitoring and verification process is being conducted in accordance with the best practice guide of the Australasian Energy Performance Contracting Association (AEP-CA)⁷. This best practice guide sets parameters for installing, reading and reporting energy usage in facilities that undergo energy efficient upgrades. The guide is a comprehensive tool that provides a user with the ability to correctly install and utilize energy measurement devices, reduce financial risks associated with verification of energy savings and information to manage plan and implement monitoring and verification programs.

Electrical energy meters have been installed on every electrical switchboard throughout the building with sub-meters installed on the lighting and power sections of each switchboard. One typical tenant switchboard has meters on every lighting and power sub-circuit and to provide detailed energy usage patterns of individual lighting and power devices. Gas usage on each individual section of the building is individually metered as is the water (clean, stormwater reuse and grey water).

BUILDING PERFORMANCE

The building was given a 3 star ABGR rating prior to any work being carried out. The electricity consumption prior to works was 208 MWh. Gas was not connected to the building initially. After installation of all the energy conservation measures listed above, it is predicted that the annual electrical energy usage will drop to 40 MWh. Gas has been connected to the site and will use 245 000 MJ/Yr. The amount of CO₂ generated as a result of running the building has been reduced from an annual production of 277 000 kg to 142 000 kg. In percentage terms, it is calculated that the building's energy usage will drop by 45% and will result in a cost saving of approximately 9 500 Euro. The cost to supply and install the energy conservation measures over and above standard practice upgrade is approximately 225 000 Euro. This figure gives a very misleading picture of the success of the project as photovoltaics and the amorphous solar cells were extremely expensive and have grossly distorted project payback figures. These two items were included to showcase leading edge technologies, not for pure commercial and financial considerations. Other inclusions which have distorted payback periods such as the high performance glazing were included to improve the working environment and the staff amenity within the building. In general most energy conservation measures have returned a 5 year payback or better.

Case Study – Hornsby City Council

As part of its commitment to the Cities for Climate Protection program, Hornsby Shire Council initiated a major program of works to improve energy and water efficiency as well as to increase use of renewable energy. The council was also influenced by other Australian Greenhouse Office initiatives

such as the greenhouse challenge and by NFEE policies. Energy performance contracting was identified as the best route to achieve actual energy savings and to implement energy efficiency and renewable initiatives under the CCP.

Thirty nine separate energy efficiency projects were identified under the EPC process and all these were bundled together under the one energy performance contract. The EPC upgrade covers all of the council's major sites including the Administration Building (four levels), Council Chambers, Works Depot, three Aquatic Centres, Nursery, Senior Citizens Centre and two Libraries. Water conservation measures are also installed across the extensive range of parks and gardens.

Two solar (photovoltaic) power generation systems are being installed, at a community centre and the Council's nursery. Although these projects will have a longer-term payback, they allow the Council to demonstrate publicly their commitment to renewable energy and greenhouse gas reduction, and to raise awareness of energy saving practices in the community.

The Council's initiatives have been financed through an internal loan from their own funds, with the loan to be repaid using the savings guaranteed by the project.

ENERGY CONSERVATION MEASURES

Energy Conservation Measures (ECM's) in the project included:

- Gas heating
- Solar heating
- Swimming pool blankets
- Tuning refrigeration
- Photovoltaic power generation
- Energy efficient lighting
- Occupancy based lighting control system
- Daylight dimming and controls
- High efficiency boilers
- Storm water collection and re-use
- Water flow restrictors
- Spring loaded taps
- Power factor correction
- Heat pumps

According to Hornsby Shire Council's Rima Lauge-Kristensen, one of the main attractions of going with an EPC was that it enabled 'a big sweep'. "We could implement a lot of measures in one hit", she says, "including some which, by themselves, couldn't be justified financially."⁸

The project is saving the Council approximately 104 400 Euro per year, and is reducing greenhouse gas emissions by more than 900 tonnes annually which is the equivalent to taking 200 cars off the road in Australia.

7. "AEP-CA Best Practice Guide" – www.aepca.asn.au/documents/BPGtoMeasurementandVerificationofEnergySavings.pdf

8. Rima Lauge-Kristensen (Facility Manager) from Hornsby Shire Council.

Conclusions

Government programs in Australia are having a profound effect on the energy efficiency of buildings and facilities throughout Australia. These programs influence building owners and occupiers at many different times and stages of building development. The Greenhouse Challenge is a program that sows the seed of energy efficiency and sustainability in the minds of all owners and occupiers, from the chief executive of the largest company down to the individual floor workers of very small organisations. The Greenhouse Challenge sets the framework and stimulates the interest in greenhouse and efficiency issues. Once this seed is sown and starts to germinate, the building owners and occupiers look further for tools to assist in achieving goals and targets and it is quite often these tools that prove the catalyst for implementation and fulfilment of energy efficiencies.

Government agencies are now mandating that their buildings (owned and leased) perform to energy efficiency standards whilst private companies are also embracing the concept of building rating tools for their buildings and tenancies. The drivers behind the decisions to rate buildings and become involved in energy programs are three fold. Governments and private companies are making commitments (generally under the Greenhouse Challenge) and are becoming morally obliged to meet energy efficiency and greenhouse targets. Secondly, Government and private companies are using greenhouse strategies and rating tool results as marketing tools to enhance the image of their organisations. Finally, and most importantly, a key driver to energy efficient implementation is the financial gain to be made from energy savings.

Glossary

ABARE	Australian Bureau of Agriculture and Resource Economics
ABGR	Australian Building Greenhouse Rating
AEPCA	Australasian Energy Performance Contracting Association
AGO	Australian Greenhouse Office
CCP	Cities for Climate Protection
GGAP	Greenhouse Gas Abatement Program
ICLEI	International Council for Local Environmental Initiatives
MCE	Ministerial Council on Energy
MRET	Mandatory Renewable Energy Target
NFEE	National framework for Energy Efficiency
NABERS	National Australian Built Environment Rating System