21st Century Energy Management

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Synopsis

Staying on top of the technology, the "people issues", portfolio energy management, energy codes – mandatory *and* voluntary? Energy or ESD? - Energy management for Facilities Managers seems to have become a complex task.

This paper draws on many years' experience in successfully managing energy and environmental issues for some of Australia's largest commercial property energy users. It provides practical approaches to establishing effective energy management regimes for single facilities or large multi building portfolios and shows how to harness the technology, begin to tackle the ESD challenge and put energy and environmental savings on your organisations *triple bottom line*.

Energy management used to be pretty straightforward didn't it?

Spend a bit on an energy audit, implement a few of the recommendations, the ones with the best payback and the lowest cost, some new controls, high efficiency lights or some such, and the jobs done, right? Lets move onto the next thing.

Wrong!

The truth is it never really was ever that simple. As anyone who has set out to save energy and actually account for the outcome, energy management, that is *successful* energy management has always been a "long row to hoe". It has always been about putting a good plan in place, making the right people responsible and monitoring and managing for a demonstrated outcome, over time. Now, whilst the essentials of effective energy management haven't changed a lot of other things in the world have changed over the last few years making the management of energy consumption in buildings a more complex task in the 21st century.

- Technology is now a major factor in the management of energy consuming building services. Whilst the potential for technology to work for us in this area is huge it is often installed as "set and forget", rarely delivers on the promise and more often than not is expensive to maintain and can actually cause energy waste. How do we stay on top of the technology and make sure it delivers?
- The same technology, used in conjunction with modern IT software, spreadsheets and databases and the like, is also capable of being an extremely effective management *tool*. It can be used to identify improvement opportunities worthy of our focus and investment, and monitor and prove out the energy savings from those investments to either encourage us to do it again or learn so as to do better next time. Often attempts to use technology in this way result in information overload and its potential as a management tool is seldom realised.
- The role of people in buildings and their interaction with building services has changed. Building occupants used to be a prime focus for energy saving programs, but people don't turn the lights and the air-conditioning on any more and as a result have become largely ignored in the energy management effort. They are now often seen as a barrier to improvement. The building occupants are of course why the building is there in the first place and they can be an important ally in the energy management process.

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- The ownership of buildings and their management is now concentrated like never before and the day of the large institutional owner-occupier has virtually come to an end. Energy Management in the *new* portfolios has its own particular lessons that are of increasing interest and importance.
- Energy Management, Ecologically Sustainable Development or both? Energy management seems to have become passé. We've been there, done that, now we are tackling sustainability and triple bottom line reporting. Energy usage is still the biggest issue in sustainability by far and we are a long way from getting it right. What's the best way forward to make a difference today and set the scene for the future?
- There is increasing talk of energy codes and regulating energy efficiency in buildings. What's happening, what should happen, and what should we do?

How do we deal with all of this and chart a way forward for effective energy management?

Getting the Technology to Deliver

Technology has made a tremendous penetration into buildings. Technology controls most if not all of the energy consuming systems in modern buildings. It turns the air-conditioning and lights on and off, modulates internal temperature and even lighting levels; it may even turn your computer on and off!

Mechanical plant can be controlled to anticipate changes in building heating and cooling requirements and compensate ahead of time or even make decisions based on historical operational profiles. In the latest design hybrid buildings the technology manages the smaller air conditioning system to supplement natural ventilation to provide an almost seamless internal condition. Lighting systems can monitor natural lighting levels and adjust the artificial lighting system accordingly.

All very high tech!

The problem isn't the ability of the technology. Many buildings now have more computing power in them than that used to send human beings to the moon. The problems, in terms of energy efficiency, are twofold. Firstly in the initial set up, commissioning and tuning of the systems to the requirements of the occupants, and matching the *building services to the building physics* to get the best out of the systems. And secondly, in the still largely unrecognised requirement to monitor and maintain the technology, to ensure it keeps performing.

- In the first instance the technology to be installed into a building should be appropriate to the need. Is there any point in paying for and installing expensive control and monitoring technology if it isn't going to be used. Will the functionality specified be actually implemented, be maintained over time, and be of some benefit, or is it simply the latest and greatest from overseas. Over complex technology is expensive, costly to set up and difficult to maintain. As a consequence it often times under performs as a result.
- The technology must be set up correctly and commissioned to do what was promised. This is often not the case.
- Adequate documentation should be prepared, both in terms of functionality and as-commissioned settings, so that others can follow on from the installation technicians.
- The systems should be tuned during the defects liability period to optimise time schedules to best match occupant needs and system performance, and to align the

systems operation to the attributes of the built space it serves. The energy consuming systems and the building are an inter linked physical system. Things like warm up times, cool down times, night purge conditions, chiller scheduling, base lighting levels and the like will reflect the physical interaction between the services and the building.

- The technology that controls energy consuming systems must be checked regularly. Many of these systems can be maintaining conditions and doing their job whilst consuming very excessive amounts of energy. Systems will drift for all manner of reasons, very few systems are self diagnosing as yet and most will not tell you when they are out of whack and wasting energy. Maintenance providers should be attuned to not only ensuring that systems perform effectively but also that they do it energy efficiently.
- In large and complex facilities change is continual, new fit outs, change of use, open plan to enclosed offices and back again etc. Without a well developed change management process small changes to the space, controls and systems can occur without anybody accounting for the effect on energy consumption. Change proposals should be reviewed with an "energy eye" and modified to maintain or improve energy efficiency if possible.

A high tech building that is well set up and well managed and maintained will be energy efficient. If it is not correctly commissioned and tuned, or not assiduously managed and maintained, it will consume more energy and cost significantly more to run.

A more detailed treatise titled "Staying on Top of the Technology" setting out how to manage the technology in buildings to achieve energy efficiency is attached at the rear of this paper.

Technology as a Management Tool

There is great potential in the technology now available to many building and facility managers to provide significant informational support to the energy management process. Building Management Systems can be set up to report by exception to identify when things go awry and energy is being wasted or at the very least give clues to something being amiss. Trend logs can be established to identify how things are working and the potential for improvement. They can also help quantify the likely extent of the improvement to assist in decisions about commitment of capital and resources to realise the change. Electricity consumption records, which are now readily available for most commercial buildings in Australia on a 15 minute or 30 minute resolution, can be used to "spy" on energy usage and identify areas of wastage or the potential for improvement.

Building Management Systems: The primary function of the Building Management System is to control building equipment and systems. It also has a capacity to provide a wide range of data and information to enable better energy management.

- The system can be used to provide trend logs that over time by comparison can indicate if systems are performing satisfactorily or not. e.g. VSD/supply air fan operation tracked over time can be used to indicate the drift of VAV box settings
- Report-by-exception arrangements (alarms) can be established that will indicate when systems are operating outside predetermined parameters e.g. economy cycles operating on high ambient temperature days.

The Building Management System should be viewed as a large data capture system and used intelligently to deduce opportunities for energy saving and act as a watchdog against energy wastage.

Electricity consumption logs: Records detailing the energy consumption profiles for systems may be available directly from the building management system. If they are not available within the building they will be available from the electricity supply organisation. These should be reviewed against building operational requirements to assist in determining appropriate On/Off arrangements, correct plant operation and sequencing and to check out-of-hours usage and loads. These are an extremely powerful energy management tool and should be reviewed regularly.

Make intelligent use of the technology and the information available to identify improvement opportunities worthy of your focus and investment, and monitor and prove out the energy savings from those investments to either encourage you to do it again or learn so as to do better next time.

People, Help or Hindrance?

"Turn the lights off when you leave".

"Turn the air-conditioning on when you come in if you think it is going to be a hot one".

People used to be the prime component in energy management. Time based controls, BMS's, BAS's, DDC's all this technology takes the human out of the loop, or does it, or should it?

Commercial buildings exist largely to house people and support their activities; technology should be part of that support and should be as seamless as possible. Ideally efforts to reduce energy consumption should also be seamless and transparent to the buildings occupants. This may not always be the case:

- Reducing the hours of operation for air-conditioning or lighting is a case in point. Yes you can adjust the services to come on at 7.30 a.m. every morning and go off at 6.00 p.m. instead of on at 6.00 am and off at 8.00 p.m. to accommodate the occasional early riser or late stayer. But how do you get them to accept using the out of hours control without complaining.
- Yes you may be able to let the temperature drift a little further away from the magical 21.5^{o}C during hot spells to save some energy but how do you deal with the complaints from a vocal few.

Service providers have become very complaint adverse. "So what if it was a good idea and it would save thousands of dollars in energy annually, the first day we tried it we got complaints so we put it back to the way it was." Complaint levels are a principal KRA in many service contracts, energy management is often just a feel good "continuous improvement" clause in the contract.

Two distinct strategies come to mind:

1. "Stealth". When seeking to save energy by reducing system operating hours, or increasing temperature dead-bands don't do it in one foul swoop, make the changes little bit at a time, over time. For example, progressively start the plant 15 minutes later for a couple of weeks, then another 15 minutes and so on. Monitor response and act accordingly. In this way you will find the real boundaries of the service requirement for the building and reduce energy consumption accordingly.

2. Take people along for the ride. Get them engaged in the energy management process if you can or at the very least make them aware of what you are trying to achieve and why. Have them understand what you are doing and they will be half way there to supporting you or at least not actively acting against you. There are all sorts of strategies that can be employed in this area.
    - Inform people of the energy and environmental impact the building makes, show them what can be done and the improvements that can be achieved. Explain to them the changes that are proposed and what is likely to happen. Ask them to be patient. Respond to their concerns. Don't forget to close the loop, tell what you've done and what's been achieved.
    - Make sure people understand how to use out of hour's controls and the other technology they have some input to. Make changes to these systems to make them easier to understand and use if required.
    - Relate the office experience to home. Show them how to save energy at home. Provide something that's of personal use to engage them.
    - Show people the sorts of activities and circumstances that waste energy, give them a contact route and they will identify things that may inadvertently happen to cause energy waste.
    - Don't forget maintenance providers and their personnel. Make sure they understand your objectives. They will be a great help in identifying and implementing change, often at no cost simply by doing something a little differently.

Often a combination of the two strategies is most successful. Do what you can as unobtrusively as you can and for further activities get people involved in a genuine way. Don't forget that people are fallible and energy is unlikely to be their central focus in life. They will need reminding and retraining, and yes this is a cost, but you might be pleasantly surprised with the ideas and help they come up with.

So, technology doesn't take people out of the loop, they should not be ignored and should be considered intelligently. Involve them as appropriate, and if engaged effectively they will be a boon not a barrier to energy saving change.

Building Ownership and Portfolio Energy Management

More buildings are being owned by fewer and fewer entities. The ownership of buildings is very significantly more concentrated than what it was even 5 years ago. Property trusts, superannuation funds, growth funds, "own" the property market. These organisations now control building portfolios, often diverse in terms of size, age and use, and geographically widespread that consume very large and costly amounts of energy. They have typically outsourced the property management function to a new breed of "super" property manager and these have become, over a short space of time, organisations that may be trying to look after national portfolios of thousands of buildings.

Building portfolios used to be the domain of the Government or big financial institutions like Banks. Now both have virtually divested themselves of freehold property as owner-occupiers. The time of the big owner-occupier is now gone. In terms of energy management it could be said that we now have base building portfolios and building tenancy portfolios.

The new "base building portfolios" are typically the domains of the absent landlord with the local property management representative. From the base building operator's point of view the direct energy saving opportunities relate to base building functions only. However, the indirect and sometimes just as substantial opportunities relate to helping tenants reduce energy consumption. For the more enlightened landlord this has two positive attributes. Reducing tenant's light and power consumption usually leads to reductions in air-conditioning energy consumption which is usually part of net rent arrangements and therefore is a benefit to the landlord. Landlord assistance with energy management can also be a much appreciated value adding service to the Tenant and raise the value of the Landlords' stocks in the competitive tenancy market.

For the "tenancy portfolios" the energy question gets bound up in net/gross/outgoings arrangements and the opportunities for energy management are fairly well limited to lighting control and management of business machines, PC's, photocopiers and the like. It is very rare for a landlord to share any of the benefits they receive as a result of the tenants energy management as these are difficult to quantify and problematic to come to an equitable commercial arrangement over.

Three of the primary issues of portfolio energy management, no matter whether you are focusing on base building issues as an owner, or on tenant issues as an occupier, or both, are:

- *Logistics, the size and extent of the issues across many buildings:* The nature of the local energy supply arrangements for electricity and gas. Billing regimes, tariffs, network versus energy charges, the nature of the building and how it is metered. The nature of the energy split in the building between base building and tenancy. The size of the building and the use of the building, business hours or 24 hours operation or part thereof in different parts of the same facility. The climate. The variance of public holidays around the country. Multiply all these issues by the number of buildings you are responsible for and you start to get a feel for the complexity involved. How do you know "where you are" let alone what the opportunities for improvement are?
- *The dynamic nature of portfolios:* In any large portfolio there is a state of flux. There will be new properties coming on board, there will be sales and properties moving out, renovations taking all or parts of properties out of the equation for a period of time and changes of use effecting energy consumption. Monitoring this state of flux can be a daunting task.
- *People, their role and varying levels of engagement in the organisation:* For example the Bank Manager in Port Macquarie is not going to *really* care about doing things to save 10% off their $10,000 annual electricity bill, they can "write" four times that much business in ½ an hour. But if you as portfolio energy manager have 500 properties like theirs $500,000 in potential savings is a serious issue. How do you engage the Bank Manager or do you engineer them out of the process.

OK so its not going to be easy but it is possible, and it has been done successfully. What are some of the approaches that can be applied for successful energy management in portfolios without blowing the budget and without sending the portfolio energy manager around the twist?

- *Pareto's Principle:* Firstly, the complex logistics, the nature of the task and the dynamics of portfolios suggest the application of Pareto's Principle, the 80:20 rule, to portfolio energy management. This should be the overarching approach to portfolio

energy management. Simply put don't get caught up with or daunted by the detail required to identify the *all* the opportunities, establish the *exact* potential for savings or likely costs and don't become obsessed about *accurately* gauging the effectiveness of what you've done in terms of energy saving. By all means aim for 100%, and plan for that but once you've achieved the "80%" move on, leave a tolerance, don't get obsessed about the remaining "20". Energy management in terms of assessment and reporting in portfolios is also not an exact science. It is far more important to gauge a broad and reasonably accurate and consistent view across the portfolio rather than trying to ensure absolute accuracy and completeness for every building.

- *People or Technology?:* Citing the Bank Manager example, technology would be the obvious answer, something that engineers the human out of the control loop, and hopefully builds in a permanent reduction in energy usage. However in some instances the cost of installing technology in lots of small properties to do the energy management job for you is prohibitive. And as discussed previously having an engineering solution doesn't necessarily mean you take people out of the process entirely. Some of the most successful portfolio energy management programs have worked so well because of the way they engaged people as well as implementing technology and other initiatives. It can be as simple as making people aware of what is being achieved and aligning them to the goal. You need to develop a strategy for how you will involve, or not involve people. Some organisations decide from the outset to largely eliminate people from the process, that's OK as long as it is a conscious and well thought out plan, others seek to fully involve staff and management, and plan and act accordingly.

  If you do use technology it should be appropriate to the task and assessed not only for its ability to perform the function but also its reliability, maintenance and ongoing management requirements, and consequential cost, and its durability and likely useful life. It would be nice to think that one could apply a standard technology solution across a portfolio and enjoy the associated buying benefits. The diverse nature of buildings and building services, even in portfolios of buildings with very similar uses such a retail chain often means that there is no "standard solution". That doesn't mean you can't take a "BMW" approach and come up with a process that allows you to produce site tailored solutions using standard "solution components" and still achieve the benefits of bulk buying.

- *Identification of Opportunities, Savings, Costs and Barriers to Realisation*: Identifying where the opportunities are, quantifying the potential, quantifying the likely costs of realisation, identifying the issues and problems associated with the realisation, and prioritising the opportunities. Add to these, acquiring the resources to start the process and then managing the process and monitoring the outcomes and reporting. These are the typical stages in establishing and realising an energy management program. These tasks are all much more complex and challenging in a portfolio. The key principal here must be value for money and an approach that is strongly grounded to the concept of return on investment. The entire process that goes into making a change to improve energy efficiency should be viewed as the investment upon which a return by way of energy and energy cost savings is expected. How much you invest and how you go about investing should reflect the expected quantum and likelihood of return. Energy audit programs should be about sifting through the portfolio for best return opportunities and then focusing to accurately identify costs, returns (savings) and risk (implementation issues or barriers) for these

"best bets". Just as you would any investment opportunity, with the extent of your effort (investment) reflecting the anticipated return. Energy audits and the subsequent processes leading up to implementation of energy saving change should also be structured, systemised and delivered to ensure a universal approach to assessment. A consistent and believable view across the portfolio is the aim.

- *Attack the Basics:* Control the change process. The most effective way to improve energy efficiency and build in the outcomes for the long term is through the existing change process. It is far easier than to try and make changes for energy saving reasons alone. Change in buildings is driven by higher business imperatives, get on board this process and introduce energy efficiency through improved design standards and a project management approach that is conscious of the energy related aspects of the outcome. It wont happen overnight but this is also one of the most powerful ways to change the organisations culture to one of being more energy or environmentally conscious. And it is not only about buildings themselves. This approach should also embrace the purchase of business equipment such as PC's and photocopiers. If you build or buy with an eye to energy efficiency it will ultimately become the culture of the organisation throughout.
- *Manage the energy procurement process*: Energy is a resource, to manage it effectively you need to get involved with both the demand and supply sides. If you can improve the supply conditions and save some money this will promote the energy cause and potentially offer up funds for energy saving improvements.

  Know who you buy energy from:

  - On sites where you haven't got a "contestable" contract make sure the sites are on the correct tariffs. In a large national portfolio you could end up dealing with in excess of 20 different suppliers with different cost structures all of which are prone to change. So, the job will not be easy, but is likely to be rewarding in terms of finding sites where because of usage changes, tariff alterations or tenancy changes you are not on the best tariff. It is also well worthwhile to review tariffs at least annually. The other thing a tariff analysis will lead you into is a metering review. This also is likely to yield positive outcomes through eliminating situations where you are paying for energy someone else is using, especially if you set up a periodic review process.
  - On sites that are supplied under contestable contracts, review the contracts, the rates, the contract conditions and the terms. There may be opportunities to align the sites and take a group buying approach. Be aware that the opportunities in this approach, no matter how large the size of the "buy" are likely to be in economies of cost for you in establishing and administering a common contract across many sites rather than many contracts. And for the suppliers in accessing many sites through a single entity and thereby reducing their cost of sales. The nature of the competitive electricity market is such that its pricing dynamics are not directly responsive to the size of the buy (within the range of what is likely to be a reasonable large building portfolio contract).
- *Information Technology Systems:* It would be impossible to manage today's portfolios without sophisticated IT systems and a successful energy management programs will depend on the intelligent compilation and use of large amounts of information:

  - Your information systems must reflect the nature of the task and Pareto comes into play here again. The dynamism and complexity of a portfolio makes the

accuracy of any assessment of energy usage not only suspect but out of date, probably before you finish compiling it. Incompleteness of data is also a significant issue. If you set up spread sheets or databases to track the portfolio they must be able to deal with "holes" in the data. There will always be a "recalcitrant" somewhere that is slow to provide information. Spreadsheets and databases should where possible incorporate self checking and reporting by exception features, firstly to minimise entry errors and secondly to minimise reporting time.

- How do you assess change? How do you know if you are actually achieving any thing amongst so many different "currents"? Are you getting nearer the shore? Comparing one period with the last is fraught with difficulty, how do you factor out all the variables? The answer is that in most cases you cannot. What you can achieve if you do try is a data set that is so derived and sanitised that it has no real world relevance. Even so a believable assessment approach is required and a consistent method is essential to be able to track trends over time. Put some thought into how you are going to track consumption and the associated variables, develop a method and stick to it. A 12-month rolling average system has been found to be relatively successful in factoring out seasonal variations in climate, building usage and portfolio dynamics (buildings in and out) in large diverse and geographically spread groups of buildings.
- Use the systems to report only what matters. Don't become, and don't cause others to become victims of information overload. There should be various levels of reporting and output. As energy managers we are looking for an objective and honest assessment of performance. Systems should also be able to output other levels of information that will be useful and influence others involved in the process. There will be site level information reflecting local performance and opportunities for comparison to other parts of the portfolio that may be of use in motivating people and providing them with tools to manage with. Be careful with this information, you can seldom compare like with like when it comes to buildings, and be careful engendering competition between buildings on an energy savings or energy efficiency basis. It is very hard for them to "race" if they are all driving essentially different "cars". It is far better to encourage people to work towards ensuring that their buildings are the best they can be and provide structured information to help them in this.

Energy or ESD?

Sustainability, ultimately, is what we should be about in all that we do. At its core is the need to leave the world in as good, if not better state for those who follow us. Sustainability is about managing our use of resources, minimising our waste and effluent and generally reducing the ecological "footprint" we place on the world. It has, by this definition, many dimensions in buildings, some of which are relatively clear and understood such as energy consumption where there is a straightforward method of measurance, relatively clear quantification of environmental relevance and obvious economic linkages. For other dimensions such as resource scarcity or embodied energy we do not, as yet, have such a developed and commonly accepted understanding.

Resource usage and in particular operational energy usage make up by far the largest component of the footprint, especially from the point of view of what we can do today to make a difference.

"Sustainability is the big picture, some of which remains unclear and a little fuzzy in terms of definition and what we can and should do. Energy is the substantial part of that picture that is sharp and where it is clear what we can do."

A constructive way forward involves pursuing a broader ESD objective over time whilst achieving energy savings now. Establish an Environmental Management Plan with energy as its centerpiece and develop this plan as you go adding the additional environmental dimensions and depth as and when appropriate.

Begin to identify what the environmental footprint of your organisation is and broadly map out a plan to account and manage for a reduction in the size of the impact over time. Identify what can be done today and what will have to wait until later when we better understand the issues or have an opportunity through a refurbishment or some other change process to make a material difference. Focus on energy in the short term, put the resource management infrastructure in place that can also be applied to other areas later and gets some runs on the board as follows:

- Identify the range of environmental impacts for your buildings. What are they, what are the issues, who is responsible and who can influence. Electricity, gas, water, sewage, stormwater, garbage and paper are the obvious ones. Less obvious are the materials of its construction, its proximity to public transport and bike tracks, and the impact it may have on the local micro-environment (uncaptured stormwater run off, shading, wind tunnel effects, reflected glare etc.)
- Quantify the impact. Track resource usage and other impacts if possible. Determine how would you go about it? Start to identify the challenges. Energy and water bills are relatively easy but don't forget that usage needs to be normalised against variables such as, hours of operation, floor area, full time staff etc. So these need to be tracked as well. Effluent, stormwater, garbage and paper are usually less straightforward. Some of the other elements mentioned above are also very difficult to quantify let alone track in a meaningful way.
- Identify how improvements could be made, quantify the likely benefits, disbenefits and costs, prioritise, establish how the change could be put into place and how to account for the outcome.
- Establish a program for change including budget, responsibilities and timeline.
- Take control of the change process and use it to improve the environmental performance of your building. Develop an ESD flavored specification for new works. Focus on energy efficiency and other areas that can be quantified for cost and benefit in the first instance. Require that designers meet specific targets in these areas and require that they consider the options in other areas such as material selection based on embodied energy, use of renewable resources etc. Require that they demonstrate the consideration of options in their designs. Designers should also be required to apply good design and forethought to ensure the things we do create are:
  - Flexible and thereby reducing the need, frequency and extent of change required to meet new business demands in the future.
  - Adaptable to ensure that when things do need to be changed this can be done readily and with minimal environmental consequence, and
  - Durable, so that they will remain serviceable for the envisaged life span.

  Consideration of internal environmental issues such as selection of materials with low or non-toxic emissions should also be addressed. Remember that the

development of an ESD specification or Brief should be an iterative process and the Brief should be developed and enhanced over time. Whilst we must challenge the market to improve the ESD standards of its designs and built products we need to be cognizant of the current capabilities of the market to deliver, its ability to make progressive steps in this area and the costs of this development.

So it's not ESD *or* Energy. By all means tackle the broader issue of sustainability sooner rather than later but focus on energy first. If you get that right the rest will be much easier.

Energy Codes and Building Rating Systems

We are on the cusp of mandatory regulation, albeit *only* minimum design standards for energy efficiency in Commercial Buildings. Changes to the Building Code of Australia are currently under development that will see the introduction of minimum energy efficiency standards for new residential construction throughout Australia early in 2003 and standards for commercial buildings are set to follow in 2004. It is unclear at this stage whether the Code relating to commercial buildings will only apply to new buildings or also to works in existing buildings.

Minimum Energy Performance Standards (MEPS) already apply to some components of building services and will over time apply to most energy consuming equipment. These initiatives are designed to eliminate worst practice and provide a base level for energy efficiency in buildings. They will be implemented through the design / change process for new and existing buildings. For example, you simply will not be able to buy an air conditioning unit with less than a certain level of energy efficiency just as you now cannot buy a refrigerator below a certain standard.

What will be more of a challenge in the management of facilities in the future is the application of market driven voluntary energy efficiency or more probably bigger picture environmental standards or rating schemes. With the growth in market sentiment towards ethical investment, the increasing consciousness of environmental issues and the significant involvement in the property market by the superannuation and property funds there is a growing call for an industry accepted (and believable) method for assessing the environmental "rating" of buildings and thence the building portfolios of the various property investment vehicles. This will enable investors to make better informed choices about the "greenness" of their options and provide the market with another opportunity to differentiate their products. Tenants and particularly those with European or North American parentage are also looking for means to environmentally grade tenancy options in the market in keeping with corporate "triple bottom line" reporting requirements.

There are already a number of building related energy / environmental programs or rating systems in use.

- The Commonwealth's Greenhouse Challenge Program encourages industry to make a public commitment to account for its attributed greenhouse gas production, set mitigation targets, enact greenhouse gas reduction strategies and objectively account for the effects. It doesn't provide or require building ratings as such.
- The New South Wales Government's SEDA Greenhouse Building Rating Scheme has now been established nationally. It assesses the energy related greenhouse impact of a building based on its energy usage, floor area and occupancy and produces a Star Rating for the building. Various State Governments and Industry groups promote this scheme.

- Broader based environmental rating schemes such as the US LEED system and the UK BREEAM system, which take into account environmental impacts in addition to energy usage, are being looked at by a number of large Australian building portfolios. An Australian arm of the World Green Building Council, which promotes the LEED System, is being established in Australia. An outline of an Australian based environmental rating guidelines system called NABERS has also been developed.
- The Australian Building Energy Council has long proposed an industry driven and developed voluntary Code of Practice. This would apply throughout the buildings life cycle utilising a web based information repository concept to rate both the environmental performance / impact of the building, and the environmental performance of the buildings manager.

None of these initiatives are yet either sufficiently developed or industry tested to foresee a likely "market accepted standard" outcome. What is clear however is that any such system must have energy consumption as its centerpiece.

Additionally such a system must address not only new buildings but also the existing stock of facilities as new buildings are being added to Australia's property portfolio at the rate of only about 1.5% a year. To rate energy or environmental performance across the market existing buildings and their operation must be included. As such a rating system must cover qualitative issues relating to the standard of energy management as well as the absolute quantitative energy efficiency of the building. It must be remembered that rating systems are in effect as much part of the mechanism for encouraging better market behavior in this area as they are systems of performance measurement.

There are many very well run, energy efficient, existing buildings whose energy consumption is relatively high and is driven by factors outside the control of its present owners, managers or tenants. In these buildings every thing that can be done within the bounds of commercial reality may have been done to lower energy consumption. A quantitative assessment of these buildings on a consumption / floor area basis totally ignores their superior energy management standards and may rate them relatively poorly compared to a new building with new technology and designed from the outset for energy efficiency. Such a rating system, whilst obviously encouraging the construction of better performing new buildings, will have a much lessor effect in encouraging better energy management practices in existing buildings than a rating system that addresses both absolute energy efficiency performance and the efficacy of the energy management practices that are being applied.

Notwithstanding whatever type of rating system is ultimately devised an Environmental Management Plan as set out previously, that accounts for energy usage and the variables that influence energy usage, would be a very good preparation for the future application of a environmental rating system.

Summary and Close

If you have the technology, stay on top of it, make sure it serves you, your buildings and the people therein. Remember, its not "set and forget", it can be tuned for better performance. A lot of that is about ensuring that the services fit the habits of the occupants and matching service provision to their real needs. And it needs to be checked and maintained periodically because it will drift, sometimes it would appear for no good reason and without any obvious signs other than a hard to detect gradually rising energy bill.

Use the technology to provide you with management information and use IT intelligently to track and report progress and to identify opportunities. Don't forget to report. You must close the loop on your energy management. If you don't you won't learn what works and what doesn't, you will be doomed to repeat the mistakes of the past, probably won't repeat the successes, and certainly won't be recognised for your efforts.

Work on the people bits. Take the building occupants along for the ride, engage them where appropriate as part of the "control loop" but don't forget they are fallible and will require regular reminding (training). When they are not directly responsible for controlling energy usage get them involved in the energy saving challenge. That way they will be far more supportive of your efforts and forgiving of any small inconvenience or change in service provision you would like them to accept in the name of saving the environment. Who knows, they may actually come up with some good ideas, after all it's their building and their planet too.

Portfolio energy management is a challenge that is facing an increasing number of Facilities Managers. It has it own lessons that are distinct from those that you would apply to a single building or facility. Apply Pareto's Principle to what you do, portfolio management is dynamic you must be too. Engage your people where you can and keep them informed. Attack the basics and get them to work for you, control design and systematically improve built-in energy efficiency through the existing change mechanisms. Manage the energy procurement process and control the resource. Use technology where you can to eliminate the human in the control loop, take advantage of economies of scale and don't forget that with technology, it has to be appropriate technology, it has to installed and set up right, and it has to be checked and maintained regularly. And use IT intelligently to report by exception and keep everything, including yourself, honest.

Sustainability must be the way of the future but don't loose sight of the "trees for the forest." (sic). Its still primarily about energy and greenhouse and will be for some time to come. Probably until we all have roofs covered in photo voltaics and have fuel cells in the basement. Focus on energy and greenhouse and add other dimensions as appropriate through the design process. Don't try to do it all at once or you will achieve little.

Energy Codes are coming for minimum design standards in the next 2 years but it will be sometime before mandatory operational codes arrive, if ever. What is likely to be an issue for many Facility Managers well before then is the need for believable and transparent triple bottom line reporting or voluntary compliance with programs like the Commonwealth Governments Greenhouse Challenge, or market driven building rating systems like the SEDA Building Greenhouse Rating Scheme. Compliance with these requirements is primarily about accounting and reporting and establishing a reliable information system that provides a good level of knowledge about the building(s) and the activities therein.

And the future? There is likely to be a lot more accountability to Governments, the Market and the Community with regard to the impact buildings place on the environment. And yes, there is lots of wonderful technology on the way; hopefully a lot of it more attuned to the environment and human behavior. But whilst we also hope it will be more reliable and even self-diagnosing it too will need to be monitored and managed. We need to embrace the technology and understand it to stay on top of it and manage it for an outcome. It must always serve us not the other way around. Energy Management in the 21ST Century will continue to be about people and good management.

If its not we are doing something very wrong.

STAYING ON TOP OF THE TECHNOLOGY

Modern buildings are highly serviced to provide supportive and productive environments for the activities housed within. Whilst these buildings typically feature relatively sophisticated air-conditioning and lighting control systems there is often room for improvement in tuning the systems and their interaction with the building occupants to further improve energy efficiency. Also, notwithstanding the sophistication of the installed systems, the continued efficiency of the building and its systems is dependent on ongoing and diligent review of operations, and appropriate maintenance. The following practical opportunities to improve energy efficiency exist in many modern buildings.

Lighting and General Purpose Power

Lighting Time Control

Lighting Control System (LCS) On/Off time settings should be checked. These are usually set during the building commissioning period and may not relate to actual current space usage patterns. Actual usage patterns should be determined for the lighting zones controlled and the LCS adjusted accordingly to minimise operational time and resulting energy usage whilst ensuring staff are not inconvenienced. This initiative can achieve significant savings if large numbers of lights are involved. Operational reductions of as little as 10 to 15 minutes per day can be worthwhile pursuing.

Occupancy Sensor Control

If occupancy sensors are installed a selective audit of the sensors operation is recommended to gauge whether these devices are operating appropriately. These sensors can “drift” over time or fail leading to excessive energy usage due to prolonged time of operation. Changes in use of the space often lead to the sensor settings being inappropriate and they are often disabled rather than readjusted leading again to excessive energy usage. A sample of sensors should be tested throughout the building and if the test shows a significant number of problems the testing should be made more extensive.

Daylight Sensor Control

Like occupancy sensors light level sensors can drift over time, or fail, and be subject changes in space usage or tampering. The operation of these sensors should be selectively audited and any rectification carried out to reinstate correct operation.

Out-of-Hours Lighting Usage.

There is often the opportunity with a LCS to improve its operation when lighting is required out-of-hours to reduce the impact that out-of-hours access has on lighting energy usage. Out-of-hours usage requirements should be determined and the LCS checked to ensure that within the limitations of the lighting system design only the lights that are required operate and only when required.

Light Levels and Luminaries Placement

Space usage functions can change over time sometimes making the designed lighting levels and/or luminare placement inappropriate and energy wasteful. For example offices may become storage areas, or shelving units or partitions may be placed under luminares. An audit of the space would identify any such opportunities to optimise the lighting system by removal, disconnection or dimming to reduce energy consumption.

Out-of-hours Loads

Power usage during out-of-hours periods should be audited to ensure that business and other equipment is not operating inappropriately during these periods and causing excessive energy usage. This audit will also indicate the level of staff compliance with any out-of-hours PC switch off policies that may be in place.

Air-conditioning and Ventilation

Time Schedules

Start and stop times for air-conditioning systems should be checked against actual building usage patterns. Ideally warm up time allowances should be tuned to the minimum required to achieve comfort conditions at the time the majority of staff arrive. The air-conditioning and ventilating (exhaust) systems should shut off at the time the majority of staff leaves. (See Optimal Start/Stop below) Operation outside this period should be subject to an out-of-hours control system that allows operation for a fixed period of time on demand, usually no more than one hour per call, and ideally only in the area required. Reducing weekly air-conditioning operating times by only an hour or two will have a marked effect on energy consumption in a large highly serviced building.

Ventilation Rates

Over time ventilation rates in modern buildings may drift away from the original settings or may be changed inappropriately during tenancy changes or renovations. This can result in rates higher than those required for ventilation as required by Regulation. Reducing ventilation rates can result in reduced energy consumption due to the reduction in fan energy; it can also in some instances alleviate local draft problems. Any proposed reduction in ventilation rates should be carefully investigated before any action is taken as reducing ventilation rates may have deleterious effects on thermal control, local air quality, and because of system design may not save a worthwhile amount of energy.

Outside Air Rates

Inappropriate outside air rates may have a detrimental effect on energy consumption through the heating or cooling of greater than necessary amounts of ambient air. Outside air settings should be checked against the design rates and these rates reinstated if required. If the are indoor air quality issues in the building these should be rectified before any reduction in outside air rates is carried out.

Outside air rates can be modulated during night purge (maximum) or early morning warm up (minimum) to improve the energy efficiency of these functions.

Economy Cycle Operation

Incorrect operation of economy cycles can be responsible for wasting more energy than they potentially save. Wrongly set dampers and controls can allow excess amounts of ambient air into the building and it may not be until the situation becomes so chronic that the system cannot maintain internal conditions that the problem is discovered. In the interim the system may have been operating in this fashion for years. The operation of economy cycles must be checked regularly. Correct damper positions and system operation should be recorded and tested against.

Night Purge

The night purge function on the Building Management System should be checked to ensure it is enabled and its operation reviewed for correctness. These systems are sometimes disabled for a variety of reasons (e.g. airflow on things like vertical blinds resulting in interference with occupancy sensing security systems) and also their settings may not always be appropriate.

Variable Speed Drive Audit – Fans

The operation of VSD units driving fans should be periodically checked out against the design strategy and commissioning records. This should identify any malfunction in the drive control arrangements and also provide an indication of problems in the air distribution system (VAV).

Thermal Control Audit

Air-Conditioning controls systems can be operating incorrectly and causing energy wastage with out any obvious system problems. “Heating” can be fighting “Cooling” and this is often not detected until the system is unable to maintain conditions and/or hot or cold spots occur. Even then the energy wastage dimension of the problem will not be appreciated and may not be fully rectified. It is seldom cost effective to carryout a large-scale thermal controls audit of a building on the off chance that something may be awry. However it is worthwhile to regularly review the operation of significant control valves on large air-handlers, and address the energy wastage dimension of any hot spot or cold spot problems that arise. It may also be possible to utilise the Building Management System that track and log system performance to conduct a thermal audit on the building, determine the energy balance for the systems and detect if there is counterproductive heating/cooling taking place. This would provide justification for a further investment in a control’s audit.

Sensor Placement

The location of thermal sensors may over time, due to occupancy changes or changes in space usage, become inappropriate for energy efficient control of the space conditions. Where the thermal sensors are “addressable” their readings may be combined, discounted or swapped as required to gain the best sensing outcome for the space and its usage. An inspection of the building is recommended, in conjunction with a review of the control’s sensor set up, to confirm that sensor placement remains appropriate.

Optimal Start/Stop

Notwithstanding night purge functions, air-conditioning systems can be controlled to start early to maximise the use of cooler outside air to cool the building in preparation for the buildings activities and thereby reduce the need to expend energy later in the day. This can also have the added advantage of running thermal plant on lower cost Off Peak electricity and thereby further reduce operating costs. Building Management Systems can have the capability to calculate the most energy efficient time to start systems taking into consideration current building space temperatures, outside ambient temperatures, the required building space temperature and the scheduled building occupancy time. Electricity tariff arrangements can also be factored in with some systems. Where these systems are installed and used their operation should be checked at least yearly to ensure its correct operation.

Thermal systems (chilled water and heating hot water) can also be turned off before the end of the day and the thermal inertia in the systems used in conjunction with the

ventilation plant to continue to maintain space temperature. Some Building Management Systems can calculate shut off times and manage the systems accordingly, less sophisticated systems can be programmed to shut down early. This type of energy management is best done on an incremental trial basis to determine appropriate shut of times.

VAV Boxes

Measuring the airflow through supply fans and tracking these measurements over time can monitor the total performance of variable air volume (VAV) distribution systems. These systems drift over time and are sometimes re-adjusted locally to address local problems at the expense of overall system efficiency.

Zone Reheats

With some Building Management Systems it is possible to log the operation of zone reheats using the Building Management System. The profile of reheat coil usage over time may be correlated to identify control system drift that could lead to excessive usage of the reheats, and energy, to achieve space conditions.

Out-of-hours Operation

Out-of-hours operation of air-conditioning should be audited to ensure that systems operate only when required and that only the system serving the area is use operates. Many buildings feature out of hour's air-conditioning controls with switches located in the tenancies. These sometimes get by-passed or run on times are extended resulting in energy wastage.

Supplementary Air Conditioning Systems

Supplementary air-conditioning systems are often installed for meeting rooms and usually have local on switches and are programmed to run for a finite period of time after initiation. The programmed running times should be checked to ensure that they are the minimum that is acceptable given the particular usage of the space concerned. e.g. in a meeting room where the typical meeting runs no longer than 1 hour and most for about 30 minutes the unit could be set to run for 30 minutes. In many instance these systems are not activated until the meeting has been going for some time and the base building air-conditioning has began to struggle with the load in the room.

Ventilation (Exhaust) Systems

Many Carpark exhaust systems remain time switch controlled. The opportunity to retrofit carbon monoxide sensing control should be investigated for its potential to save energy. These systems modulate ventilation rates according to pollution levels and can dramatically reduce the energy consumed by Carpark exhaust systems.

Buildings often include thermostatically controlled ventilation systems for lift motor rooms and other plant spaces. The operation of theses systems may be able to be logged by the Building Management System and correlated against ambient temperature records to check appropriateness of operation.

Dehumidifiers

Some buildings have dehumidifiers installed to control humidity in particular spaces. These devices can consume excessive amounts of energy if incorrectly set. Operational set points and dead bands should be checked and adjusted to the minimum required to fulfill their purpose.

Central Plant

Chilled Water/ Condenser System Tuning

There are a range of opportunities to "tune" chilled water / condenser water systems to operate more energy efficiently whilst providing satisfactory operation. These opportunities should be addressed with a "whole of system" approach to ensure that a net improvement in energy efficiency is achieved without deleterious effects.

Sequence Control of Chillers:

Most large chilled water installations feature 2 or more chillers. Often larger centrifugal machines combined with a single smaller reciprocating machine. The larger machines are designed to efficiently operate at high loads and the smaller machines are of a design to efficiently operate at varying loads.

It is important for the energy efficient operation of the chiller installation that these machines are appropriately sequenced to ensure best matching of their operation to the varying cooling load in the building. The sequencing approach is established at the time of commissioning and it is often worthwhile reviewing this arrangement after a season of operation and at seasonal intervals thereafter. The Building Management System and the chiller control system can be used to provide records of operation against load and from these it can be used to determine if the current sequencing arrangements remain optimal, and provide information for adjustment if required.

Chilled Water and Condenser Water Temperature Set Back:

The higher the operating temperature of the chilled water system and the lower the temperature of the condenser water the less energy will be required by the chiller to cool the water. In general chiller efficiency improves as you reduce the difference between chilled water temperature and condenser water temperature, and obviously less heat must be removed and this requires less energy to achieve. It may be possible to increase the chilled water setpoint during cooler periods of the year, and other low load periods, whilst reducing the condenser water set point, without significantly affecting the required water flows. It should be remembered that reducing condenser water set point might incur an energy penalty at the cooling tower with an increase in cooling tower fan operation. It may also upset the control balance with the heating system. Any proposal to change chilled water and condenser water set points should address the combined energy implication (chiller and cooling tower, and should also consider potential for impact on the air-conditioning systems ability to maintain space conditions, both in terms of cooling/heating balance and capacity.

Cooling Tower Operation:

Many buildings use cooling towers to reject heat from the chilled water system. These towers are often "matched" to counterpart chillers. The sequencing of these towers, and their fan control strategy should be reviewed as part of an investigation into chilled water and condenser water temperature set back opportunities.

Supplementary Air-conditioning Condenser Water System

If installed the operation of the condenser water system serving supplementary air-conditioning equipment should be reviewed:

- Hours of Operation should be checked against the actual building operational profile to ensure that the system (pumps and cooling tower fans) operate only when required.

- The opportunity to vary the condenser water temperature during periods of lower ambient temperature could be investigated for the potential to improve the energy efficiency of any refrigerated air-conditioning plant (DX) that is served by the system.

Heating Hot Water System and Boiler Operational Review and Tuning

The operation of the heating hot water system should be checked periodically to ensure appropriate and energy efficient operation:

Heating Hot Water Temperature Reset

Following the principle behind chilled water temperature reset there may be the potential to reset the temperature of heating hot water during the warmer periods of the year and thereby reduce the energy required for generation. This may be possible without a significant change in the amount of water to be circulated and therefore minimal effect on pumping energy.

Scheduling:

There are often a number of boilers installed to provide heating capacity. Sometimes there are a number of larger high load boilers combined with a smaller low load unit. Boilers operate most efficiently at high or full load. The sequencing of boilers should be reviewed to ensure that the time boilers spend at part load is minimised.

Combustion Control:

The efficiency of combustion has a significant effect on the gas consumption of boilers. Burner Controls and associated maintenance procedures should be reviewed that the units are operating efficiently.

Operational Records:

Boiler operation and system demand should be reconciled to ensure that the design solution remains appropriate for the building and its usage. Extensive part load usage, perhaps not anticipated during design, may offer a cost effective opportunity to install a smaller part load boiler, reduce inefficient part load operation of the larger boilers and thereby save energy.

Domestic Hot Water System

The temperature set point should be adjusted so as to minimise energy consumption and still comply with the relevant guidelines (OH&S, Legionella if applicable)

After Hours Domestic Hot Water

Where domestic hot water is generated using heat exchangers and the heating hot water system the provision of domestic hot water after hours can see the operation of large heating hot water boilers for extended hours at low loads and efficiencies. In some instances the installation of a small modular boiler for after hours loads is warranted.