Key aspects of implementing an energy management programme

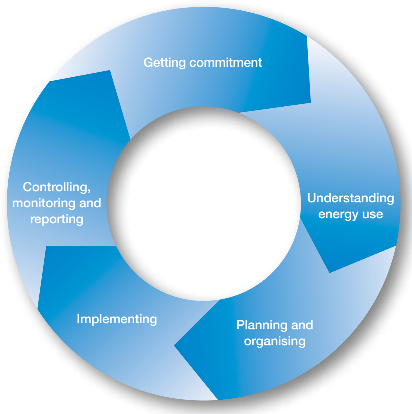
A blueprint for your Energy Management Programme

EECA BUSINESS
PUTTING ENERGY TO WORK

Key aspects of implementing an energy management programme

After several years' experience working with hundreds of different businesses, we've found there is a very distinct cycle to making energy efficiency changes happen successfully:

Energy Management Cycle



There are two parts to this guide, published separately.

Part one looks at the high-level responsibilities that will involve top management, from policy setting and planning to appointing someone to take responsibility for the programme, and an overview of what's involved in implementing a programme. It assists with the "Getting Commitment" and "Planning and Organising" stages in the Energy Management Cycle.

This is Part two, which is more technical. It is intended more for the people who are tasked with actioning an Energy Management Programme. It introduces an in depth look at the implementation process including reviewing historical energy use, setting up an energy audit and ongoing monitoring and reporting. Part two assists mostly with the "Understanding"," Implementing " and "Controlling, Monitoring and Reporting" stages in the Energy Management Cycle.

Part two covers seven key aspects of implementing an Energy Management Programme (EMP):

- Tips for an energy manager (part of Implementing)
- Motivating staff (part of Implementing)
- Reviewing historic energy use (part of Understanding)
- Auditing (part of Understanding)
- Developing the business case (part of Implementing)
- Target setting
- Monitoring and reporting (part of Controlling, Monitoring and Reporting)

It is relatively detailed, and will be of most use to the people implementing your Energy Management Programme.

Part one of the Guide has more general information on the initial steps for establishing an Energy Management Programme. It covers the following:

- Developing an energy management policy and strategy
- Developing an action plan – critical success factors
- Appointing an energy manager/co-ordinator

You'll also find tips about setting up and implementing an Energy Management Programme, and case studies involving a range of different businesses on our website **www.eecabusiness.govt.nz**

Copies of both parts are available online at **www.eecabusiness.govt.nz**.

Contents

Tips for an energy manager

If you've just been appointed energy manager or co-ordinator, congratulations.

This section will give you some practical tips on how to make a success of the role. There are five key things you need to do:

1 Gain control

- Ensure you are buying energy as economically as possible and using it as efficiently as possible.
- Raise awareness of energy waste and promote good housekeeping.
- Invest your time and resources where it will have maximum impact.

2 Measure how well you are doing

- Compare current and past energy use and cost performance.
- Continue to claim credit for accumulated savings from past investments.

3 Report simply, clearly and relevantly

- Match energy reports with the format and timing of other management reports.
- Keep reports simple.
- Include relevant energy metrics and suitable benchmarks for each audience.

4 Share the glory

- Ensure all who have contributed get the praise and credit for making savings.

5 Promote your achievements with your managers

- Publicise your success to secure further funding.

Getting the best results in your organisation

The energy manager's job of introducing change into the organisation mostly involves helping move people's attitudes and behaviour. It involves influencing and persuading, as you usually have only limited direct authority over those who use the energy.

The energy manager needs to understand the culture of the organisation and develop strategies which are in line with it.

Opportunities

An energy crisis, such as a shortage of water in hydro dams, often triggers an ad hoc energy conservation programme. These temporary solutions are unlikely to be self-sustaining unless everyone in the organisation is motivated and trained, and has an active interest and part to play. There is also a difference between conservation and efficiency, which includes efficiency being more self-sustaining than conservation.

Promoting success

The golden rule for the energy manager is 'success breeds success'.

Accompany the whole energy management drive with training, newsletter articles on successful energy saving projects, posters, and stickers on switches. Staff awareness, motivation and ownership can be the most difficult aspect of the Energy Management Programme.

Monitoring all energy projects, whether technology-based or operational or staff-focused, is essential, not only for justifying your actions, but also for personally identifying with the success you have helped to create.

Motivating staff to manage energy

It is people, not just technology, that control, use and save energy. Motivating them is vital to successful energy management, which is part of the "Implementing" stage in the Energy Management cycle. The challenge is to change the low priority that energy has for most people. Refer to EECA Business guide "Staff Awareness and Motivation" **www.eecabusiness.govt.nz/node/6757**

- Motivation involves finding out why people behave the way they do. If cleaners turn the lights on right through the building rather than just in the area they are working in, you need to understand their reasons for doing so before you can introduce more energy-efficient work practices.
- The least costly investment you can make for energy efficiency is to motivate your staff. Group management techniques and self-managed teams are as effective in energy management as they are in other areas.

Getting the message across

Most people aren't motivated by technical data. You need to present this information in ways that encourage response.

Graphs and diagrams are more interesting than tables and spreadsheets. They also make it easier to see a trend, or change. Figures are still important, but you may need to show the significance of energy savings in dollars as well as in energy use (kWh).

Most people usually think of energy as only a small cost element in a business. However, as an easily controllable cost, you can give it relevance by expressing it in new and different ways.

For example, in a university, energy might be less than 1% of overall costs. However, if you present that cost as 15% of the fees charged to students, it's a much more effective context. Similarly, if the university implements an energy management system which saves $100,000, this could be expressed as enough to buy 40 computers, or employ more staff.

Training

You can't rely on common sense and voluntary action. Training is necessary to focus on the significance and value of saving energy and the targeted actions that can be taken. Training also helps motivate staff. It's a tangible demonstration of management support for energy management, and shows that you value staff skills and contributions. Refer to **Training Section** on the Energy Management Association of New Zealand website **www.emanz.org.nz** for more information on training**.**

A small investment in training can generate a lot of savings. Training involves everyone in an organisation:

- Senior management may need a developed sense of awareness of the strategic and financial issues of energy use.
- Technical staff will need to be kept up to date with new technology opportunities, and maintain competence in the effective implementation of these.
- Operational staff will need training to improve awareness of the impact of their actions on energy use.

Rewarding success

Financial rewards for a staff initiative is a very tangible recognition. But you may be able to use other more imaginative and ultimately more effective rewards e.g. competitions between departments with suitable prizes.

Responsibility and recognition

It is important to treat all staff as responsible members of an energy-saving team, rather than as probable energy wasters. Management's attitude to this could be the single most important motivator you have.

Promoting and supporting those who achieve energy savings sends a motivational signal to other staff.

Ploughing back the savings

Making use of the savings in a tangible way can be very effective. Some of the more innovative examples we've seen include:

- All financial savings from energy activities are credited to an energy management budget to fund further projects.
- Individual departments get to keep their energy savings for discretionary spending.
- Improving staff facilities.
- Donating a percentage of the savings to a charity selected by the staff.
- Sponsoring a student training project.

Motivating different people

Senior and strategic management

The main motivator for senior management will be the potential for improving the organisation's performance and profitability. They're judged on their ability to achieve performance improvements, and energy efficiency can make a significant contribution.

To motivate senior management, you need to use their language. Having an energy champion in senior management can be very effective. Try motivating a key person. This may get quick action and will be useful for starting an Energy Management Programme.

However, it is important not to rely totally on your 'champion'. While your energy management champion is providing the initial spark, you should be putting in place long-term integrated energy management practices.

Departmental and technical management

Making departmental managers effective advocates for energy management is as easy as making them responsible for their energy budgets. They should regard success in energy management as their own achievement, even if won with the support of others. Setting up measuring and monitoring systems in conjunction with these managers' teams is important.

The autonomy to spend part of the savings on alternative budget items is a key motivator. Letting staff know their new furniture has been paid for out of energy savings shares the credit with them, and acknowledges the manager's success.

Operational staff

Operational staff have direct control over everything from plant and machinery to light switches. You need to convince them that energy management is important.

Empowerment is important for this group of staff. People are better than any technical control system at recognising and dealing with problems. Energy management can be made a personal goal for them, and they should measure and report their own success.

Promotional tools

In-house newsletters and publicity campaigns are useful tools at all levels to motivate staff. They don't need to be too elaborate. Simple highlighted messages, scoreboards and performance indices can all be mixed with social and community notices.

Staff need to be made aware of the following:

- Why and how energy is consumed in your organisation.
- Why energy management is important to both the organisation and themselves.
- How their everyday behaviour affects energy use.
- How their energy-saving actions will have real and positive impacts on their organisation and on the environment.

Reviewing historic energy use

The energy used by any business varies as production processes, volumes, and inputs vary. Determining the relationship of energy use to key performance indicators, which is part of the "Understanding" stage in the Energy Management cycle, will enable you to determine:

- Whether your current energy use is better or worse than before.
- Trends in energy consumption that reflect weekly or other operating patterns.
- How much your future energy use is likely to change aspects of your business.
- Specific areas of wasted energy.
- Comparisons with other businesses with similar characteristics. This benchmarking process will provide valuable indications of the effectiveness of your operations as well as an indication of energy use.
- How your business reacted to changes in the past.
- How to develop performance targets for an Energy Management Programme.

Reviewing historical energy use costs little. The data you need is usually at hand within your organisation's electricity and fuel accounts. Developing this data into useful management information is something you can either do yourself, or have done by people such as your energy suppliers or external consultants.

Your current energy utilisation and the scope for improvement can be easily quantified by reviewing your current and historical energy usage against industry benchmarks.

A process for reviewing energy

Start by assembling all your energy accounts for the last 12 months. Be aware that your tariffs will have a number of elements, depending on the way your business purchases energy.

Most tariffs have some or all of the following features:

- A supply charge or network connection fee charged monthly with each account.
- An energy charge:
  - Electricity: kilowatt hours (kWh) or 'units' for electricity, with varying rates for day, night, summer, winter, or time of use.
  - Solid or liquid gas: a charge based on volume or mass purchased. (Delivered bottled gas is sold by weight).
  - Reticulated gas: a gigajoule (GJ), day and/or night rate charge.
- Network charges:
  - A delivery or connection cost – maximum kVA or kW (electricity), or for reticulated gas a GJ/hour draw off rate.
  - Maximum demand charges – these vary between lines companies and are used to incentivise customers to reduce the number of peaks in their consumption pattern.
  - Power factor – affects kVA and sometimes an addition charge in terms of kVAr (reactive power).
- GST and prompt payment discounts.

You need to be consistent in handling account data. Include or ignore these charges as suits you, but always be consistent.

The simplest way to get an overview of your accounts is to plot your account data on a graph. Include separate plots for each chargeable item, as well as the total.

Because unit energy costs vary considerably, it's usually worthwhile plotting both cost and energy. This can be done easily using a computer spreadsheet. Refer to Figure 1.

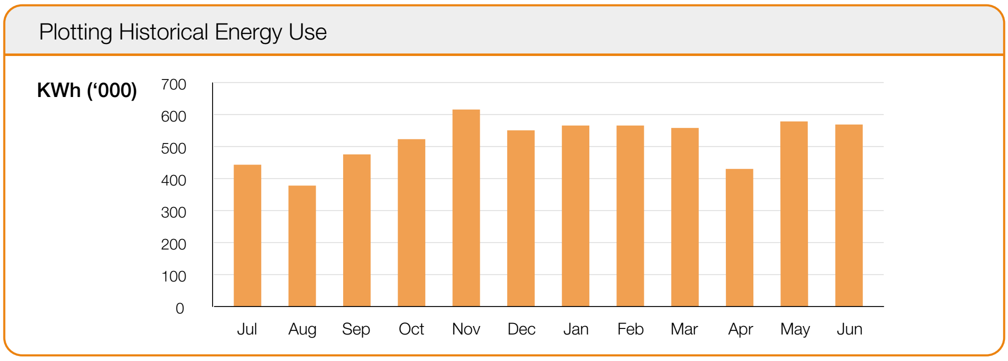
Most energy retailers will be able to supply you with detailed plots of your energy use on monthly, weekly or daily graphs. Negotiate with them to get the information that best suits you.

The patterns or trends from this simple process allow you to identify:

- Variations in energy consumption – you should be able to relate these to variations in your operations.
- Seasonal patterns.
- Abnormally high peaks in consumption.
- Opportunities for improved management of your energy-using systems, e.g. can you change operations to reduce the kVA demand to reduce your network costs and maximise the use of cheaper off peak energy?
- Unexpected consumption, e.g. are you using significant amounts of night-rate energy when your facility is shut down? Can you account for the amount of energy consumed at any particular time e.g. over the weekend?
- Simple key performance indicators, such as the total cost of energy divided by the total energy consumed, measured in cents per kilowatt-hour or dollars per gigajoule.

Repeating this simple exercise for the previous two or three years will give you an indication of how your longer-term energy use patterns change. It is best to cover at least two years worth of energy to enable the effects of seasonal changes in production or mild versus cold winters to be studied.

Figure 1 – Plotting historical energy use



Normalising your data

You may need to factor out changes in variables that are beyond your control, such as weather conditions or operational changes caused by seasonal demands. Refer to EECA Business guide "Monitoring and Targeting" **www.eecabusiness.govt.nz/node/6634**

You can normalise, refer to Figure 2:

- Seasonal output variation by dividing energy by actual output.
- Production demand changes by dividing energy by actual output.
- Space heating and cooling loads by dividing energy by weather (heating or cooling degree-day) data, available from NIWA (the National Institute of Water and Atmospheric Research), **www.niwa.co.nz** or similar organisations.

Calculate the Energy Use Index (EUI), which is total energy use divided by floor area of a building, or divided by production. Plotting these energy use and other variables on graphs is the clearest way to convey this information to others. Some energy managers add a second vertical axis with production data to their energy use plots.

Figure 2 – Normalising energy use

Example of normalising data using degree days			
Annual energy accounts for a hospital show the following			
Year 1	2459 tonnes of coal consumed		
Year 2	2300 tonnes of coal consumed		
At a first glance it appears that the lower the energy consumption in Year 2 represents a more efficient use of energy. However, when the severity of the winter is taken into account, a more accurate and quite different picture is shown.			
	Coal	Degrees days	T / dd
Year 1	2459	1495	1.645
Year 2	2300	1296	1.775
The Year 2 (with the less severe heating requirements) has a greater use of energy per unit of required heating, implying a less efficient use of energy.			

Comparative energy pricing

By developing simple models of total energy cost, divided by delivered energy, you can accurately assess the real costs of alternative energy sources. For example, compare the use of coal and gas to fuel a boiler.

Energy purchase costs are not the only costs involved in this analysis. Some types of energy have additional on-site handling costs, or energy conversion and distribution costs, e.g. coal to steam to final process, or even post-use/emissions treatment costs. Only when you have the information that you get from an analysis of your historical energy use do you have the information needed to make informed choices.

Advanced analysis tools

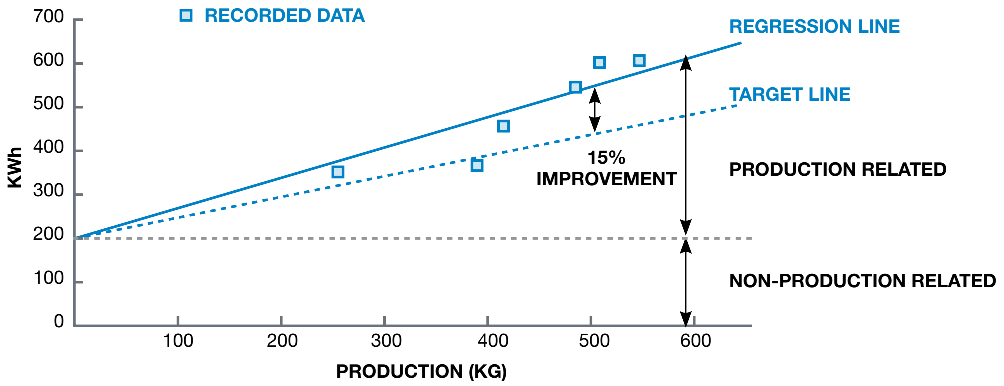
Statistical analysis of your data provides an added level of information. Statistical procedures which may assist you and are available on spreadsheet programs include regression analysis and CUSUM (cumulative sum difference) analysis. Refer to the EECA Business guide “Monitoring and Targeting” for an in depth understanding of these techniques.

With regression analysis, refer to Figure 3, you can:

- Predict energy use for any production output. This simplifies budgeting and planning.
- Set targets by defining a target line at a given percentage below the regression line.
- Establish base load (non-production related energy use).

Analysing changes in energy use with CUSUM analysis can show clearly the long-term effects of cumulative changes. CUSUM is a plot of the differences between targeted energy use and the actual usage, and accumulates that difference as a historical trend.

Figure 3 – Regression analysis



Effective energy auditing

This is part of the "Understanding" stage in the Energy Management Cycle. Usually, one of the early steps in an Energy Management Programme is to conduct an energy audit.

This section includes some 'best practice' tips for conducting a successful audit. Energy audits are a crucial part of the energy management process. They determine how efficiently energy is being used, identify energy and cost saving opportunities, and highlight potential improvements in comfort and productivity.

The aims of an audit

The ultimate goal is to improve your profitability, however some energy audits may be initiated because of immediate energy shortages, environmental concerns, or to improve an energy or environmental star rating. Because of this financial focus, the audit should express energy uses as costs and recommend the most cost-effective options – and these may not always be the ones that use less energy overall.

A well-conducted audit gives you benchmarks by comparing your energy use with that of similar installations. You also gain information to support possible changes and improvements. Options for improvements are costed so you can weigh these investments against future energy cost savings, and prioritise the options in order of cost and benefit.

As energy is such an integral part of any industrial or commercial activity, an audit often exposes opportunities to improve productivity, comfort, or safety. These additional benefits often exceed the returns available from energy-saving opportunities.

Who should do audits?

The staff who operate the plant or building may appear to be obvious candidates. They live with the system, they know its characteristics, and the reasons why it is called on to operate as it does. They will continue to live with it long after an audit.

An in-house audit may keep the costs internal, but often lack the necessary investigative and technical skills. Also, an in-house approach looses the independent third-party perspective. Staff undertaking the audit may have been involved in the original plant design or set up. Using staff from another division with similar systems may go some way to resolving this problem.

External, and Accredited (refer to **www.emanz.org.nz**), auditors have technical ability, third-party independence, work to an Audit Standard (AS/NZS 3598:2000), and often bring wider experience than your own staff in the behaviour of plant and control systems. They look at the operating problems from an external perspective, and often analyse performance from an independent benchmark or from first principles.

Whoever does the audit must be able to express problems and solutions clearly to management. The financial aspects of energy and productivity costs and savings are the key information. They need to be substantiated by concise technical overviews that allow others to understand the technical processes involved.

The energy auditor should also be able to advise on options such as fuel switching, equipment and controls, upgrades and heat recovery equipment. Tariff assessment and negotiation, and fuel tendering, may also come into the energy audit.

To find an energy auditor visit the Energy Management Association of New Zealand website **www.emanz.org.nz** or contact:

- EECA **www.eecabusiness.govt.nz**
- Energy and multi-disciplinary consulting engineers.
- Product suppliers that provide specialist expertise – note, they may lack overview and independence.

Presently, grants for up to 33% of the cost of an accredited auditor are available from the Energy Efficiency and Conservation Authority (EECA). For more information on whether you're eligible phone EECA on **0800 358 676** or **visit www.eecabusiness.govt.nz**

Targeting the audit

For large or multiple sites, it is sometimes valuable to do a pilot survey to get an overview and identify key areas for an audit. Similarly, audits can be targeted by undertaking a historical review of energy usage to determine the major areas of energy use for a detailed audit. The better an audit is targeted, the more likely it is to provide the focused information needed.

Different types of audit

The New Zealand and Australia Energy Auditing Standard AS/NZS 3598/2000 specifies what should be done in an audit. The standard lists three levels of energy audit:

Level 1. A survey of the energy costs on-site and a comparison to the relevant benchmark. This type of audit is relatively inexpensive but only shows whether or not energy consumption is excessive – it doesn't identify savings opportunities. However, the observations of an experienced auditor can be very useful. An on-site visit is optional.

Level 2. This is what is normally considered an 'energy audit' in New Zealand. It includes everything in a Level 1 audit plus a comprehensive site inspection, energy balance (reconciliation of purchases and end-uses) and a list of savings opportunities. It is based on observations, one-time (snapshot) measurements made during the survey, and interviews with site staff. Costs and savings are estimated based on the known assumptions. This level of audit is adequate for most premises, unless more detailed justification of capital expenditures is required.

Level 3. This is a more detailed and comprehensive version of a Level 2 audit. Savings opportunities are identified in more detail and are based on measurements taken over time, so they are more reliable. Costs and savings are typically estimated to within 10%, and more effort is put into assessing the long-term financial aspects of any recommendations. Level 3 audits can be done on specific opportunities as well as on whole sites. Typically this level of audit is done for investment purposes e.g. where a financier requires credit risk analysis as well as a technical and cost report.

The most valuable part of the audit report is often the list of energy savings opportunities which will enable you to prepare an action plan. The savings opportunities should be ranked by the nature of their investment and payback cost streams. A generally-accepted system based on capital investment will probably be used to order the opportunities.

For a copy of a model audit visit the Resources section of **www.emanz.org.nz**

1. Determining the brief for an auditor

All energy uses in the building or plant should be considered, including process energy, refrigeration, lighting, motor systems, heating, ventilating, air conditioning (HVAC systems) and domestic hot water. As the client you may decide to restrict the brief to specific systems or features, or to widen it to include associated issues such as water consumption.

In addition, all audits should review the effectiveness of your energy monitoring, implementation, and energy management systems.

2. Analysing historical energy usage

This should compare present energy use with other months' or years', and analyse the use pattern for unusual highs and lows and seasonal variations. Abnormalities such as heating systems that operate into the summer can often be identified by this analysis. Discrepancies between billings and observed use patterns may be identified.

3. Technical analysis

Usually this is the heart of an audit. Significant energy loads should be analysed by a person skilled in those systems. For example, an auditor reviewing the technical features of a lighting system comments on:

- Condition and potential remaining working life
- Maintenance
- Suitability for their application and safety issues
- Compliance with accepted lighting codes
- Energy consumption
- Comparison of energy use with established benchmarks
- Options for modification or replacement
- Costs and benefits of alternative options.

Each major energy-using system should have its own section in the audit report.

Although an industrial process may be the main energy-using system in a plant it does not mean that ancillary systems should be treated less rigorously. They often have opportunities for improvement that are easier to capture.

Auditors need to make themselves familiar with your process, and you need to take care specifying what the audit covers. You will get the level of investigation you ask for! Refer to Standard AS/NZS 3598:2000 – Energy Audits.

4. Reporting

A useful audit report will have clear and brief discussions, easily read tables or graphs, concise explanations, and clearly prioritised costs and payback periods.

Calculating simple payback period is a useful tool for prioritising, but may under-sell the long-term projects (see page 20 for more information on simple payback). Ensure these benefits are accounted for by specifying the type of long-term analysis your organisation usually uses.

5. Verifying savings

Without measurements to verify the performance of energy management initiatives, it is difficult to track savings. You need to monitor all initiatives to find out whether they require financing or not. This will involve an on-site survey, possibly with temporary metering.

Staff involvement

Staff involvement, both during the audit and in on-going monitoring of energy use, is particularly important. The effectiveness of audits can be compromised because auditors can't or don't access your staffs' wealth of understanding about the plant, process or buildings. The closer you and your staff work with your auditor, the more valuable your audit report will be.

Maintaining the information

Because the operation and working environment of any organisation changes, an audit does have a use-by date. This may be as little as one year in a fast-changing industry. An audit does not replace, but rather complements, a continuous energy monitoring process which tracks changes in energy use and the resulting savings. Refer to the Energy Management Cycle at the beginning of this guide.

Past audits should be reviewed periodically. Energy costs, technologies and your business all change. Projects that were not cost effective 18 months ago may well be cost effective now.

To get funding for energy efficiency projects you will require a well developed business case which evaluates how the project will benefit the organisation.

Developing a business case for projects

Developing a business case is part of "Implementing" in the Energy Management Cycle. The demand for investment capital always exceeds supply. Energy efficiency projects compete for funds with other projects, so the business case for each project must be presented in a logical and thorough way if it is to be approved.

The business case evaluates how the proposal will benefit the organisation. The financial benefits are the most important aspect. When formulating them, it is important to work closely with your accountant or finance department.

You should also include the benefits of the project which are difficult to quantify in financial terms, but are essential elements of the business case, e.g. improved health and safety.

Developing the business case requires looking at all aspects of the investment. The financial justification must be sound, but remember to include benefits which are difficult to quantify but could sway the decision in your favour.

Issues to consider in developing the business case

Competition: You are competing for funds with other parts of the business. Consider which other projects will be competing for the same funding dollar.

Perception: Many organisations view energy as a fixed overhead without appreciating that it can be controlled.

Invisibility: The financial benefits of energy savings are often not allocated to the department or site that approves the expenditure.

Priorities: Energy management is often seen as maintenance rather than business development. Companies prefer to invest in schemes which might generate new business, rather than energy saving projects which would increase profits from existing business. Energy projects sometimes require a higher rate of return to receive funding so you may need to put a case for all projects to be treated equally in terms of financial payback.

Filter-down: While senior management may have committed itself to energy efficiency, this may not have been communicated to the level where funds are allocated.

Tools: It can be difficult to find the information necessary to develop the business case – for example, the correct discount rate to use or the details of potential savings.

Information you need to develop the business case

Cash outflows

- Capital cost of the equipment
- Cost of equipment installation (both internal and external costs)
- Additional operating costs

Cash inflows/savings

- Energy savings from reduced power bills and/or alternative types of energy
- Sale of the old equipment
- Labour savings in the form of wage reduction and reduction in employment overheads
- Reduced maintenance costs

Energy tariff details

- Current tariff structure
- Possible alternative tariffs due to reduced energy consumption

Estimated life of the investment

- Life of the energy efficient equipment
- Life of the plant or installation

Taxation impact (necessary only for larger projects)

- Depreciation rates for new equipment and equipment upgrades
- Basis of depreciation calculation (straight line or diminishing value)
- Other funding streams

Non-financial impacts

- Safety
- Productivity improvement
- Product quality
- Equipment reliability
- Environmental improvement
- Working conditions

Discount rate

- This is determined for the whole organisation, depending on its circumstances. Typically it will lie between 8% and 20%

Evaluating potential projects – financial aspects

The time value of money

Money on hand is worth more than the same amount at some future date. How much more depends on the interest rate and how far into the future the expense or savings will occur.

The interest rate

The terms 'interest rate', 'discount rate' and 'rate of return' are often used interchangeably, but each has a slightly different meaning:

Interest rate is the charge made by the lender of the funds and is determined by external factors, the financial history of the borrower and the use to which the funds will be put.

Discount rate is the rate at which money devalues with the passage of time, and is used in evaluation calculations. The discount rate often differs from the prevailing interest rate.

Factors influencing the discount rate:

- The interest the company pays when it borrows money. This depends on its credit rating, and the proportion of its operating funding that is from borrowings (the debt/equity ratio).
- The premium the company expects to achieve above the borrowed funds interest rate.
- The level of taxation the company can expect to pay on profits resulting from the investment.
- The need to pay dividends in order to retain investor confidence.
- The desire to retain profits for expansion and to cover inflation.
- The amount of risk associated with the investment.

All these factors drive the discount rate used above the ruling interest rate available from financial institutions.

Rate of return is the equivalent annual cash flow that will result from an investment, expressed as a percentage. A company will often determine a minimum acceptable rate of return which can be used as the discount rate for financial calculations.

Companies usually decide upon a rate of return that is applicable to their business. It is important that the energy manager is aware of any changes to that rate and incorporates them into the financial calculations.

Most energy efficiency investments have an irreversible component (i.e. little or no salvage value), unlike a bank deposit which can normally be redeemed at any time with no loss of principal. For this reason, and because of risk, the required rate of return can be much higher than prevailing interest rates.

1. Simple payback

Applying simple payback gives an approximate indication of the economic viability of a project. It can be defined as the time required for accumulated savings to equal the initial investment.

Calculation

The investment cost for the project divided by the value of the annual savings achieved, stated as a number of years.

Advantages

- Simple payback is a convenient way of comparing potential projects in different countries, where economic circumstances can be widely diverse in terms of energy costs, labour rates, taxation levels and depreciation practices.
- It can be a useful screening method for establishing which projects should be considered for more detailed evaluation.
- It excludes influences outside the control of the organisation, such as changing electricity tariffs. Short payback periods mean the capital costs will have been paid off while there is still some certainty about these external factors.

Disadvantages

- Simple payback does not take into account costs incurred or savings made after the payback period.
- The time value of money is not considered. This becomes increasingly significant for longer payback periods where future savings have not been discounted back to their present value.
- No consideration is given to the value of the equipment after the payback period.

Example

The cost of replacing a control valve with a variable speed controller in a pump system was $15,900.

This reduced the electricity bill by $5,500 per year.

The simple energy payback = $15,900 divided by $5,500/year = 2.9 years

Any additional savings such as reduced maintenance costs are added to the bottom line to get the total savings payback period.

2. Annual cost or annual savings

In this method, all costs for alternative investments are converted to their equivalent uniform annual costs at your company's discount rate. The capital cost of the equipment is broken down to an equivalent annual cost over the life of the equipment. This annual cost is added to the running costs of the equipment and compared with the annual savings.

Calculation

The PMT (periodic payment) function on spreadsheet programs and financial calculators calculates the periodic payments equivalent to a lump sum payment upfront. For annual cost calculations each period is one year.

> In Microsoft Excel this has the format:
> PMT(rate, nper, pv)
>
> where:
> rate = discount rate for one period
> nper = number of periods
> pv = present value of the capital expenditure

Advantages

- Annual cost or annual savings fits in with the normal patterns of business, in terms of annual budgets and accounts.

Disadvantages

- It depends on the availability of cost and savings data, and needs an assumed interest rate or rate of return.

> **Example**
>
> A motor vehicle fleet of 30 vehicles was converted to run on CNG fuel. The cost of each conversion was $1,800, and the annual fuel saving amounted to $1,000 per year based on travel of 30,000 km per year per vehicle. The estimated life of each vehicle was four years, and the owners of the fleet used a discount rate of 12%.
>
> The periodic payment equivalent of $1800 over 4 years = $593 per year
> Annual savings $1000 -$593 = $407 per vehicle
> Annual savings for the fleet of 30 vehicles = $12,210

3. Discounted Cash Flow (DCF) or Net Present Value (NPV)

This considers the project's revenue streams in future years and converts them to their present value, using a selected discount rate.

Calculation

The NPV (Net Present Value) function in spreadsheet programs and financial calculators calculates the value in today's money of future payments and savings at a particular discount rate.

> In Microsoft Excel this has the format:
> NPV (rate, value 1, value 2...)
>
> where:
> rate = discount rate for one period
> value 1, value 2 = payments and income at each period or cells containing these values

Advantages

- DCF or NPV bring all payments and savings back to a common base: their value in today's money.
- This method allows for simple comparisons between alternatives, especially where alternative projects have differing economic lives.

Disadvantages

- Depends on the availability of payments, costs and savings data.
- Needs an assumed rate of return.
- Does not take price inflation into account, such as:
  - future energy price increases,
  - future labour rates,
  - future costs of maintenance spares.

While these can be estimated, the estimates are usually less accurate towards the end of the life of the installation.

Example

A company is considering replacing the incandescent lamps in its offices with compact fluorescent lamps. The lamps are in use for 2000 hours per year, the cost of electricity is 9c/kWh, and the building has an estimated life of 15 years. The company uses a discount rate of 11%.

Incandescent lamps
Rating = 100W
Life =1,000 hrs (1/2 year)
Replacement cost = $7 ($1 parts and $6 labour)
Annual electricity cost = 100W x 2000 hrs x 15c/kWh = $30
NPV of $30 electricity cost per year for 15 years = -$215.73
NPV of $7 replacement cost every 6 months for 15 years including the initial installation (11% per year is equivalent to 5.54% per 6 months) = -$102.25

Total Discounted Cash Flow for the incandescent lamps = -$317.98

Compact fluorescent lamps
Rating = 28W
Life =10,000 hrs (5 years)
Replacement cost = $13 ($8 parts and $6 labour)
Annual electricity cost = 28W x 2000 hrs x 15c/kWh = $8.40
NPV of $8.40 electricity cost per year for 15 years = -$36.24

NPV of $30 replacement cost every 5 years for 15 years including the initial installation (11 % per year is equivalent to 68.5% per 5 years) = -$27.24

Total Discounted Cash Flow for compact fluorescent lamps = -$84.64

Thus, using compact fluorescent lamps provides an NPV benefit of $230.34 per lamp.

4. Internal Rate of Return (IRR)

This is probably the most powerful and universally applicable method. It does not require a predetermined interest rate or rate of return, but instead determines what this rate is. The calculated rate can then be compared with the organisation's 'hurdle rate' to decide whether to proceed with the investment.

Investments can be ranked according to their respective IRR.

Calculation

The IRR (Internal Rate of Return) function of spreadsheet programs and financial calculators calculates the effective interest rate for a series of cashflows.

> In Microsoft Excel this has the format:
> IRR(values, guess)
>
> where:
> values = cells containing the positive and negative cash flows
> guess = an estimate of the IRR

Advantages

- IRR does not require a predetermined rate of return or discount rate.
- It is a universally accepted method which is widely understood.
- Enables a 'one off' calculation to be compared with the company's 'hurdle rate' or other possible investments. The IRR calculation does not need to be repeated if the hurdle rate changes.

Disadvantages

- IRR is a complex calculation involving an iterative approach, and usually requires a computer.
- Estimates of costs and savings towards the end of the life of the installation can be inaccurate.

Example

The company considering replacing incandescent lamps with compact fluorescent lamps (see DCF example) would have a cash flow for each alternative as follows:

Year	0	1 – 4	5	6 – 9	10	11 – 14	15
Incandescent cash flow	-$7.00	-$44.00	-$44.00	-$44.00	$44.00	-$44.00	-$44.00
Compact cash flow	-$14.00	-$8.40	-$22.40	-$8.40	-$22.40	$8.40	-$22.40
Net cash flow	-$7.00	$35.60	$21.60	$35.60	$21.60	$35.60	$21.60
The IRR for the net cash flow is 508% [IRR(-7, 35.60 x 4, 21.60, 35.60 x 4, 21.60, 35.60 x 4, 21.60)]. Thus the internal rate of return of installing the compact fluorescent lamps is 508%.							

The effect of depreciation and taxation

Businesses allow for the depreciation of physical assets for two reasons:

- To provide for the recovery of capital for the eventual replacement of the assets.
- To enable depreciation cost to be properly charged to the cost of production.

Taxation is applied to the profits of a business. Because energy efficiency benefits the profits of a business directly, the benefits have tax applied to them. At present (2010) the tax rate for business profits is 30%. However, the depreciation costs of the energy efficient equipment investment can be set off against the savings (i.e. increased profits) and thus reduce the tax payable.

Consult your company accountant to determine the minimum project value for which depreciation and taxation need to be considered. The business case for smaller projects below this value can ignore the effects of depreciation.

Methods of depreciation

Two methods are used to depreciate physical assets. You should check with the finance department which method is used in your organisation.

Straight line method: This method assumes that the reduction in value of the asset is directly proportional to its age. Thus the annual depreciation is equal to the cost of the asset, divided by its expected life in years.

Diminishing value method: This is the most common method for plant, machinery and vehicles. The depreciation is calculated as a fixed percentage of the diminishing value of the asset.

Different types of assets are depreciated at different rates. How an asset is recognised for depreciation purposes may alter its business case. Consult your company accountant to ensure that the correct depreciation rate for each item of equipment is used.

Note that when the asset is disposed of at the end of its useful life, the residual value ($316 in the Diminishing Value example above) is added to the normal depreciation for that year. Any proceeds from the disposal of the asset are considered additional income in that year.

Example

A rest home invests $160,000 in a boiler house control system which has the benefit of reducing the energy bill by $50,000 per year. The estimated life of the control system is five years, with a second-hand value of $10,000. The control system is depreciated by the Diminishing Value method at a rate of 25% per year.

If the rest home is operating profitably, the increase in profitability from the reduced energy bill will be taxed. It is therefore important to consider the depreciation when developing the business case for the project as this reduces the tax liability considerably and makes the project far more attractive (IRR of 12.6% versus 2.8%).

Example

Straight line depreciation diminishing value depreciation:

	Straight Line depreciation		Diminishing value depreciation	
Year	**Value Asset**	**Depreciation**	**Value of Asset**	**Depreciation**
0	$1,000	$1,000		
1	$750	$250	$750	$250
2	$500	$250	$563	$187
3	$250	$250	$422	$141
4	0	$250	$316	$105
	Life of asset = 4 years		**Depreciation rate = 25%**	

If the rest home is operating at a loss, there will be no tax payable and the investment will have an IRR of 18.2%. Note that for this example the energy efficiency investment has a finite life of five years. The IRR calculations are based on achieving returns on the initial investment in this period when depreciation and taxation have a dramatic effect on the IRR. If the life of the equipment was substantially longer, the difference between ignoring and considering depreciation would not be as great.

Life of the control system	5 years	10 years
IRR when depreciation is ignored	2.8 %	16.6 %
IRR when depreciation is considered	12.6%	22.1%

Yr	Ignoring Tax and depreciation		Including Tax		Including Tax and Depreciation			
	Initial Cost X	Saving A	Tax @ 33% B	Net Savings X+A-B	Depreciation C	Taxable Savings A-C	Tax @ 33% D	Net Savings X+A-D
0	$160,000							
1		$50,000	$16,500	$33,500	$40,000	$10,000	$3,300	$46,700
2		$50,000	$16,500	$33,500	$30,000	$20,000	$6,600	$43,400
3		$50,000	$16,500	$33,500	$22,500	$27,500	$9,075	$40,925
4		$50,000	$16,500	$33,500	$16,875	$33,125	$10,931	$39,069
5	$10,000*	$50,000	$20,000	$43,500	$40,625**	$9.374	$3,093	$56,907
	Payback = 3.2 yrs		Payback = 4.6 yrs				Payback = 3.7 yrs	
	IRR = 18.2%		IRR = 2.8%				IRR =12.6%	
	*$10,000 = Disposal Value		**$37,970 = Residual value after five years					

Intangible benefits – non-financial aspects of the business case

Investing in energy efficiency projects often results in benefits to the organisation that are not quantified by normal financial analysis. Examples could include:

- Improved safety and working conditions.
- Reduced environmental impact.
- Improved product quality.
- Reduced maintenance.

The less tangible benefits can often be at least as important as the financial benefits. Details of how and when these intangibles will occur forms an important part of the business case.

The financial benefits that result from the energy efficiency investment sometimes relate to the marketing potential for the business and can be difficult to quantify.

For example, if the project reduces steam usage in the factory, this could free up boiler capacity which would allow expansion into new products or services without needing to invest in additional boiler plant.

Or reduced energy costs could reduce the product unit costs, enabling the company to enter new, low-cost market niches for its products. Both of these examples would result in increased revenue streams as well as reduced costs.

Another example could be the promotion of the company and its products as ‘green’ through its adopting energy efficient manufacturing processes. This could result in increased market share in those niches which are sensitive to environmental concerns.

Setting targets

Targets are a statement of management's goals and priorities. Targeting is the management process of setting realistic goals to improve energy efficiency using recorded data, observations, and insights. Refer to EECA Business guide "Monitoring and Targeting" **www.eecabusiness.govt.nz/node/6634** for further information.

Key issues

- Targets need to be attainable. Setting goals too high or too low will compromise your energy programme.
- Targets should be measurable, achievable and consistent with overall policy and output requirements.
- Targets need two essential components – an amount and a time.

Targeting is often linked with monitoring but they are actually two separate activities.

Many organisations install excellent monitoring software, but do not go as far as targeting improvements in their energy use. Other companies take a stab-in-the-dark approach to improvements, without doing the analysis needed to establish if the target is relevant, achievable or challenging enough.

Types of targets

There are two categories of targets – activity targets and quantity targets. Activity targets are particularly suitable for the engineering function, quantity targets for general staff achievements. You should also set financial targets to stimulate and maintain senior management interest.

Activity targets

An activity target requires a programme of activities to be completed over a set time. For instance, the target might be to assess the insulation needs of five buildings in a year.

Other activity targets might be:

- To review the electricity tariffs of all premises in the organisation over the next financial quarter.
- To complete lighting assessments in every building over the next financial year.
- To install meters on all plant expected to consume more than a given threshold amount of energy in the six months ending March 31.

Activity targets are valuable in allocating resources because they can be directly related to the resources required to achieve them. For example, if it takes a week to measure an electricity demand profile and the target calls for profiles at 20 sites over three months, then obviously two recorders will be needed.

Quantity targets

Energy-saving quantity targets are usually expressed in terms of energy intensity. Energy intensity is the ratio of energy consumption to production. This is typically expressed in units of energy per unit of product (kWh/unit or GJ/tonne), enabling ready comparison within a sector.

A quantity target is derived in two ways, 'top-down' or 'bottom-up'. Top-down, you decide the magnitude of the target and the means to achieve it. Bottom-up requires a detailed analysis of what energy saving measures could be implemented, and the level of energy savings they would bring.

Top-down targeting

Setting a good top-down target requires careful consideration. Where possible, you should try and find some reference to use for comparison. If you have more than one factory or a number of buildings, you can use internal comparisons. Otherwise, there is a growing amount of published information you can use.

Bottom-up targeting

Setting a good bottom-up target requires more detailed information on the process and the aims of the Energy Management Programme. There are four areas to consider:

1. How much energy is currently used and where?
2. What savings can be achieved by proper housekeeping with the present plant and processes?
3. What further long-term savings can be achieved from investments in improved plant and processes?
4. What would the minimum energy usage be with new state-of-the-art plant and advanced technology?

Monitoring and reporting

A monitoring and reporting system monitors ongoing energy use, as well as reporting the results in an appropriate and clear form. It is the energy manager's main tool for doing the job but it is not, however, an Energy Management Programme. Refer to EECA Business guide "Monitoring and Targeting" **www.eecabusiness.govt.nz/node/6634** for further information.

Monitoring and reporting can begin as a very simple manual system, with energy bills as the only source of data. Basic calculations can be done using a simple spreadsheet.

At the other end of the spectrum, the monitoring and reporting system can be a complex multi-site computer-based system, with sub metering for every energy accountable centre (EAC), fully integrated into the plant control system. Data can be read on-line, as events occur. The monitoring and reporting system can also be incorporated with the resource and waste management programme, quality assurance and maintenance planning.

Monitoring

Installing check meters through your operation will give you a valuable insight into where your energy is being used and will help target areas of abnormal use. Information from check meters also enables better input costing when tracking product component costs.

It is best to log the energy used by each functional group separately so energy costs can be assigned accurately to various cost centres. You can produce graphs tracking the amount of energy used hour-by-hour or day-by-day to make the point that energy is a variable cost, not just another overhead.

These graphs can be invaluable to an energy manager for identifying problem areas.

Many successful systems run well without computer assistance. It's a case of 'horses for courses'.

Large energy users can justify the cost of expensive computer-based systems. Smaller users may find it a waste of money, effort and time to automate too much.

The system will need to justify itself in terms of potential cost savings. Benchmarking may be needed to determine the potential for improvements. For example, a company that is already using energy efficiently may not be able to justify an expensive monitoring system.

Allocate costs accurately. Create logical energy-accountable centres (EACs) with work groups that reflect responsibility for energy usage. Costs can then be allocated to specific plant areas, services or products, to determine responsibility and accountability for energy use and to calculate the energy use index (EUI). Use EUIs to benchmark your performance against other organisations in the same sector.

Set up metering for each EAC. This can be one of the most expensive parts of the project, especially if the electrical wiring or services piping routes have no relationship to the functional division of the areas. Setting the number of sub-meters involves considering their cost against the cost of the energy supply, and the level of separation required to achieve accountability. You can create 'virtual' meters, which are simply the sum or difference of real meters.

Select and install an appropriate recording mechanism. This can vary from a standard paper form on a clipboard to an on-line data logger. List what the system must deliver, e.g. recording and reporting periods, production variables, and meters required; then select a system that meets your needs within your budget. In many cases, your energy supplier can help.

Monitor and analyse the data. Use whatever tools are required to turn the data into useful information, e.g. regression analysis, CUSUM, degree-days or production normalising.

Perform benchmark studies. These can be both internal, as time-based comparisons, and external, as performance benchmarks. Many industrial sectors have associations which can supply EUI information. This gives a good starting point for setting targets, but care must be taken to fully appreciate the basis of the surveyed information.

Guidelines for an effective monitoring system

- Record only the most relevant variables.
- Ensure measurements are accurate enough to be useful.
- Ensure recordings are regular and frequent enough to pick up any relevant highs and lows, and are compatible with the rate at which control actions occur.
- Record relevant associated data simultaneously, e.g. ambient temperature and production rate.
- Install sub-meters to measure energy use by areas with separate accountability.

Reporting

There is no sense in generating great volumes of spreadsheets that won't be used. You need to determine which people require regular energy reports. Generally, only people with significant control or accountability for energy usage need them. Then decide exactly what form that information needs to take, and how frequently it must be supplied.

Accountants may require a monthly spreadsheet. A production manager however, may prefer to see a weekly report presented in graphical form.

You should also consider the degree of precision. Some of your recipients, e.g. an operational manager, will need precise numbers, whereas others will just need a general trend.

To make energy reporting part of your organisation's 'business as usual' processes you must find ways to present them which integrate with other regular reports for production, management or board meetings.

This can be crucial for success. Effective reporting to every level will ensure awareness of energy issues is kept high throughout the company and that energy management isn't left out on a limb.

Staging

Monitoring and reporting systems can be implemented in stages, starting with a simple system to confirm the benefits. Often this initial system can be justified and funded based on the improved control that it gives. Logical building blocks, particularly with computer systems, can be added to the monitoring and reporting system for future development. Savings made can be used for funding ongoing improvements.

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For more information contact The Energy Efficiency and Conservation Authority:

EECA HEAD OFFICE: PO Box 388, Wellington, (04) 470 2200

EECA AUCKLAND: PO Box 37444, Parnell, Auckland, (09) 377 5328

EECA CHRISTCHURCH: PO Box 13983, Christchurch, (03) 353 9280

www.eecabusiness.govt.nz

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