Archwilydd Cyffredinol Cymru
Auditor General for Wales

ENERGY AND WATER MANAGEMENT IN THE HIGHER EDUCATION SECTOR IN WALES

Report by the National Audit Office Wales on behalf of the Auditor General for Wales

Published by the National Audit Office Wales and available from:

The Stationery Office Oriel Bookshop
18-19 High Street, Cardiff,
CF10 1PT
Tel 029 2039 5548
Fax 029 2038 4347

Printed on Greencoat paper.
Greencoat is produced using 80% recycled fibre and 20% virgin TCF pulp from sustainable forests.

DG Ref: 5478VE

This report has been prepared for presentation to the National Assembly under the Government of Wales Act 1998.

John Bourn
Auditor General for Wales

National Assembly for Wales
Cardiff Bay
Cardiff
CF99 1NA

30 March 2005

The Auditor General for Wales is totally independent of the National Assembly. He certifies the accounts of the Assembly and its associated sponsored public bodies; and he has statutory authority to report to the Assembly on the economy, efficiency and effectiveness with which the Assembly and its sponsored public bodies have used their resources in discharging their functions.

This report was prepared for the Auditor General for Wales by the National Audit Office Wales.

The National Audit Office Wales study team comprised Janice Lawler, David Metcalfe, Matthew Mortlock, Martin Peters and Darren Williams. For further information about the National Audit Office Wales please contact:

National Audit Office Wales
3-4 Park Place
Cardiff
CF10 3DP
Tel: 029 2067 8500

email: ian.summers@nao.gsi.gov.uk
gillian.body@nao.gsi.gov.uk
Web site address: http://www.agw.wales.gov.uk/index.htm

ISBN 1-90-421926-8

9 781904 219262

ENERGY AND WATER MANAGEMENT IN THE HIGHER EDUCATION SECTOR IN WALES

Report by Auditor General for Wales, presented to the National Assembly on 30 March 2005

Contents

Executive Summary

1 Energy and water management is an important part of estates management in the higher education sector in Wales. The twelve institutions that make up the sector spent in excess of £11 million on energy and water in 2003-04, consuming 355 million kilowatt hours of energy (resulting in carbon dioxide emissions of around 87,000 tonnes) and 1.3 million cubic metres of water. Rising unit energy costs and additional pressures on consumption as a result of the expansion of the higher education sector and the increased use of technology present the risk of escalating energy and water expenditure in future.

2 It is important, therefore, to identify any scope for financial savings from measures to improve energy and water efficiency. This would contribute towards the aim of maximising value for money across the public sector in Wales, highlighted in the Welsh Assembly Government document, *Making the Connections: Delivering Better Public Services for Wales (October 2004)*, which sets a target of an annual one per cent improvement in efficiency for all public organisations. As well as contributing to financial savings, effective energy and water management is necessary in order to help fulfil the requirements of various environmental targets and related legislation. These include the Welsh Assembly Government's sustainable development commitments and targets for reductions in carbon dioxide emissions; the United Kingdom Government's commitments under the Kyoto Protocol; and the impending revision of UK Building Regulations in line with the requirements of the European Union Directive on the energy performance of buildings.

3 This report compares the energy and water consumption of the higher education institutions in Wales with existing benchmarks, and considers the extent to which arrangements for energy and water management across the sector reflect good practice (Part 2). It also identifies practical opportunities for reducing energy and water consumption, and their associated financial and environmental benefits, which might be applied more widely across the sector (Part 3).

Main findings and conclusions

On the use of energy and water by the sector as a whole

4 Energy and water efficiency vary widely among the twelve Higher Education institutions in Wales. For example, energy consumption ranged from 204 to 383 kilowatt hours (kWh) per square metre of internal floor space in 2002-03, and five of the twelve institutions exceeded the Building Research Establishment benchmark of 278 kWh per square metre of floor space.

5 However, local factors such as the proportion of academic and residential space (residential buildings generally consume more energy and water per square metre), and the particular use to which buildings are put are likely to explain some of these differences. The available benchmarks for energy consumption were also set in 1996, since when there has been a significant increase in student numbers and expansion of the higher education estate, as well as an ongoing increase in energy intensive research activity[1]. Notwithstanding these points, the range of energy and water consumption performance of the institutions in Wales suggests that there is scope for improvement, something supported both by our own energy survey findings (Part 3), and by the opinions of most of the estates managers across the sector.

On institutions' arrangements for energy and water management

6 An energy and water management policy is an essential ingredient of effective energy and water management and should help to secure the commitment of senior management to tackling this issue. By January 2005 nine of the twelve institutions had developed, or were in the process of developing, such a policy. Most of these policies included broad statements of intention to follow good practice but lacked any obvious reference to an operational plan with clear and measurable targets. Of the three institutions that were without a policy, two had annual expenditure on energy and water in excess of £1 million.

1 *The Higher Education Funding Council for England has recently sponsored a project on environmental performance improvement and benchmarking in higher education institutions (the HEEPI project), which is intended to develop more up to date benchmarks for the sector at an individual building level.*

7 Current good practice suggests that organisations with annual energy and water expenditure in excess of £1 million should consider employing a dedicated energy and water manager. This would be in addition to, rather than replacing, other operational estates staff with energy and water management responsibilities as part of their role. Only five of the twelve higher education institutions had established such a post, or in one case an environmental officer with significant energy and water management duties. At two of the institutions without an energy and water management post, annual expenditure exceeded £1 million, although in the other five institutions without such a post, annual expenditure was less than £320,000. These smaller institutions may find it difficult to present a business case for a full time energy and water manager but, where appropriate, could consider working with other institutions or public sector bodies in their locality to perhaps jointly fund a position, or to generally share knowledge and experience.

8 A lack of funds for investment was widely identified as a barrier to improvements in energy and water efficiency, with only three institutions having established a dedicated budget for investment in energy and water saving measures. The lack of a dedicated budget does not preclude investment, but means that prospective energy and water saving measures will have to compete against other priorities for funding. Comments made by some estates managers suggested that their institutions were often reluctant to invest their limited capital funds in this area, which was not seen to be related to core business activity.

9 The collection and analysis of reliable data is necessary to identify trends in energy and water consumption and to establish patterns of usage. Only five of the twelve institutions had systems in place for monitoring and targeting energy and water consumption, although a further four institutions were in the process of developing one. Most institutions had installed some sub-metering which enables trends in energy consumption to be analysed at a lower level, such as for individual parts of a larger building. However, where institutions have not incorporated sub-metering within a general monitoring and targeting regime, the full benefits are not necessarily being realised.

10 Institutions need to engage the commitment of staff and students to reducing energy and water consumption, something that was widely identified as a problem by estates managers. As the student population changes annually, this will require a rolling campaign to inculcate an awareness of energy and water consumption issues. In response to our questionnaire survey, four of the twelve institutions were unable to provide any recent examples of any activities undertaken to raise awareness of energy and water efficiency among staff or students.

On the oversight of energy and water management by the Higher Education Funding Council for Wales

11 The Welsh Assembly Government provides funding to, and oversight of, the higher education sector through its sponsored body, the Higher Education Funding Council for Wales (the Council). The Council has undertaken in its corporate strategy and corporate plan to ensure that institutions clearly address sustainability issues, although no specific reference is made to energy and water management.

12 While the Council's own rolling audit review of institutions' management and governance arrangements covers a range of issues relating to energy and water management, this process does not appear to have had any significant impact on these arrangements. Nor has there been a performance management system in place for monitoring energy and water consumption across the higher education estate in Wales. Although figures related to energy and water expenditure are collated as part of the Higher Education Estates Management Statistics (HEEMS) process, which also covers institutions in England and Scotland, data on energy and water consumption has not been included.

13 However, some progress is now being made and discussions are underway between the Carbon Trust in Wales and the Council to involve the higher education institutions in a carbon management project. Also, from 2003-04 the HEEMS data will include coverage of energy and water consumption, as well as related carbon dioxide emissions.

On the scope for financial and environmental savings through practical measures designed to reduce energy and water consumption

14 Energy surveys are an important tool in identifying areas for improvement in energy and water management and can now be obtained free of charge through the Carbon Trust. Prior to our fieldwork, only four of the twelve institutions had themselves commissioned an energy survey in the previous two years.

15 We commissioned our own consultant to carry out energy surveys across a sample of the estate at four of the twelve institutions in Wales. As a result of this work, we identified potential annual financial savings of around £180,000, equivalent to four per cent of their total energy and water expenditure, for an initial investment of £289,000. These financial savings equated to a reduction in energy consumption of almost 10.8 million kWh (equivalent to over 1000 tonnes of carbon dioxide), and a reduction in water consumption of 13.5 thousand cubic metres. Almost two thirds of these savings could be achieved through no or low cost measures.

16 Our consultant's findings were based on only a sample of the estate within each institution and were not extrapolated across the institution as a whole; the value of these savings does not include any climate change levy or VAT paid on the energy saved; and we focused particular attention on low and no cost measures with short payback timescales. However, additional reductions in energy consumption are undoubtedly achievable through more significant capital investment which may have a longer payback. The Welsh Assembly Government's energy efficiency strategy, *Energy Saving Wales*, points to potential energy savings of up to 20 per cent in the public sector in Wales.

17 Our consultant identified a number of recurrent examples, both of good practice that could be adopted more widely across the sector, or poor practice that should be avoided. In many cases institutions could generate reductions in energy and water consumption through simple good housekeeping such as turning off lights, radiators and computer monitors in unoccupied rooms; setting thermostats at a lower level; and ensuring that windows in heated rooms are not left open. Future energy savings may also be possible through the wider application of combined heat and power technology (the local generation of electricity and useful heat in a single process), although current applications are not necessarily appropriate for all University sites due to their seasonal energy demand.

Recommendations

The report makes a total of 13 recommendations, the majority of which are directed specifically at the higher education institutions.

To the Council

i We recommend that the Higher Education Funding Council for Wales agree with the sector a timetable for institutions to:

- appoint a dedicated energy and water manager in line with their annual expenditure on utilities;
- develop an energy and water policy, approved by senior management, with responsibility for its implementation assigned to a named individual;
- make provision for setting aside specific funds for investment in energy and water saving measures, with the aim of achieving investment equivalent to 10 per cent of their energy and water revenue expenditure; and
- adopt management systems to monitor and target their energy consumption.

The Council should monitor the implementation of these measures and hold the institutions to account for their performance. A necessary prerequisite for this will be the development of suitable indicators, building on the current Higher Education Estates Management Statistics, to enable useful comparisons of performance across the sector. This should be facilitated by the environmental performance improvement and benchmarking in Higher Education Institutions (HEEPI) project, which is looking to develop revised performance indicators for the sector at an individual building level.

To Institutions

We recommend that the institutions:

ii compare energy and water consumption performance against national benchmarks at least on an annual basis and, as further benchmarks for individual buildings are developed by the HEEPI project ("Environmental performance improvement and benchmarking in Higher Education Institutions), institutions should use these measures to add further value to their benchmarking;

iii review their energy policies, or where none exists, develop one, in the light of the extensive guidance available both within the higher education sector and externally. The policy should include an operational plan that identifies clear lines of responsibility for energy and water management, sets specific time-related targets for reductions in consumption and makes provision for investment in energy and water saving measures;

iv ensure that all policies are approved at senior management level and reviewed at least biennially, while operational plans supporting these policies should be developed on an annual basis;

v consider appointing a dedicated energy and water manager in line with their annual expenditure on utilities, recognising that even if consumption remains static, energy and water costs are predicted to increase significantly over the next five to ten years;

vi in cases where they consider that an in-house energy and water management appointment is not cost-effective, institutions should seek to increase their expertise by, for example, buying in specialist help, or sharing resources with other higher education institutions or public sector bodies in their locality;

vii work towards the development of a dedicated budget for energy saving measures with the aim of setting a budget equivalent to 10 per cent of energy and water expenditure and set out clear parameters for the appraisal of potential projects, using whole life costing where appropriate;

viii ensure that opportunities for improved energy and water efficiency are maximised as part of their ongoing maintenance programmes;

ix establish a system for monitoring and targeting energy and water consumption to include, as a minimum, monthly meter readings of the main 'fiscal' utility meters (used for charging by energy and water suppliers), and commit resources to enable analysis of the information gathered (readings at more frequent intervals will often be required if problems such as water leaks are to be identified and remedied before significant costs are incurred);

x consider introducing an annual programme at the start of each academic year to educate staff and students in energy and water efficiency. This should be supported by engaging representatives from across all academic and support departments, under the guidance of the energy manager, or equivalent. The representatives would have an ongoing role in upholding good practice and reporting back to the energy manager on areas where remedial action was necessary;

xi carry out an energy survey or, where they have already done so, repeat the exercise within a five year period;

xii assess the applicability of the areas for potential energy and water savings identified by the National Audit Office Wales and, where appropriate, prepare an action plan for their implementation; and

xiii ensure that they claim their full entitlement to exemption from the climate change levy and/or to reduced rates of VAT in relation to their energy supplies, such as in the case of their student residences.

The Big Picture

The twelve higher education institutions in Wales spent over £11 million on energy and water in 2003-04. Rising energy costs and increasing demand mean that, unless improvements in energy and water efficiency are delivered, expenditure is likely to increase significantly over the next five to ten years. In addition, effective energy and water management is necessary in order to help fulfil the requirements of UK and Wales specific environmental targets.

Energy and water efficiency vary widely across the higher education sector in Wales, with several institutions exceeding national benchmarks. Although direct comparisons between institutions must allow for the different uses to which the estates may be put, the overall performance suggests there is scope for improved energy and water efficiency, a view supported by our own local energy survey findings and by the opinions of estates managers across the sector. Furthermore, current arrangements for energy and water management commonly fall short of good practice. For example, it is important that institutions develop formal energy and water policies and related action plans, review the staffing resources available for energy and water management and introduce robust systems for monitoring and targeting energy and water consumption. In addition, institutions need to commit dedicated financial resources for energy and water saving measures and actively engage staff and students in reducing energy and water consumption. The Higher Education Funding Council for Wales must take a more prominent lead in these matters, setting a timetable for action by the institutions, and more rigorously monitor energy and water consumption performance across the sector. These measures, together with local energy surveys to identify more efficient uses of plant and equipment, could yield annual financial savings of at least £500,000 per annum.

Background 1

Higher education institutions in Wales spent over £11 million on energy and water in 2003-04

1.1 Buildings in the higher education estate in Wales cover approximately one million square metres, of which some 55 per cent is academic, teaching and research space, about 28 per cent is residences and 17 per cent office services. In 2003-04 the twelve higher education institutions in Wales[2] spent over £11 million on energy and water, with institutions consuming more than 355 million kilowatt hours (kWh) of energy and 1.3 million cubic metres of water **(see Figure 1)**. The energy component of this consumption resulted in equivalent carbon dioxide emissions of around 88,000 tonnes.

1.2 The largest single source of funding for higher education institutions in Wales is the Higher Education Funding Council for Wales (the Council), an Assembly Sponsored Public Body originally established in 1992 to administer the funding of higher education. The Council is accountable to the Welsh Assembly Government for the use of this money, and a financial memorandum between the Council and each institution sets out the terms and conditions on which funding is provided. As the individual institutions are self-governing, it falls to them to ensure that they obtain value for money from the public funding granted to them. However, the Council also has a responsibility to ensure that public funds are used in an economic, efficient and effective way. The Welsh Assembly Government's document, Making the Connections: Delivering Better Public Services for Wales (October 2004), sets out a commitment to maximise value for money across the Welsh public sector, with a one per cent annual efficiency improvement target for all public organisations. Any improvements in energy and water efficiency would make a contribution to achieving this target.

1 Estimated Energy and Water Consumption and Costs across the Higher Education Estate in Wales, 2003-04

	Consumption	Costs (£'000s inc VAT)	Equivalent carbon dioxide emissions (tonnes)
Electricity	120 million kWh	5,330	42,452
Gas	231 million kWh	3,128	43,862
Oil	4.4 million kWh	86	1,089
Water	1.3 million m^3	2,675	n/a
Total Energy and Water	**355 million kWh 1.3 million m^3**	**11,219**	**87,403**

NOTE

Carbon Dioxide emissions are calculated using standard conversion factors available from the Carbon Trust (Electricity = 0.43kgCO^2/kWh; Gas = 0.19kgCO^2/kWh; Oil = 0.25kgCO^2/kWh. Carbon Dioxide emissions for electricity consumption have been adjusted downwards to account for the fact that around 20.8 million kWh of the electricity consumed was generated from green supplies (renewable/CHP) and therefore resulted in no carbon dioxide emissions.

Although the supply of freshwater and treatment of waste water require an energy input, and therefore result indirectly in carbon emissions, we have not attributed these emissions to the institutions themselves.

Source: National Audit Office Wales Survey of Estates Managers in Higher Education Institutions

2 There were twelve institutions from August 2004 when the University of Wales College of Medicine (UWCM) merged with the University of Wales, Cardiff to become Cardiff University. To avoid confusion, we refer throughout this report to twelve institutions and have excluded UWCM from our analysis, both in terms of its energy consumption/costs and its energy and water management arrangements.

Increasing prices are likely to have a significant impact upon future energy costs, even if the overall level of consumption remains stable

1.3 The opening up of the electricity and gas markets to competition in the 1990s, coupled with relatively low energy costs in real terms, has enabled institutions to achieve savings in energy budgets over the last ten years simply through competitive tendering. Institutions may be able to reap similar benefits with regard to their water supplies with proposals for the introduction of competition in respect of customers who purchase over 50 million litres of water per annum (50,000 cubic metres)[3]. These measures are expected to be introduced in the final quarter of 2005.

1.4 However, electricity and gas costs have risen steadily, and at times sharply, in recent times, reaching a four year peak in October 2004 **(see Figure 2)**. While prices fell back slightly in the last quarter of 2004, they are widely predicted to remain high and to steadily increase over the next decade. Although the full impact of these price rises may not yet have impacted upon institutions, depending on when current contract prices were agreed, efficient energy management is increasingly important both to ensure that current usage is at an appropriate level and to offset the likely rising unit cost of energy[4].

"The general downward trend in utility prices over the last ten years has tended to satisfy the organisation's need to control budgets. There has not been sufficient interest in pursuing additional savings."

Source: National Audit Office Wales Survey of Estates Managers in Higher Education Institutions

The higher education sector has undergone a number of changes that have impacted on the management of energy and water

1.5 In addition to the trends in energy prices, a number of factors within the higher education sector are contributing to the complexity of controlling energy and water management budgets, and increased the demand for utilities.

Rising student numbers will inevitably impact upon energy and water consumption

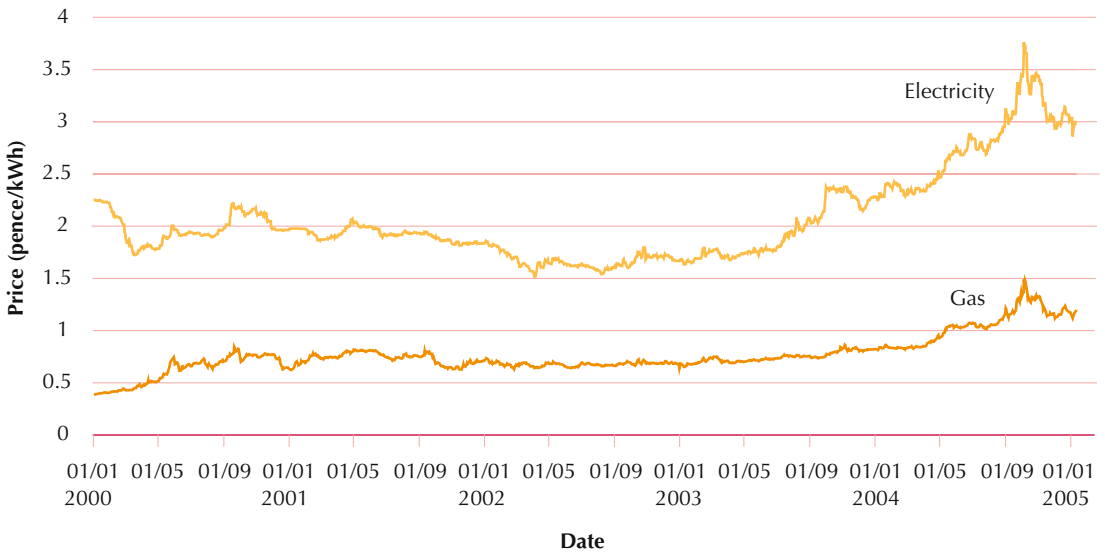
1.6 Enrolments on courses in higher education institutions in Wales increased by 27 per cent (from 89,001 to 113,082) between 1995-96 and 2002-03[5]. This trend is likely to continue as the National Assembly for Wales (the Assembly) is aiming to boost student numbers. In its strategic document *'Better Wales'*, published in 2000, the Assembly set a target of an additional 36,000 students in higher and further education in Wales by 2003.

3 Six of the twelve institutions consumed more than 50,000 cubic metres of water in 2003-04.

4 In addition to the trends in the wholesale cost of energy, the introduction of the Climate Change Levy, from 2001-02, added 0.43 pence per kWh to the cost of electricity and 0.15 pence per kWh to the cost of gas, although exemptions apply to most supplies from renewable, 'green', sources or to certain types of accommodation such as student residences.

5 ELWa 'Higher Education, Further Education and Training Statistics in Wales - 2000-01 and 2002-03'.

2 Wholesale Gas and Electricity Prices, January 2000 to January 2005



Source: John Hall Associates Ltd

The design and condition of much of the higher education estate presents a challenge to energy and water efficiency

1.7 Many of the existing buildings in the sector are increasingly inadequate for the purposes for which they are used. According to the Association of University Directors of Estate, which represents estates and facilities management in higher education, much of the sector's building stock has experienced long-term decline due to under-investment in maintenance and renewal[6]. Based on the A to D classification scale for building condition developed by the Royal Institute of Chartered Surveyors, an average 35 per cent of building space was assessed by institutions as being 'operational, but with major repair or replacement needed soon' **(see Figure 3)**, although this was as high as 69 per cent in one institution. Four per cent of buildings were described as inoperable or presenting a serious risk of failure or breakdown, with one institution describing nine per cent of buildings as falling into the category.

3 The Condition of the Higher Education Estate in Wales

		Percentage of the estate
Category 'A'	As new.	13
Category 'B'	Sound, operationally safe, exhibiting only minor deterioration	47
Category 'C'	Operational, but major repair/replacement needed soon	35
Category 'D'	Inoperable or serious risk of failure or breakdown	4

NOTE

Figures have been rounded to the nearest percentage point

Source: National Audit Office Wales Survey of Estates Managers in Higher Education Institutions (Figures based on responses from eleven institutions that were able to provide this information).

6 *Association of University Directors of Estate response to the DFES consultation paper 'Issues for Higher Education', www.aude.ac.uk/uploads/Issues%20in%20HE%20comment.pdf*

1.8 Other sector buildings, which may be structurally sound and in good repair, have nevertheless proven inefficient in energy terms, as increasing demands have been placed on them. 56 per cent of the sector's non-residential building stock in Wales, measured in terms of floor area, was constructed in the 1960s and 1970s (and a further 27 per cent even earlier). It was therefore constructed at a time when less consideration was given to incorporating energy efficiency features into building design than is the case today. The Association of University Directors of Estate estimates that the energy consumption of an existing sector building, expressed in terms of kWh/m², is typically five times that of a building designed to comply with today's building regulations. Modern buildings, for example, embody design improvements that allow heating and cooling to be integrated through special floor slabs or climate walls, along with new designs for natural ventilation. But none of these innovations can economically be applied retrospectively to existing buildings.

1.9 Several institutions have, in the past, sought to accommodate the expansion of student numbers by purchasing properties such as schools, factories, warehouses and residential houses, which are even less efficient in terms of energy consumption than purpose-built stock dating from the 1960s and 1970s. There are also a number of listed buildings, which are expensive to maintain, and which institutions are therefore constrained in adapting to maximise their energy and water efficiency.

The use of information and communication technology and other energy intensive equipment is increasing

1.10 In the 1960s and 1970s, when most of the sector's present building stock was constructed, use of information and communication technology (ICT) was negligible. Nowadays, teaching in all academic disciplines is increasingly reliant on ICT and, with the expansion of scientific research at some institutions, there is greater use of other energy-intensive equipment. We have been told, for example, that the use of computer equipment at Cardiff University has approximately doubled over the last six years. There has also been a significant growth in computer usage within student residences (as well as the introduction of more en-suite facilities, with consequent increases in water usage).This, coupled with a general increase in the operational use of buildings for teaching and research, where a growing number of academic units are open twenty four hours a day, places greater demands on utilities.

There are limited resources available for investment in more energy and water efficient buildings

1.11 Institutions' capacity to rectify these problems is, however, limited by a lack of financial resources. The availability of funding for the development of the sector estate has historically been subject to tight constraints, either imposed at a national level, or adopted locally by the management of the institutions themselves, which have been reluctant to borrow, even within the criteria set by the Higher Education Funding Council. New types of funding initiatives have become available in recent years, but these can bring their own problems. Private Finance Initiative (PFI) schemes, for example, are suitable for student residences, which have a certainty of costs and benefits, but can burden institutions with higher infrastructure costs and curtail their flexibility for adapting to future challenges in the sector.

Effective energy and water management is necessary in order to fulfil the requirements of certain environmental targets and legislation

1.12 The benefits of improved energy and water efficiency are not only financial: more careful management of these utilities can help to conserve scarce natural resources for future generations. Such considerations are reflected in the increasing commitment by the Assembly and the United Kingdom Government to sustainable development. Under section 121 of the Government of Wales Act, the National Assembly for Wales has a statutory duty to produce a scheme setting out its proposals for promoting sustainable development in the exercise of its functions. In compliance with this, the Assembly published a Scheme, *Learning to Live Differently*, in November 2000, which includes as one of its objectives, 'the prudent use of … non-renewable resources like oil and gas, making sure we use them efficiently and ensuring that alternatives are developed to replace them.' In addition, the Assembly undertook to 'steer sustainable development in Wales, through its own work and that of its sponsored bodies.'

1.13 Carbon dioxide emissions are one of the key sustainable development indicators for Wales, with the Assembly committed to the general UK wide target of a 20 per cent reduction in emissions by 2010, from a 1990 baseline. This target was set by the government with the intention of going beyond the requirements of the United Kingdom's legal obligations under the international Kyoto Protocol. This established a target for the UK of reducing greenhouse gas emissions by 12.5 per cent on 1990 levels by between 2008 and 2012. The role of improved energy efficiency and renewable energy supplies in driving down carbon dioxide emissions is also reflected in the Welsh Assembly Government's energy efficiency action plan, 'Energy Saving Wales', although this does not make any direct reference to the higher education sector.

1.14 In order to encourage progress towards meeting the requirements of the Kyoto Protocol, European Union Directive 2002/91/EC on the energy performance of buildings was brought into force in January 2003. Member states are expected to introduce national legislation in line with this Directive by January 2006, which in the United Kingdom is being translated into a revision of the Building Regulations. The main provisions of the new Directive, which apply to both domestic and non-domestic buildings, are given below **(see Figure 4)**:

4 The Energy Performance of Buildings Directive

- the development of a common methodology for calculating the energy performance of a building, taking into account local climatic conditions;
- minimum standards for energy performance to be determined by Member states and applied to new buildings and to major refurbishments of existing large buildings;
- a system of building certification to make energy consumption levels more visible to owners, tenants and users;
- requirements for the regular inspection of boilers and air conditioning systems above a certain size to verify their energy efficiency and greenhouse gas emissions.

Previous reports on the management of energy and water in the higher education sector have set out a range of good practice

1.15 In 1996, the Higher Education Funding Councils in England, Wales and Scotland, and the Northern Ireland Department for Education carried out a national study of energy management as part of a broader value for money initiative. This resulted in a national report that identified examples of good practice with the aim of generalising them across the sector[7]; a management review guide to facilitate institutions' examination of their own practices[8]; and energy management benchmarking software to enable institutions to produce their own management performance data.

1.16 In July 2003, the United Kingdom Value for Money Steering Group for Higher Education commissioned an updated report which assessed the degree to which institutions had improved their energy management arrangements since 1996, in line with best practice[9]. This report also set out a range of guidance and information including:

- a summary of developments that have impacted on the sector and its energy management arrangements since 1996, e.g. increased student numbers, increased use of information technology and the New Electricity Trading Arrangements governing procurement;
- placing energy management within the context of the wider sustainability agenda in the higher education sector;
- specific guidance on developing an energy policy, developing business cases for funding or appraising potential projects;
- summarising sector-wide initiatives, guidance and events;
- identifying future issues that will impact on energy management arrangements, such as the EC Directive on the Energy Performance of Buildings;
- providing checklists against which to assess the effectiveness of an institution's energy management arrangements in line with best practice; and
- summarising common energy efficiency measures which could be incorporated as part of an energy saving strategy.

7 *Energy Management Study in the Higher Education Sector: National Report, Ref: M5/96 (February 1996). www.hefce.ac.uk/pubs/hefce/1996/m5_96.htm*

8 *Energy Management in the Higher Education Sector: Management Review Guide, Ref M16/96 (May 1996). www.hefce.ac.uk/pubs/hefce/1996/m16_96.htm*

9 *The UK Value for Money Steering Group, Energy management in higher education (July 2003/30). www.hefce.ac.uk/pubs/hefce/2003/03_30.htm*

Scope of the National Audit Office Wales' examination

1.17 This is the first report by the National Audit Office Wales on energy and water management in the higher education sector in Wales. It considers whether the higher education institutions have adequate policies and management systems to help ensure prudent use of energy and water and examines the extent to which the Higher Education Funding Council for Wales is exercising oversight of, and providing guidance and assistance to, the higher education sector in this area of responsibility. As well as examining management arrangements, we consider the opportunities for improvements in the management of consumption, leading to both financial and environmental savings, and make a number of recommendations on how this might be achieved. The report highlights examples of good practice that might be adopted more consistently throughout the sector and, indeed, elsewhere in the public sector[10].

1.18 Our study methods are set out at Appendix 1. In summary, we:

- established the energy and water consumption levels of the twelve higher education institutions and compared these figures with established benchmarks for building performance in the higher education sector;
- examined energy and water consumption policies and processes through fieldwork interviews or survey questionnaires, and compared these with good practice;
- interviewed Welsh Assembly Government and Higher Education Funding Council for Wales staff to assess their role in providing strategic direction and monitoring of the higher education sector's management of energy and water consumption; and
- engaged an energy and water management consultant to identify opportunities for improved energy and water efficiency in a sample of the estate of four of the twelve institutions.

10 *Our examination did not extend to a detailed assessment of the procurement of energy and water supplies, nor to the question of whether Institutions are being correctly charged for the energy and water they consume. However, our forthcoming report on NHS Energy Management will cover these issues.*

2 Energy and water management in the Higher Education sector falls short of good practice in a number of key areas

2.1 This part of our report examines the energy and water efficiency of the higher education institutions in comparison to established benchmarks for consumption, and considers the extent to which the strategic arrangements for energy and water management reflect best practice, with particular reference to the following:

- the development of strategic policies for energy and water management, and any related targets;
- the employment of dedicated staff with responsibility for energy and water management;
- the extent to which dedicated funding is set aside for investment in energy and water saving measures;
- systems for monitoring trends in energy consumption; and
- measures taken to raise staff and student awareness of, and engagement with, energy and water efficiency.

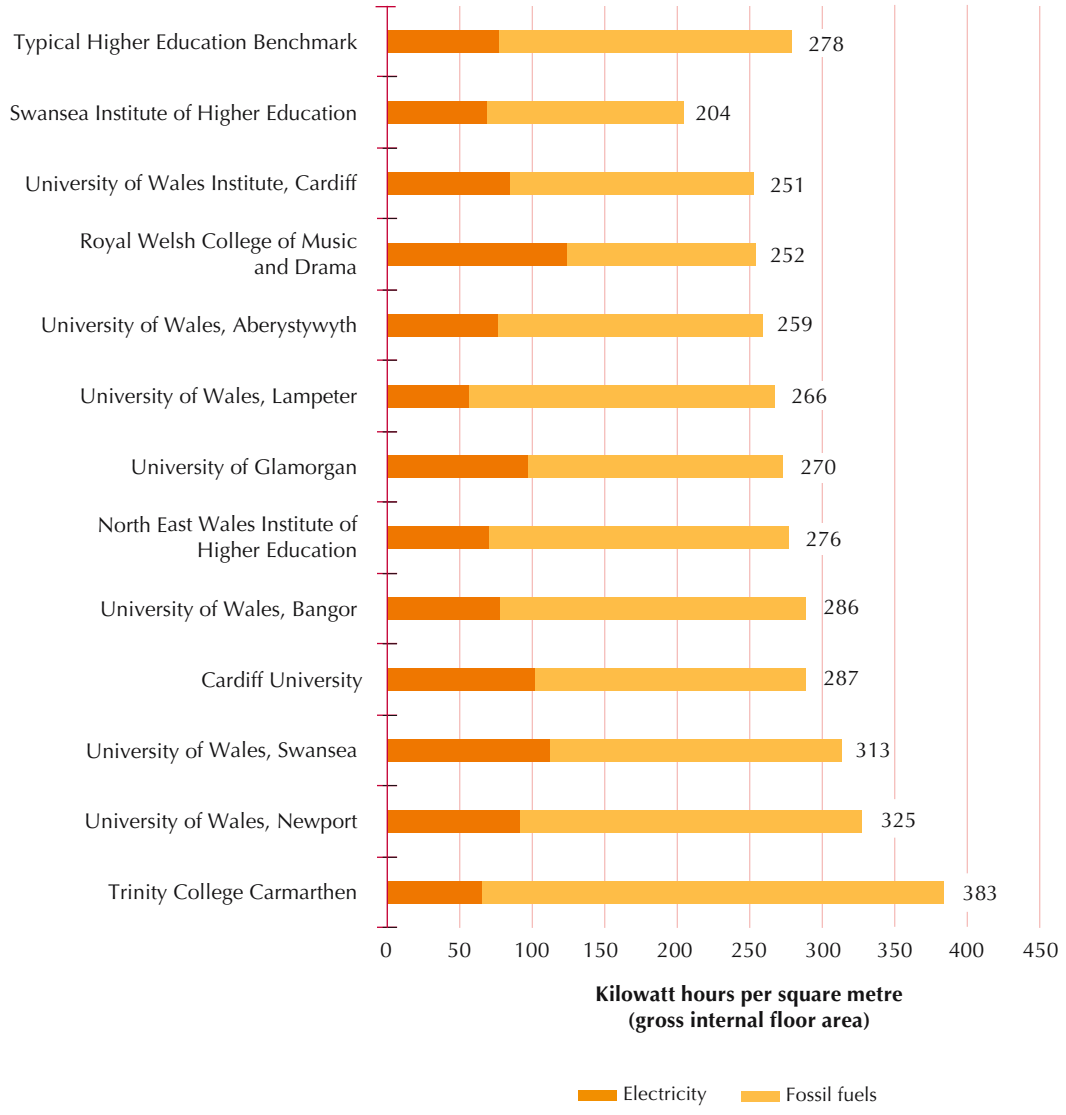
2.2 We also consider the degree of strategic direction given to energy and water management related issues by the Higher Education Funding Council for Wales in its role as the Assembly sponsored public body responsible for administering the funding of higher education in Wales and ensuring value for money in the use of these funds.

There is significant variation in the overall energy and water efficiency of the twelve higher education institutions, while several institutions exceed national benchmarks for energy or water efficiency

2.3 **Figure 5** compares the 2002-03 energy performance of the twelve higher education institutions in Wales. There are significant differences in energy efficiency between the institutions in terms of both their overall consumption, ranging from 204 to 383 kilowatt hours per square metre, and their consumption of electricity and fossil fuels. Five of the twelve institutions are also above the typical benchmark for energy consumption across the sector of 278 kilowatt hours per square metre.

2.4 Variance between institutions, and in comparison to the 'typical' benchmark may be explained by particular local circumstances such as the presence or otherwise of energy intensive research laboratories, hours of use, or the proportion of academic and residential buildings. Furthermore, the benchmark of 278 kilowatt hours per square metre was developed in 1996 by the Building Research Establishment and, as a result of the developments in the higher education sector described in paragraphs 1.6-1.10, some energy managers have questioned its current suitability for many establishments. However, it is also the case that higher average winter temperatures in 2002-03 will have had a negative impact on energy demand, in particular fossil fuel demand for heating, when compared with the benchmark year.

5 Analysis of energy consumption across the twelve higher education institutions in Wales 2003



NOTES

1 Consumption figures for the Royal Welsh College of Music and Drama have been estimated based on their annual energy expenditure when compared to consumption and cost trends in other institutions.

2 Differences between institutions may be explained by the different uses to which the estate is put and the proportion of time in the day during which it is used – for example: research laboratories would be expected to consume more energy and water per square metre than lecture theatres, while residential buildings typically consume more energy and water than academic buildings.

Source: National Audit Office Wales survey of Estates Managers in Higher Education institutions

2.5 In response to these issues, the Higher Education Funding Council for England is sponsoring a project on "Environmental performance improvement and benchmarking in Higher Education Institutions" (the HEEPI project), which is looking to develop revised performance indicators for the sector at an individual building level. Notwithstanding these issues, there are clear opportunities for improvement and in our questionnaire survey to estates managers, nine of the twelve institutions told us that there was scope for a significant reduction in energy and water consumption within the resources currently available.

2.6 Water consumption also varied considerably, from 0.5 cubic metres per square metre of floorspace at Trinity College, Carmarthen to 1.7 cubic metres per square metre at the University of Wales, Swansea. Benchmarks for water consumption in the higher education sector were developed in 2003 as part of the UK Government's Watermark project (www.watermark.gov.uk), carried out under the auspices of the Office for Government Commerce. The 'typical' benchmark level for non-residential buildings[11] is set at consumption of 0.62 cubic metres of water per square metre of internal floor area per year, with a best practice benchmark of 0.4 cubic metres per square metre of internal floor area per year.[12] Of the five institutions that were able to provide an analysis of consumption for non-residential buildings, four were above both the 'best practice', and 'typical' benchmarks for the sector **(see Figure 6)**. However, local factors may again explain these trends, notably the significant scientific research departments at the University of Wales Aberystwyth, Cardiff University and the University of Wales Bangor.

Residential buildings account for a disproportionate amount of the total energy and water consumption

2.7 Five of the twelve institutions were able to provide a breakdown of both energy and water consumption by type of building. Analysis of these figures shows that, although they comprised an average 31 per cent of the total floor area, residential buildings accounted for 50 per cent of the total water consumption and 39 per cent of the total energy consumption. However, this is a common trend across the sector, reflected in the fact that the 'typical' benchmarks for energy consumption developed by the Building Research Establishment are higher for residential buildings than for academic areas, particularly in relation to fossil fuel consumption.

KEY POINTS

on benchmarking energy and water consumption

- There is considerable variation between the energy and water efficiency of the twelve Higher Education institutions and several institutions are in excess of national benchmarks. However, local factors, such as the proportion of academic and residential space, or the presence of energy intensive research laboratories, may contribute to these differences.

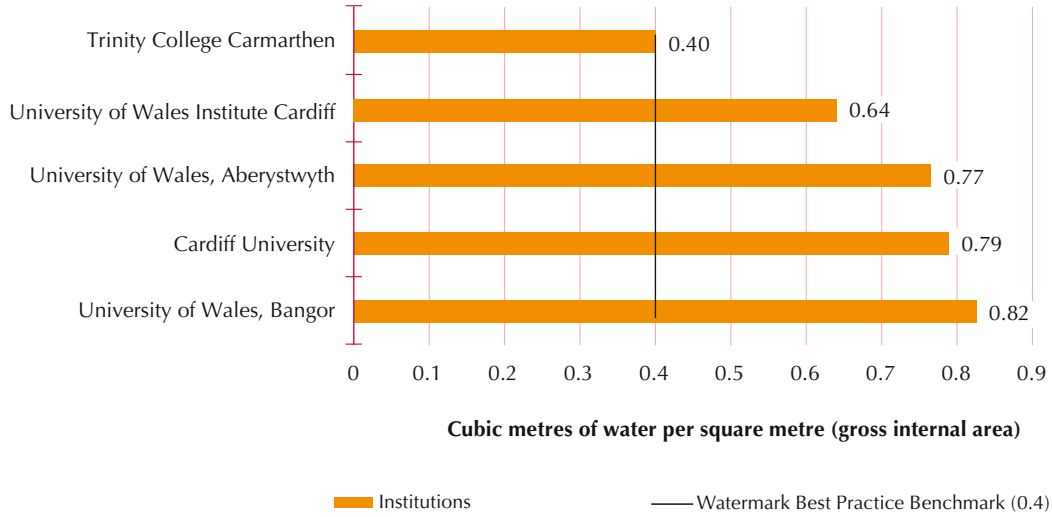
We recommend that:

- institutions compare energy and water consumption performance against national benchmarks on at least an annual basis and, as further benchmarks for individual buildings are developed by the HEEPI project (Environmental performance improvement and benchmarking in Higher Education Institutions), institutions should look to use these measures to add further value to their benchmarking.

11 There is not currently any overall benchmark for water consumption across both residential and non-residential buildings in the higher education sector.

12 Best practice benchmark based on the upper quartile of performance across the United Kingdom.

6 Water consumption across non-residential buildings in five of the twelve higher education institutions in Wales, 2003



NOTE

Differences between institutions may be explained by the different uses to which the estate is put and the proportion of time in the day during which it is used – for example: research laboratories would be expected to consume more energy and water per square metre than lecture theatres, while residential buildings typically consume more energy and water than academic buildings.

Source: National Audit Office Wales Survey of Estates Managers in Higher Education Institutions

Not all institutions have a satisfactory energy and water management policy

2.8 An energy management policy is essential for the efficient management of utilities. It provides the framework and direction within which resources can be prioritised and activity developed. As well as seeking to minimise the cost of procurement, policies should set out the principles for controlling energy consumption, identify areas of high usage and set targets for energy reduction. They should also consider an investment programme to improve the energy efficiency of the buildings. In order to take account of changing circumstances, institutions should review their policies every two years.

2.9 At the time of our survey, nine of the twelve institutions reported that they had produced, or were in the process of developing, an energy management policy **(see Figure 7)**. Of the three institutions without a policy, two had average annual energy and water expenditure in excess of £1 million, although both of these institutions reported substantial coverage of energy and water management issues in other corporate documents such as their corporate plan, estates strategy, procurement strategy, or separate environmental policy.

7 Institutions with an energy and water management policy

Institution	Average annual energy and water expenditure 2002-04 (£000s inc. VAT)	Does the institution have an energy and water management policy?
University of Wales, Swansea	1,722	✓*
University of Wales, Bangor	1,480	✓
University of Glamorgan	815	✓
University of Wales Institute, Cardiff	757	✓*
University of Wales, Newport	453	✓*
North East Wales Institute of Higher Education	318	✓
Swansea Institute of Higher Education	304	✓*
University of Wales, Lampeter	225	✓*
Royal Welsh College of Music and Drama	82	✓
Cardiff University	2,994	✘
University of Wales, Aberystwyth	1,394	✘
Trinity College, Carmarthen	241	✘

* Under review or development at the time of our survey

NOTE

Corporate policy statements on energy and water conservation at the University of Glamorgan are contained within their Environmental Handbook as part of their wider environmental strategy and ISO14001 certified environmental management system. However, these policies are not as detailed as in those institutions with stand alone documents.

Source: National Audit Office Wales survey of Estates Managers in Higher Education Institutions

2.10 Advice on the development and implementation of an energy policy is available from a number of organisations, for example, the Carbon Trust, a government - funded body, which advises businesses and the public sector on how to reduce carbon emissions. In addition, the UK Value for Money Steering Group, an advisory group to all the Higher Education Funding Councils, has produced guidance specific to the sector **(see Figure 8)**, including links to recommended policies from other institutions in England and Scotland.

2.11 The policies that we examined varied in length, style and content. Although no one style is obligatory in this context, all policies should include certain elements common to good practice. For example, it is important that a corporate policy statement is supported by a more detailed operational plan with specific measurable targets for consumption. At the time of our survey, only three institutions reported having developed specific targets for energy and water consumption but these were not contained in their energy policy documents, and none of the policies reported on energy and water consumption performance. Most strategies were deficient in at least one other key area, for example:

- linking the policy to the institution's corporate plan, and specifically to objectives for sustainable development;
- identifying clear lines of responsibility for energy and water management; and
- making a clear commitment to investment in energy saving measures or project appraisal criteria.

8 Guidance on the Development of an Energy and Water Management Policy

In their report *'Energy Management in Higher Education'*, published in July 2003, the UK Value for Money Steering Group reviewed a sample of policies from Higher Education institutions that demonstrated the implementation of good practice. These were all found to have contained two core strategic elements:

1. A comprehensive energy policy covering the management of all utilities that formed an integral part of the institution's corporate plan
2. A shorter term operational energy plan covering the implementation and monitoring of clearly defined annual objectives and performance measures

Key features of the energy policy

- Forward looking to take account of planned and possible future regulatory frameworks;
- Defined key strategic aims and values (linked clearly to the institution's corporate plan);
- Assessment of risk (ensuring arrangements are in place regarding risks to energy supplies); use of alternative energy sources; impact of UK government energy taxation policies; EC guidelines and directives;
- Establishment of a management structure which might include the responsibilities of senior management and major committees, the appointment or definition of an energy management team and the personal responsibilities of staff and students; and
- Commitment to the implementation of legislation and best practice guidance relating to energy and water management.

Key features of the energy plan

- Performance monitoring and reporting, target setting and communication;
- Energy awareness campaigns and training, including the training needs of those directly responsible for energy management
- Energy purchasing, including available sources of energy and possible improvements in supply, as well as the impact of emerging energy technologies;
- Inclusion of energy related matters and projects in maintenance programmes and adoption of energy efficient design specifications; and
- Investment in energy saving measures and project appraisal criteria.

2.12 In addition to these core elements of good practice, senior management oversight of, and support for, an institution's energy management policy is critical to ensuring that the organisation gives the appropriate priority to this area. We found that the higher education institution policies that were in place had all been approved at Management Board level or by the Vice Chancellor. Notably, the estates manager at one of the three institutions without an energy policy highlighted a lack of serious interest at senior management level as one of the key barriers to improved energy and water efficiency, although even in one of the institutions with a policy, a lack of commitment from senior managment was still a source of concern.

Staffing resources within estates departments are often limited and only five of the twelve institutions have a dedicated energy and water manager

2.13 Dedicated staff resources are needed to monitor and control energy and water use, develop an investment programme and monitor progress against targets. Best practice guidance recommends that a full-time manager should be engaged where energy expenditure exceeds £1 million per annum. This is based on one hour a week per £25,000 expenditure on energy, and reflects the general principle that these posts should be self-financing from the savings they can deliver.

KEY POINTS

on energy and water management policies

- By January 2005 nine of the twelve institutions had developed, or were in the process of developing, an energy and water management policy. Most policies included broad statements of intention to follow good practice but lacked any obvious reference to an operational plan with clear and measurable targets. Of the three institutions that were without a policy, two had expenditure in excess of £1 million.

We recommend that:

- all institutions should review their energy policies, or where none exists, develop one, in the light of the extensive guidance available both within the higher education sector and externally. The policy should include an operational plan that identifies clear lines of responsibility for energy and water management, sets specific time-related targets for reductions in consumption and makes provision for investment in energy and water saving measures; and
- all policies should be approved at senior management level and reviewed at least biennially, while operational plans supporting these policies should be developed on an annual basis.

2.14 Overall, only six of the twelve institutions' estates managers believed that they had sufficient resources available with which to effectively manage energy and water efficiency, while **Figure 9** shows that only five institutions had a dedicated energy and water manager or, in the case of University of Wales, Newport, an environmental officer with energy and water management duties. Those institutions without an energy and water manager post include the three institutions highlighted previously in Figure 7 as also lacking a formal energy policy. In the case of Cardiff University, although there is no formal energy policy nor energy and water manager, our consultant identified some examples of good practice in relation to their monitoring and targeting and building energy management systems (see paragraph 2.22 and 3.9). Our consultant nevertheless recommended the establishment of an energy and water manager post, the business case for which should be even stronger now, following the merger with the University of Wales College of Medicine and the additional energy expenditure that will result.

2.15 One advantage that higher education institutions are likely to have is access to internal academic expertise to support their estates departments in carrying out their energy and water management functions, with five of the twelve institutions reporting that such expertise was available and being used. For example, the North East Wales Institute of Higher Education utilises expertise from within its School of Environmental Studies in delivering energy awareness campaigns, while at Cardiff University a staff member in the School of Architecture produces monthly reports analysing consumption trends for individual buildings, and providing action points.

9 Higher Education institutions with a dedicated energy and water manager

Institution	Average annual energy and water expenditure 2002-04 (£000's inc. VAT)	Does the institution have a dedicated energy and water manager?
Cardiff University	**2,994**	✘
University of Wales, Swansea	**1,722**	✓
University of Wales, Bangor	**1,480**	✓
University of Wales, Aberystwyth	**1,394**	✘
University of Glamorgan	815	✓
University of Wales Institute, Cardiff	757	✓
University of Wales, Newport	453	✓
North East Wales Institute of Higher Education	318	✘
Swansea Institute of Higher Education	304	✘
Trinity College, Carmarthen	241	✘
University of Wales, Lampeter	225	✘
Royal Welsh College of Music and Drama	82	✘

NOTES

1 Institutions in bold have energy and water expenditure greater than £1 million per annum, which, best practice suggests, warrants a dedicated energy and water manager.

2 The lack of a dedicated energy and water manager does not mean that there are no staff resources for energy and water management, but rather that there is no single individual with energy and water management as a significant part of their job description.

Source: National Audit Office Wales Survey of Estates Managers in Higher Education Institutions

2.16 In some smaller institutions, where resources are more limited, two or more establishments might jointly consider funding an energy and water management post. Alternatively, a post holder employed by one institution could be engaged as a consultant by a smaller institution requiring a more limited degree of support. Such solutions are in keeping with the 'reconfiguration' agenda of the Assembly, which seeks to make better use of the resources available in the sector by promoting more collaborative methods of delivering both teaching and support services. All the institutions told us that they already seek to spread best practice through informal networking or through professional bodies such as the Association of University Directors of Estate. The basis therefore exists for a cross-institutional approach to energy and water management. Alternatively, institutions could look to forge links with other public sector bodies in their locality **(see Case Study A)**.

A Cross sector co-operation at the North East Wales Institute of Higher Education (NEWI)

NEWI buys in the expertise of the principal energy officer of Wrexham County Borough Council. He monitors the usage of energy on site, ensures that bills are checked against meter readings and produces a quarterly report. In addition, he advises on the procurement of energy and gas and provides back-up and support to the estates officer. He does not formally advise on energy efficiency measures but draws attention to problems where he comes across them. He has succeeded in obtaining energy and water at competitive prices and in carrying out effective monitoring and targeting of the Institute's utilities' consumption. Moreover, the cost of buying-in his services compares favourably with that of equivalent consultancy available elsewhere.

Source: National Audit Office Wales visit to NEWI

KEY POINTS

on the appointment of an energy and water manager

- Only five of the twelve higher education institutions have a dedicated energy and water manager. At two of the institutions without such a post, annual expenditure on energy and water exceeds £1 million, the recommended threshold for a full-time appointment.

We recommend that:

- all institutions consider appointing a dedicated energy and water manager in line with their annual expenditure on utilities, recognising that even if consumption remains static, energy and water costs are predicted to increase significantly over the next five to ten years; and
- where institutions consider that an in-house energy and water management appointment is not cost-effective, they should seek to increase their expertise by, for example, buying in specialist help, or sharing resources with other higher education institutions or public sector bodies in their locality.

Only three of the twelve institutions set aside specific budgets for energy and water saving measures

2.17 In response to our questionnaire survey, six of the twelve estates managers cited a lack of investment as one of the three main barriers to improving energy and water efficiency in their institutions. Of these, two estates managers also made specific mention of payback periods as an obstacle to the institution's willingness to commit to projects.

"Resources for capital expenditure are very limited leading to a make do and mend culture."

"Whilst it is arguable that energy efficiency improvements will provide a long term pay-back the capital outlay can be an obstacle with so many other claims on resources."

"Last year the replacement of three boilers by more efficient models was deferred because of cash constraints. Expenditure on energy efficiency measures must compete with other calls on funds that are more obviously related to core business activity, and is not regarded as an investment."

Source: National Audit Office Wales Survey of Estates Managers in Higher Education Institutions

2.18 These views are borne out by the fact that only three institutions have established specific budgetary provision for investment in energy saving measures. At the University of Wales, Bangor, the new energy and water management policy makes provision for the equivalent of five per cent of their annual energy and water revenue expenditure for investment in energy saving measures which, if met, would be equivalent to around £70,000. There is also a specific energy conservation budget at Cardiff University, set at £55,000 per annum. However, even these examples fall short of best practice which suggests setting aside the equivalent of 10 per cent of annual energy and water expenditure specifically for energy saving measures.

2.19 The lack of a dedicated budget for energy saving measures does not necessarily preclude all investment, but prospective projects have to compete against other priorities for funding from the general estates budget. It is also the case that, in the course of routine maintenance, improvements may be made which will also deliver benefits in terms of energy and water efficiency, but that would be met from the general maintenance budget. For example, Cardiff University noted that their maintenance budget had recently funded £50,000 worth of lighting improvements, with subsequent energy efficiency benefits. Similarly, Swansea Institute of Higher Education reported that energy reduction measures such as energy saving lighting and thermostatic radiator valves were being fitted, where possible and practical, during maintenance and upgrades. Most of the twelve institutions stated that considerations of energy and water efficiency were generally or fully reflected in the planning and prioritisation of maintenance programmes, although two institutions reported that this was only occasionally the case. However, provision within the sector is generally ad hoc and in most cases funding has not been allocated to the "invest to save" measures recommended in previous energy surveys.

KEY POINTS

on investing in energy and water saving measures

- Only three institutions had established dedicated budgets for investment in energy and water saving measures, with some estates departments reporting that their institutions are often reluctant to invest their limited capital funds in measures that are not related to core business activity.

We recommend that:

- all institutions work towards the development of a dedicated budget for energy saving measures with the aim of setting a budget equivalent to 10 per cent of energy and water expenditure and that they set clear parameters for the appraisal of potential projects, using whole life costing where appropriate;
- institutions also ensure that opportunities for improved energy and water efficiency are maximised as part of their ongoing maintenance programmes.

Only five of the twelve institutions routinely monitor energy or water consumption

2.20 The collection and analysis of reliable data is necessary to control energy and water consumption and to identify patterns of usage. As a minimum, institutions should collect readings from fiscal meters (used for charging by energy and water suppliers) on a monthly basis. Relying on bills from suppliers is not satisfactory as their frequency and timeliness may vary, and they may provide estimated rather than actual readings.

2.21 In response to our questionnaire survey, only five of the twelve institutions reported that they regularly monitor and target energy and water consumption, although in one case this was limited to energy consumption, and related to a minor part of the total estate. A further four institutions reported that a monitoring and targeting system was in the process of being developed. In some cases, this lack of management information was reflected in the difficulties that some institutions have had in providing us with up to date statistics on their energy consumption and costs.

2.22 The use of sub-metering, whereby meters are fitted to individual buildings, or to parts of buildings, irrespective of whether they are used for charging by utility suppliers, can further enhance any monitoring and targeting, as it allows trends in consumption to be broken down into smaller units[13]. Six institutions reported that they had installed sub-metering over all or most of their estate, although this was limited in one case to water consumption, with the intention of extension to electricity and gas as funds permit. A further three institutions reported having installed sub-metering on a minor part of their estate. However, given that only five of the nine institutions with sub-metering reported having a monitoring and targeting regime in place, the exact purpose of the sub-metering in the other four institutions is unclear. The most elaborate monitoring and targeting system identified in the course of our work, supported by a considerable sub-metering programme, was that of Cardiff University **(see Case Study B)**.

B Monitoring and Targeting at Cardiff University

Cardiff University has a monitoring and targeting system that allows it to assess the relative energy and water efficiency of its buildings, and to identify and address any undue increases in consumption. The system is based on the use of 780 electricity, gas and water meters, which are read manually, in a process that takes two days each month. The metered data is analysed by a member of the academic staff, who produces comprehensive monthly reports, setting out trends in consumption, evaluating the impact of past conservation initiatives and identifying further energy and water saving opportunities.

Cardiff's use of monitoring and targeting was held up as a positive example for the sector as long as ago as 1996, in a Good Practice Case Study produced under the Government's Energy Efficiency Best Practice Programme. Nevertheless, there remains scope for improvement. Most importantly, the practical application of the system to make savings is hampered by the fact that there is no single person who is directly responsible for energy and water, or who has the necessary authority to control energy usage or waste by other departments **(see Case Study D)**.

13 Changes to UK Building Regulations mean that where embarking on new builds or major refurbishments of existing buildings, sub-metering will be required to be fitted as a standard measure.

KEY POINTS

on monitoring and targeting of energy and water consumptions

- Only five of the twelve institutions have systems in place for monitoring and targeting energy and water consumption, although a further four institutions were in the process of developing one.
- Most institutions have installed some sub-metering to enable trends in energy or water consumption to be analysed in greater detail. However, with some institutions not implementing a regular monitoring and targeting regime, the full benefits of these sub-meters are not always being realised.

We recommend that:

- all institutions establish a system for monitoring and targeting energy and water consumption to include, as a minimum, monthly meter readings of the main 'fiscal' utility meters, (used for charging by energy and water suppliers) and to commit resources to enable analysis of the information gathered (readings at more frequent intervals will often be required if problems such as water leaks are to be identified and remedied before significant costs are incurred).

Institutions could do more to raise awareness and secure the commitment of staff and students with regard to energy and water efficiency

2.23 Across most of the higher education sector, academic departments are free to make use of classrooms, research laboratories and other facilities as they see fit, in accordance with their own teaching or research needs. They are rarely charged directly for the energy and water they consume and considerations of energy and water efficiency are therefore likely to occupy a low priority. This problem is equally acute in the residences, where students pay a flat-rate rent, which includes energy and water consumption and provides no personal incentive to conserve resources.

"Academic schools do not seem to consider energy conservation as part of their work. I have considered energy charging (to departments) but this is difficult in shared accommodation."

"Departments will not take the initiative on energy, water or environmental initiatives unless their departments are charged."

Source: National Audit Office Wales Survey of Estates Managers in Higher Education Institutions

2.24 Six of the twelve institutions' estates managers identified a lack of awareness or commitment on the part of staff and/or students as a significant barrier to improvements in energy and water efficiency. Furthermore, five estates managers felt that staff rarely or never used the estate in such a way as to enable the efficient use of energy or water, while seven institutions indicated a similar response with regard to students. One estates manager, for example, noted that many staff continued to use portable electric heaters to raise heating levels to what they felt was a comfortable level, despite this being against the institution's policy.

"Unfortunately, although many staff will expound the virtues of energy efficiency, their practices are seldom what they preach."

"Staff often leave lighting and electrical equipment on when they leave work at the end of the day."

"Staff and students in particular often open windows to control room temperatures rather than turning radiators down or off."

Source: National Audit Office Wales Survey of Estates Managers in Higher Education Institutions

2.25 Any attempt to inculcate an awareness of energy and water consumption must take account of the annual turnover of a significant proportion of the student population. Awareness campaigns, therefore, must be repeated regularly both to capture the new intake, and to remind the remaining staff and students who may have reverted to former habits. Despite the common complaints about staff and student practices, when asked to comment on any initiatives undertaken to raise awareness of energy and water efficiency issues among staff and students in the previous two years, four of the twelve institutions were unable to provide any examples. One approach taken by a number of institutions has been the establishment of an energy and water committee, or equivalent, drawing together staff from across a range of departments, and in some cases also student representatives **(see Case Study C)**.

C The energy and water task group at Swansea Institute of Higher Education

The Swansea Institute of Higher Education has established an Energy and Water Task Group, chaired by their Environment Manager, and comprising the Director of Estates, two academic staff, two site managers, the Energy and Water Records Officer, Finance Officer and Health and Safety Officer. This group is tasked with reducing unnecessary energy expenditure, raising awareness among staff and students, and achieving good environmental practices covering both energy and water. Over the past year, this group has had a particular role in monitoring progress with the implementation of the institute's energy action plan, which builds on the findings of an Action Energy survey carried out in 2003.

KEY POINTS

on raising awareness among staff and students on energy and water consumption

- Institutions need to engage the commitment of staff and students in order to maximise the efficient management of energy and water. As the student population changes annually, this will require a rolling campaign to inculcate an awareness of energy and water consumption and best practice.

We recommend that:

- institutions consider introducing an annual programme at the start of each academic year to educate staff and students in energy and water efficiency. This should be supported by engaging representatives from across all academic and support departments, under the guidance of the energy manager, or equivalent. The representatives would have an ongoing role in upholding good practice and reporting back to the energy manager on areas where remedial action was necessary.

The Higher Education Funding Council for Wales provides only limited oversight of the higher education sector's management of energy and water

2.26 Like all Assembly Sponsored Public Bodies, the Council receives an annual remit letter from the Welsh Assembly Government setting out its responsibilities and priorities for the year ahead. Both the 2003-04 and 2004-05 remit letters underline the importance of sustainable development and the need for it to be considered as an integral part of the Council's activities. The 2004-05 letter adds that sustainable development should be *"… mainstreamed into the core of the way business is done, for example, through your estate management, procurement processes and programme activities. Your operational plan should set out how you will do this."*

2.27 The Council's Corporate Strategy to 2010 includes as one of its performance indicators *"evidence of increased attention to sustainability in institutions' behaviour";* and the Council's corporate plan for 2004-07 includes proposals to:

- work with institutions to enable them to make sustainability a central tenet of their strategic planning; and
- ensure that strategic plans and responses to Council initiatives address the sustainability agenda.

2.28 These objectives were also translated into the Council's 2003-04 operational plan, although there is no specific reference to energy and water management. Council officials told us that, while energy and water management is important, they have in the past had very limited resources with which to deal with the whole area of estates. In July 2004, however, the Council appointed a full-time head of estates, and has consequently been able to devote more time and effort to this area.

2.29 As part of its stewardship role, the Council's audit service reviews the management and governance of each institution every three years with interim follow-up reviews. The audit includes consideration of whether institutions have an energy management strategy, including initiatives or targets to reduce energy consumption, and what management information is maintained on energy costs and consumption. However, given the deficiencies that still remain with regard to these aspects of performance in a number of institutions, it would appear that this process is not having sufficient impact.

2.30 Furthermore, there is no adequate performance management system in place for monitoring energy consumption across the higher education estate in Wales. Although figures relating to energy and water expenditure are collected as part of the Higher Education Estates Management Statistics (HEEMS), these have not hitherto been sufficiently detailed to allow a useful comparison of performance within the sector. The current weaknesses in the institutions' management of energy and water indicate the need for closer oversight of their performance in this area. Although the Council has been involved, along with the other UK higher education funding councils, in the development of the two good practice reports described previously in paragraphs 1.15 - 1.16, this guidance does not appear to have been universally acted upon and, in some cases may not even have reached its intended audience[14].

14 Only eight of the twelve energy/estates managers who responded to our survey reported having read the 1996 Energy Management Study in the Higher Education Sector report produced by the UK Funding Councils, and only five reported having read the more recent 2003 follow up report by the UK Value for Money Steering Group.

2.31 The data collected and made available through HEEMS is, however, in the process of becoming more sophisticated. From 2003-04, institutions have been asked to report on their carbon emissions and to split their energy and water consumption between residential and non-residential categories. They will also be asked whether they purchase any of their energy on a 'green' tariff.

2.32 In our survey questionnaire to estates managers we asked what, if any, additional support they would like to see from the Council. Responses ranged from further information and targeted funding, to providing a financial incentive for energy-saving measures. The most detailed suggestion was that the Funding Council should institute a *"requirement to improve performance measured through benchmarking - could be linked to funding, with energy budgets set centrally, those institutions performing well could reinvest surplus, those not could self-finance their deficit"*.

2.33 In recent months the Council has discussed with the Carbon Trust the involvement of higher education institutions in Wales as part of a pilot Carbon Management project across the higher education sector in England and Wales, which is being implemented over the coming year. This project, which will be conducted in collaboration with consultants, is likely to involve one or two institutions in Wales and will result in a toolkit for institutions to assist the development of their energy and carbon reduction strategies. Decisions on possible funding opportunities for energy efficiency measures are then likely to follow.

KEY POINTS

on the role of the Higher Education Funding Council for Wales

- In their Corporate Strategy and Corporate Plan, the Council has undertaken to ensure that institutions clearly address the sustainability agenda within their own strategic planning. This was also reflected in the Council's 2003-04 Operational Plan, although there is no specific reference to energy and water management.
- The Council has had limited oversight of the sector's management of energy and water, and their current three-yearly review of institutions has had insufficient impact on the sector's performance.

We recommend that:

- the Higher Education Funding Council for Wales agree with the sector a timetable for institutions to:
  - appoint a dedicated energy and water manager in line with their annual expenditure on utilities (paragraphs 2.13-2.16);
  - develop an energy and water policy, approved by senior management, with responsibility for its implementation assigned to a named individual (paragraphs 2.8-2.12);
  - make provision for setting aside specific funds for investment in energy and water saving measures, with the aim of achieving investment equivalent to 10 per cent of their energy and water revenue expenditure (paragraphs 2.17-2.19); and
  - adopt management systems to monitor and target their energy consumption (paragraphs 2.20-2.22).

The Council should in turn monitor the implementation of these measures and hold the institutions to account for their performance. A necessary prerequisite for this will be the development of suitable indicators, building on the current Higher Education Estates Management Statistics, to enable useful comparisons of performance across the sector. This should be facilitated by the environmental performance improvement and benchmarking in Higher Education Institutions (HEEPI) project, which is looking to develop revised performance indicators for the sector at an individual building level.

3 There is scope for financial savings through improved management of energy and water consumption in the higher education estate

3.1 The scope for reducing energy consumption depends to some extent on the condition and type of building and equipment in use. However, even without investment in upgrading buildings or equipment, there are opportunities for financial and environmental savings through behavioural change on the part of the users of the estate **(see Figure 10 below)**.

10 Common examples of energy inefficiency

- **lights, radiators and computer monitors left switched on in unoccupied rooms**: for example, the Carbon Trust estimates that turning off lights in empty rooms and corridors - especially at the end of the day - can save up to 15 per cent of an organisation's lighting bill. This includes fluorescent lighting, which should be switched off for periods of absence longer than five minutes. (it is a myth that turning fluorescent lights on and off uses more energy than leaving them on);
- **using cathode-ray tube (CRT) computer monitors**: CRT monitors are increasingly being replaced by flat, thin film transistor (TFT) screens which typically consume 50 per cent less power;
- **thermostats set at an unnecessarily high level**; the Carbon Trust recommends setting thermostats at 19°C and points out that heating costs rise by 8 per cent for every 1°C increase; and
- **windows in heated rooms left open**: if the occupants become too warm, it is more efficient to turn down radiators.

3.2 As part of our examination we engaged an energy consultant to review current practices at four of the twelve institutions (Cardiff University; University of Glamorgan; University of Wales Lampeter and the North East Wales Institute of Higher Education) and to advise on areas where energy and financial savings might be achieved. This part of our report summarises the outcome of his work which identified three broad categories: where no additional cost would be incurred; where modest investment would be needed; and finally, where more significant capital investment would be necessary[15].

3.3 Prior to our own fieldwork, only four of the twelve higher education institutions had commissioned an energy survey for all or part of their estate in the previous two years. Energy surveys are important as they identify areas for improvement and provide a baseline against which to measure progress. In the cases where institutions had commissioned surveys, these had all been carried out through the Carbon Trust's Action Energy Programme which offers a range of surveys to public sector institutions mainly free of charge, and tailored to the specific needs of the organisation (see Appendix 3). The findings of these Action Energy surveys identified similar issues to those identified in our own fieldwork, suggesting that there are common areas for the sector as a whole to address if it is to improve its energy and water efficiency.

15 Full details of the potential energy saving measures identified within each institution, as well as the relative investment required, can be found in Appendix 2.

We estimate that savings of at least £500,000 per annum are possible through improved energy and water efficiency across the sector

3.4 Across the four institutions that we visited, we found evidence of scope for savings of over £180,000 per annum in the parts of the estate inspected. Two thirds of this could be delivered through no cost and low cost investments. The total investment required to deliver this saving amounted to £289,000, indicating an average payback on investment of just over one and a half years **(see Figure 11)**. The measures recommended would also produce an estimated reduction in carbon dioxide emissions of 1046 tonnes per annum.

3.5 Savings of £180,000 per annum equated to around four per cent of the total energy and water expenditure (including VAT) across the four institutions visited, although this varied from three per cent at Cardiff University to 15 per cent at the University of Wales, Lampeter. The institutions that we visited were selected in order to provide a representative sample of the sector in Wales as a whole, in terms of the size, age, condition and type of estate. It is therefore reasonable to suppose that proportionately similar savings could be achieved across the remaining institutions. This would be equivalent to an annual saving of £500,000, although we estimate that potential savings are much higher than this for a number of reasons:

- the savings identified by our consultant were based only on the proportion of the estate that he was able to examine within the context of our one to two day visits, and the value of these savings was not extrapolated across the institution as a whole. It is therefore likely that further savings potential could have been identified had we been able to examine the whole estate, or spend longer in the parts of the estate that we examined;
- we asked our consultant to focus particular attention on practical low and no cost measures which would deliver improved energy and water efficiency within short to medium term payback periods. There is undoubtedly scope for further energy savings through more significant capital investment but for which the payback periods are likely to be considerably longer. Furthermore, our consultant recommended a range of additional items for investigation in each institution which might deliver energy and water efficiencies but the costs and benefits of which were not quantifiable within the scope of our visits;
- the value of the savings identified does not allow for any climate change levy (CCL) or value added tax (VAT) that would otherwise have to be paid on the energy or water consumed; and
- although not the primary purpose of his visit, our consultant identified savings opportunities relating to the procurement of energy and water supplies, only some of which have been included in our calculations.
- the Welsh Assembly Government's energy efficiency strategy, *Energy Saving Wales*, points to potential energy savings of up to 20 per cent in the public sector in Wales.

11 Summary of potential savings identified through our visits to four higher education institutions in Wales

	Financial (£s)	Annual savings Energy (kWh) Water (m^3)	CO^2 (tonnes)	Investment required (£s)	Payback (Years)
No cost measures - immediate payback	71,160	1,117,500 kWh 50 m^3		0	0
Low cost measures - rapid payback	48,485	1,172,075 kWh 7,500 m^3	396.3	£94,595	2.0
Higher cost measures - longer payback	60,580	8,499,030 kWh 6,000 m^3	494.9	£194,200	3.2
Total	**180,225**	**10,788,605 kWh 13,550 m^3**	**1046.3**	**£288,795**	**1.6**

Source: MilTec Consulting

3.6 Our fieldwork identified several recurrent examples, both of good practice that could be adopted more widely, and of poor practice that should be avoided. The remainder of this part of our report sets out these common issues, supported by specific examples from our visits to four institutions. It should be borne in mind, however, that each institution is different and that local circumstances might mean that a particular innovation would not be applicable in every case.

Institutions could make better use of Building Energy Management Systems to control energy consumption

3.7 The application of a building energy management system (BEMS) to the building services on a large estate can save energy and maintenance time. All buildings have some form of mechanical and electrical services in order to provide the facilities necessary for maintaining a comfortable working environment. These services have to be controlled by some means to ensure, for example, that there is adequate hot water for sinks, that radiators give out sufficient heat or that systems provide cooling, depending on the prevailing conditions and irrespective of the number of occupants or individual preferences.

3.8 The purpose of a BEMS is to automate and take control of these operations in the most efficient way possible. A BEMS typically consists of one or more self-contained computer based 'outstations' which uses software to control energy consuming plant and equipment, and which can monitor and report on the plant's performance. These outstations have the ability to be linked together in a modular fashion by a network, and can communicate with each other and with an optional central operator's terminal, which is often a conventional Personal Computer (PC).

3.9 Ten of the twelve institutions reported having some sort of BEMS in operation, although the extent of the coverage varied, with three institutions reporting that these systems incorporated only a minor part of the total estate (the rest reporting coverage of most or all of the estate). The configuration of the systems can vary; this affects the effective control of the building and the ease with which they can be operated. The BEMS in the four institutions that we surveyed covered the full spectrum, from an obsolete system at the University of Wales, Lampeter, which was resulting in excessive energy consumption, to a better system at the University of Glamorgan, which could nevertheless have been improved - not least by the removal of its cumbersome dial-up communication - to the very effective system at Cardiff University, which our consultant highlighted as the standard for other institutions to emulate **(see Case Study D)**.

"The BEMS allows a quicker and better response to plant failure ensuring that systems are kept running efficiently. It also allows for the identification of hot-spots and cool-spots."

Source: National Audit Office Wales Survey of Estates Managers in Higher Education Institutions

D The Building Energy Management System (BEMS) at Cardiff University

The BEMS at Cardiff University is an example of good practice for other establishments to emulate. Without the BEMS and the dedication of the two engineers, energy usage would be much higher, particularly due to the energy intensive Bio Science research buildings. Our consultant estimated that savings of between £200,000 to £300,000 per annum were being achieved, equivalent to around 10 per cent of the institution's annual energy and water expenditure.

Whilst already operating efficiently, our consultant noted that the system could be further developed to include automatic reading of the University's 780 utility meters, to improve what is already a well developed monitoring and targeting regime. The system could also be extended to the remaining 10 per cent of properties, thus eliminating the need for local controllers and timer-switches. simplifying maintenance and allowing even greater control of consumption.

3.10 The overall success of a BEMS in reducing an institution's consumption will depend not only upon the extent of coverage, or sophistication of the system, but also upon the extent to which the opportunities offered by the system are maximised. In response to our questionnaire, one institution noted that a recent initiative to optimise BEMS settings resulted in a reduction of 27 per cent in gas consumption at their largest campus during 2003-04. Improvements to the settings or use of BEMS to control consumption was a common opportunity identified in our visits to the four institutions **(see Case Study E)**.

Improvements in lighting offer widespread opportunities for energy savings

3.11 There is considerable scope for efficiencies in lighting at institutions. Ensuring staff and students switch off lights in unoccupied rooms would alone produce savings of some £17,000. Another energy saving measure would be to improve controls to enable selective lighting in areas of partial use and/or presence detection systems **(see case study F)**. Overall, lighting issues accounted for around one third of the annual financial savings identified by our consultant during our visits to the four institutions.

3.12 Most institutions have large, several- twin tube fluorescent lights. These tend to have ageing prismatic diffusers that restrict the light output and become brittle, which can cause them to drop from their fittings, potentially causing injury. Continued improvements in lighting mean that a good economic case can be made for replacing these obsolescent fittings with high frequency T5 presence- and photocell-controlled fittings (which have slimmer tubes, typically 16 millimetres in diameter), allowing good quality light to be provided, and only when it is needed **(see case study G)**.

E Improvements to the Building Energy Management System at the North East Wales Institute of Higher Education (NEWI) at no additional cost

The Building Energy Management System at NEWI controls the heating and ventilation for the majority of buildings across the estate. Our consultant identified a number of opportunities to refine set points on the system and to improve the overall control strategy Examples included turning off boilers in the 'Students Village' and Sports Centre during periods of warm weather and, in the library adjusting by several degrees the setting that prevents chillers running during cool weather. The combination of measures identified were estimated to deliver annual financial savings of £2,810 and a carbon dioxide reduction of 39.2 tonnes at no capital cost.

F Sports Hall lighting at NEWI - presence controlled lighting recommended

The Sports Hall at NEWI is illuminated by 24 pairs of lamps. As is common with Sports Centres, the switches for the sports hall at NEWI are in the reception area so it is difficult for the receptionist to see if there are no occupants and switch the lights off. Furthermore, at times such as examinations, only 50 per cent of the hall is used but, due to the lamps being wired in rows lengthways rather than widthways, it is not possible to switch half off.

Our consultant therefore recommended the application of a remotely addressed latching reset lighting control system. This would control each half of the hall via presence sensors with a manual override timer for times when the hall is used for examinations. The estimated annual cost saving was £1,730, and 14.8 tonnes of carbon, for an investment of £4,800.

G Potential replacement of twin tube fluorescent light fittings at Cardiff University

The twin fluorescent fittings with ageing yellowing prismatic diffusers in the older premises at Cardiff University, particularly the main building, provide a good opportunity for replacement and upgrade to achieve better ambient conditions and save energy. Upgrading the fittings to modern efficient single-tube, high frequency fluorescent fittings, with T5 tubes and mirror reflectors, will reduce energy. We estimate that this would produce an annual saving of £33,040, and 344 tonnes of carbon, for an initial investment of £120,000 (payback period: 3.6 years).

Investments in water efficiency measures are likely to produce a good return

3.13 Whilst taken for granted by many, water is an expensive commodity and combined freshwater supply and sewerage costs averaged £2 per cubic metre across the 12 institutions in 2003-04. Given the relatively high unit costs, investment in water-saving measures is likely to produce a worthwhile return. One prime opportunity identified during our survey visits was the wider adoption of waterless urinals. For example, we found that the North East Wales Institute of Higher Education had achieved 18 per cent savings on its water costs as a result of using 'Ecobug', an environmentally friendly system that involves adding a tablet to the urinal bowl approximately every two weeks. In addition to significant savings on water, there is a reduction in limescale (and consequently the need for pipe maintenance) and in the use of chemicals and bleaches. Our consultant identified opportunities for the installation of waterless urinals in the other three institutions visited that could collectively save £24,555 per annum for an initial investment of £26,000.

3.14 The University of Glamorgan was found to have experimented with a similar system in the past but to have abandoned it as a consequence of pipes having become blocked by residue, partly as a result of cleaners emptying their buckets into the urinals. The cleaners at NEWI, however, seem to have coped satisfactorily with the new regime, and we would advise the other institutions to consider adopting waterless urinals as well.

3.15 If unchecked, water leaks can represent a significant cost to institutions. While such leaks will often occur underground, unseen to the naked eye, a robust monitoring and targeting regime (see paragraphs 2.20 to 2.22) would enable the identification of any significant anomalies in water consumption caused by a leak. Even minor leaks through dripping taps and valves can cumulatively result in significant costs which could be easily rectified.

Restrictions on the use of unauthorised electrical appliances within student residences

3.16 It is not uncommon for students to bring personal electrical items, such as kettles, toasters and even heaters, into institutions' residences and this will sometimes be permissible, particularly where there are no adequate communal facilities. However, this is potentially costly to the institutions, and this cost cannot be recovered from the students. Moreover, these appliances can sometimes represent a fire safety hazard.

3.17 Improved awareness among students about energy and water efficiency may help to encourage more responsible and energy-conscious behaviour but where the availability of alternative facilities obviates the need for students to bring their own high power electrical devices on to campus, institutions could simply consider prohibiting such devices. For example, the University of Glamorgan has banned students from bringing their own kettles, toasters and electric heaters. If a student should overload a circuit, causing a breaker to trip out, he or she is charged a reset fee. In 2002-03, this policy had helped the University to achieve electrical consumption for its student residences of 21kWh/m^2 compared to the benchmark of 85kWh/m^2. **Case Study H** describes the potential for a similar approach restricting the use of electrical appliances in student residences at the North East Wales Institute of Higher Education.

H Potential savings from the restriction of high power electrical appliances at North East Wales Institute of Higher Education (NEWI)

Two of the newer student village blocks at NEWI include one communal kitchenette for every six rooms, so there is no need for students to have cooking appliances or kettles in their rooms. Our consultant recommended that, to prevent the use of high power appliances, a six amp miniature circuit breaker could be fitted with an advisory note in each room (and a rule book) stating that the maximum allowable load that can be plugged in is three amps, which would allow for a reading lamp, personal computer (with printer) and a television.

If applied to these residences, this measure could deliver an annual energy saving of 22,000 kWh and financial saving of £1,100 for an initial outlay of only £1,200. The reduction in carbon dioxide emissions would be equivalent to nine and a half tonnes per annum.

Installing time-switches on canned drink vending machines is a simple and effective way of reducing energy consumption

3.18 Collectively, these machines, with their refrigeration units and fluorescent tubes represent a significant waste of energy if they are left on 24 hours a day regardless of whether the buildings which house them are open for use. Fitting time-switches to these machines therefore represents a simple and effective means of reducing energy consumption and costs. Where machines have been provided without timer switches, the institutions could either install their own or ask suppliers to provide them. Vending machines are common to all establishments and across three of the four institutions[16] visited our consultant identified opportunities for the use of timer devices that would collectively save £1,410 for an initial investment of £1,280 **(see Case Study I)**.

I The operation of canned drink vending machines at the University of Glamorgan

During our visit to the University of Glamorgan, canned drink vending machines in the various buildings were observed to be left on continually, running the refrigeration compressor and backlight unnecessarily. The addition of a 7 day plug-in time-switch set to turn these machines off during the night, weekend and holiday periods would save electricity.

16 *Cardiff University had already successfully installed timer switches to the vending machines we inspected.*

Fitting variable speed drives to motors for hot water pumps or ventilation fans can deliver significant reductions in energy consumption

3.19 The level of output of heating and ventilation systems is generally set in accordance with the highest or lowest levels of demand placed upon it. It is, however, possible and desirable to use it more flexibly. Provided that environmental conditions were being satisfied, the volume of air or water distributed around the heating or ventilation systems could be reduced during periods of intermediate demand. Typically, if the motor speed were to be reduced by 20 per cent - a factor that would barely be perceptible within the overall operation of the system - 50 per cent of the absorbed electrical power could be saved **(see Case Study J)**.

Separation of the heating from the hot water service is increasingly becoming the norm, for reasons of energy efficiency

3.20 A separate domestic hot water generator is increasingly becoming the norm, but there are some exceptions, particularly on residential buildings, where conventional calorifiers (hot water cylinders) are served by the main heating boiler. This method results in high distribution and standing losses, whereas it is more efficient for hot water to be generated as locally as possible. Local hot water generation also prevents the need for the larger main heating boilers to be run during the summer months simply to provide hot water. At Cardiff University, our consultant identified the scope for replacement of the remote hot water calorifiers with local gas fired units serving the Tower building on the University Hall site, at a cost of £12,000 but with an annual financial saving of an estimated £3,090.

J Recommended Application of Variable Speed Drives at the North East Wales Institute of Higher Education

The Library in the North East Wales Institute of Higher Education (NEWI) is ventilated by two large full fresh air plants with supply and extraction fans operating at 100% throughout the year. Variable Speed Drives could be applied to reduce the fan motor speed to 80 per cent during periods of low library usage and during the winter, resulting in savings of 50 per cent of the electrical power. Similar savings could be achieved in the Sports building, which is ventilated by a large energy intensive AHU.

An initial investment of £20,000 would be necessary for the equipment but could be expected to yield savings of £9,340 per annum, giving payback within just over two years. The reduction in carbon dioxide emissions would be approximately 117 tonnes per annum.

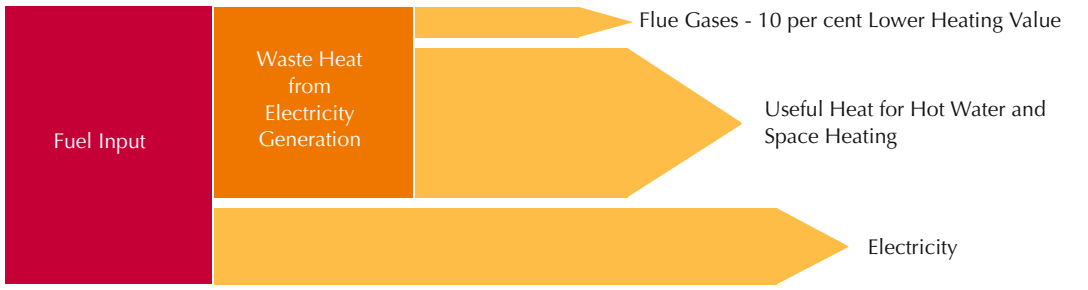
Combined Heat and Power may provide financial and environmental savings

3.21 Combined Heat and Power (CHP) is the generation of electricity and useful heat in a single process. It involves burning fuel to generate electricity and at the same time using the 'waste' heat to provide warmth and hot water **(see Figure 12)**. For each unit of useful energy produced, CHP wastes less fuel than the conventional methods of producing heat from local boilers and electricity from a power station. It thus produces less carbon dioxide and can lead to substantial financial savings, although these have to be offset against installation costs. In addition, the financial viability of CHP is dependent on realising economies of scale and, in particular, being able to make use of the spare heat generated by the process, either for hot water or space heating, a potential problem for universities as a result of uneven demand throughout the year. It is also reliant on the relative cheapness of gas, relative to electricity, from external suppliers.

3.22 At the time of our questionnaire survey, only the University of Wales, Swansea (at the Wales National Pool) and the University of Wales, Lampeter reported that they were operating a Combined Heat and Power unit[17] and in the latter case, our consultant identified that this unit was proving uneconomic **(see Case Study K)**. A more appropriate system for the higher education sector in Wales might be the smaller-scale 'micro' CHP unit that is currently under development.

3.23 In the meantime, higher education institutions might investigate the potential for CHP as part of a wider community energy scheme. For example, the University of Wales, Swansea are also investigating the application of CHP on their main campus in conjunction with the neighbouring Singleton Hospital, with possible funding support from the Community Energy programme. In this case, the Hospital's year round demand for heat/hot water should strengthen the economic case in favour of CHP and reflects the application of CHP as part of a number of community energy schemes involving higher education institutions in England.

12 Combined Heat and Power process



17 *We understand that the University of Wales, Bangor also has three CHP units installed across its estate but that these are not currently in operation because they were proving uneconomical to run and maintain.*

K Combined Heat and Power at the University of Wales, Lampeter

The University of Wales, Lampeter, installed a Combined Heat and Power (CHP) unit, together with a heat dump radiator in 1999 under a discount electricity purchase scheme which financed the installation, maintenance and capital cost. This is proving uneconomical, however, not least because the boilers are continuing to operate while the CHP unit is dumping heat to atmosphere. This has arisen because the CHP is not properly integrated into the overall boiler control scheme.

The University pays a set rate for every kWh of electricity generated by the CHP, but through competitive tendering it has achieved a lower unit price than this for its main electricity supply. This, and the near-doubling of the unit price for natural gas - which is the input into the CHP unit - had made the machine less economical by the time of our visit, particularly as 50 per cent of the heat produced is dumped to the atmosphere in summer due to insufficient hot water demand. Even with a possible increase in electricity prices the unit is unlikely to become economical under the current scheme. Moreover, gas prices are also forecast to rise.

Our consultant therefore recommended that the University investigate the legal scope for terminating the current arrangement.

In addition to improved energy and water efficiency, opportunities for financial savings may be available by reviewing energy procurement arrangements and the tariff rates for energy and water supplies

3.24 Although not the primary purpose of our examination, in two of our four visits to institutions, our consultant also identified potential savings for reduced energy costs through alternative procurement processes or changes in the tariff used. For example, at Cardiff University, our consultant recommended investigating alternative gas supply contracts without the inclusion of standing charges (which do not form part of most gas contracts). This would result in an estimated saving of £50,000 per annum, for no financial investment. At the University of Glamorgan, our consultant recommended that the institution review its energy procurement arrangements, currently dealt with through a consortium and managed internally by the procurement manager, as they appeared to be paying a relatively high price for these supplies.[18]

18 Energy procurement for the twelve institutions in Wales is carried out by a range of means, with three separate central purchasing consortia providing services to nine of the institutions, while two institutions contract with suppliers through contacts in their local authority and one institution does its own procurement and negotiation direct with suppliers.

3.25 Two of the four recent Carbon Trust Action Energy surveys also noted that the institutions had not been claiming their full exemption under the Climate Change Levy rules, particularly in respect of their residential accommodation, with potentially significant financial consequences (£12,500 in the case of one institution). As well as being exempt from the Climate Change Levy, residential accommodation should be charged at the 5 per cent rather than 17.5 per cent VAT rate although this relies on the institutions themselves registering for this reduction.

KEY POINTS

on the scope for energy and financial savings

- Energy surveys are an important tool in identifying areas for improvement in energy and water management and can be obtained free of charge through the Carbon Trust. However, prior to our fieldwork only four of the twelve institutions had themselves commissioned an energy survey in the previous two years.
- Significant energy and financial savings are possible across the higher education estate. Of those identified by our consultant, most would be at no cost to the institutions or would require low levels of investment.

We recommend that:

- all institutions carry out an energy survey or, where they have already done so, repeat the exercise within a five year period;
- all institutions assess the applicability of the areas for potential energy and water savings identified by the National Audit Office Wales and, where appropriate, prepare an action plan for their implementation; and
- all institutions ensure that they claim their full entitlement to exemption from the climate change levy and/or to reduced rates of VAT in relation to their energy supplies, such as in the case of their student residences.

Appendix 1

Study methods

1 We conducted detailed fieldwork at four institutions (Cardiff University, the University of Glamorgan, the University of Wales Lampeter and the North East Wales Institute of Higher Education), in collaboration with an energy management consultant (MilTec Consulting). The four institutions were selected to provide representative coverage of the sector in Wales in terms of size, age and type of estate, and location. In the course of each visit, the consultant examined a representative selection of the buildings and the energy and water plant, to identify inappropriate design, poor maintenance, inefficient equipment and use of resources, as well as examples of good practice. We particularly requested that our consultant focus upon identifying measures which required relatively low levels of investment, or relatively short payback periods.

2 We circulated a survey questionnaire to the estates officers of all the higher education institutions in August 2004 to establish:

- the energy and water consumption of each institution and the levels of carbon dioxide emissions;
- the management processes in place at each institution for monitoring and controlling energy and water consumption, and for investment decision-making. We benchmarked these against examples of good practice, for example, robust energy and water management policies endorsed by senior management and subject to regular review; specific objectives and systems for monitoring progress against these objectives; and the allocation of clear lines of responsibility for implementation.
- The key barriers to improvement in energy and water efficiency, as identified by the estates managers.

3 We compared the levels of energy and water consumption per square metre of internal area across the twelve institutions with national benchmarks developed by the Building Research Establishment and the Watermark project. For those institutions visited, more detailed data was sought on individual buildings, where possible, to allow a more detailed analysis of the factors contributing to greater or lesser energy efficiency.

4 We assessed the oversight of the sector by the Welsh Assembly Government and the Higher Education Funding Council for Wales. We identified the steps taken by the Assembly to discharge its statutory duty to promote sustainable development in its oversight of the sector. We also looked at the role of the Funding Council in monitoring the practices of the sector and providing strategic direction; assisting through the provision of advice and the dissemination of good practice; monitoring consumption; and reviewing management practices and strategic plans. Information on the processes was gathered through a combination of the survey of institutions and interviews with Assembly and Funding Council officials.

5 We established an expert panel of people with the knowledge and experience of the sector, and/or of energy and water management, to advise us on the direction of the study and to review key documents.

Composition of Expert Panel

We invited a number of individuals with knowledge of higher education and/or energy and water management to provide feedback on the scope of our study in May 2004, our survey questionnaire in August 2004 and the first draft of our report in January 2005.

- Derek Adams (later John Howells) - Head of Higher Education Division, Welsh Assembly Government
- Brian Blakemore - School of Applied Sciences, University of Glamorgan
- Regina Collins - Environmental Officer, University of Wales, Newport
- Charles Coombs - Strategic Policy Unit, Welsh Assembly Government
- Stephen Jones - Regional Client Manager, the Carbon Trust
- Dr. Ian Knight - Welsh School of Architecture, Cardiff University
- Alan Liddington - Estates Manager, University of Wales Institute, Cardiff
- Joao Martins - Ethical and Environmental Officer, Cardiff University Students' Union

Appendix 2

Summary of energy and water saving opportunities across four higher education institutions in Wales

Cardiff University

Our consultant visited Cardiff University on 2/3 June 2004 and surveyed 95 per cent of the plant rooms and a broad sample of the occupied spaces. A number of energy and water efficiency measures were recommended, which would be expected to produce savings of £103,230 per annum. The majority of these savings would require some relatively high cost investment; no low cost investments could be identified, reflecting the robust approach to energy management already undertaken by the University's Estates department.

	Annual savings				
Key Recommendations	**Financial (£'s)**	**Energy (kWh) Water (m^3)**	**CO2 (tonnes)**	**Investment required (£'s)**	**Payback (Years)**
Gas tariff - negotiate abolition of standing charges	50,000	0	0	0	Immediate
Lighting - encourage staff and students to switch unnecessary lights off	3,300	80,000 kWh	34.4	0	Immediate
Water - adopt waterless urinals	11,650	6,000 m^3	0	14,000	1.2
Lighting - update lighting, particularly twin fluorescent fittings in main building	33,040	8,000,000 kWh	344	120,000	3.6
University Hall Tower building - replace remote domestic hot water calorifiers, to allow water to be heated more locally	3,090	186,000 kWh	47.8	12,000	3.9
Learning Resource Centre (Library) - lighting replacement	2,150	52,000 kWh	22.4	15,000	7.0
Totals	**103,230**	**8,318,000 kWh 6,000 m^3**	**448.6**	**161,000**	**1.6**
No Cost Measures - immediate payback	£53,300	80,000 kWh	34.4	0	0
High Cost Investments - longer payback	£49,930	8,238,000 kWh 6,000 m^3	414.2	161,000	3.2

Source: MilTec Consulting

University of Glamorgan

Our consultant visited the University of Glamorgan on 10/11 June 2004 and surveyed 96 per cent of the occupied spaces. A mixture of no-cost and low-cost savings were identified, amounting to a total potential saving of £16,005 per annum.

Although the report for the University of Glamorgan was focused upon savings relating to the management of energy consumption, our consultant also estimated that a further saving of £12,000 could be made by reviewing the University's purchasing arrangements for electricity and gas.

	Annual savings				
Key Recommendations	**Financial (£'s)**	**Energy (kWh) Water (m^3)**	**CO2 (tonnes)**	**Investment required (£'s)**	**Payback (Years)**
Glyntaff main building and nurses' training building - changes to boiler controller settings	285	13,000 kWh	3.8	0	Immediate
Students' Union building - better control of energy particularly lights	235	6,200 kWh	2.7	0	Immediate
Glamorgan court residences - attend to dripping cistern valves	90	50m^3	0	0	Immediate
Water - install waterless urinals	7,330	4,000 m^3	0	6,000	0.8
Canned drink vending machines - turn off time-switch off at night	510	16,800 kWh	7.2	480	0.9
Learning Resource Centre (LRC) - control of the chiller plant onto the Building Management System (BMS)	1,590	42,000 kWh	18.1	1,800	1.1
Tyn-y-Wern sports centre - replace heating and domestic hot water controller with BMS control	1,055	47,200 kWh	14.1	2,500	2.4
Main Sports Hall - replace the 400 watt lamps with 250 watt lamps and presence sensors	1,295	34,200 kWh	14.7	3,800	2.9
Residences - link individual boilers to the BMS	1,850	87,200 kWh	25.3	6,000	3.2
Computer 'J' block and Business School - link the split air conditioners to the BMS	1,765	50,700 kWh	20.5	7,800	4.4
Totals	**16,005**	**297,300 kWh 4,050 m^3**	**106.4**	**28,380**	**1.8**
No Cost Measures - immediate payback	610	19,200 kWh 50 m^3	6.5	0	0
Low Cost Investments - rapid payback	15,395	278,100 kWh 4,000 m^3	99.9	28,380	1.8

Source: MilTec Consulting

University of Wales, Lampeter

The University of Wales, Lampeter was visited by our consultant on 7 June 2004 and 94 per cent of its occupied spaces were surveyed. Potential savings of £27,600 per annum were identified, 87 per cent of which could be realised by no-cost or low- cost investments.

Key Recommendations	Financial (£'s)	Energy (kWh) Water (m^3)	CO2 (tonnes)	Investment required (£'s)	Payback (Years)
Isolate the Combined Heat and Power Unit	10,115	735100 kWh	21.0	0	Immediate
Switch boilers to Summer mode once ambient temperature rises above 15°C.	1,310	88,000 kWh	25.3	0	Immediate
Lighting - Encourage staff and students to switch off unnecessary lights	590	16,200 kWh	7.0	0	Immediate
Lighting - Replace fluorescent tubes in Cliff Tucker Theatre and Library buildings with more efficient tubes	225	6,200 kWh	2.7	0	Immediate
Water - install waterless urinals	5,575	2,500m^3	0	6,000	1.1
Canned Drink Vending machines - switch off at night	375	14,000 kWh	6	400	1.1
John Richards Hall - install an outside air temperature inhibit programme to the heating controls.	80	4,900 kWh	1.6	150	1.9
Main building boiler plant - replace damaged controls.	705	43,600 kWh	13.1	1,800	2.6
Lloyd Thomas Hall - replace the heating controls	1,245	80,300 kWh	23.4	4,000	3.2
Students' Union - have the controls serviced	105	6,550 kWh	1.9	400	3.8
Texaco and Welfare Terrapin buildings - add presence sensing thermostats to the electric heating	1,240	34,000 kWh	14.6	4,800	3.9
Cliff Tucker Theatre - add controls	390	32,000 kWh	7.3	1,600	4.1
Arts building - install electric point of use heaters in toilets	4,000	65,200 kWh	18.7	4,000	4.2
Geography Labs - add space temperature and time controls in place of time-switch	65	4,300 kWh	1.3	300	4.6
Arts building, Canterbury building, Dawson, Harris Walker residences - improve controls	1,135	43,450 kWh	21.5	5,400	4.8
Lloyd Thomas Hall - separate the hot water from the heating	8,000	160,000 kWh	46.1	8,000	3.4
Sports Hall and Library boilers - improve controls	545	35,030 kWh	10.2	3,400	6.2
Students' Union - recover heat from the beer cellar.	505	34,000 kWh	9.8	3,800	7.5
Totals	**36,205**	**1,406,630 kWh 2,500 m^3**	**232.2**	**44,050**	**1.2**
No Cost Measures - immediate payback	12,240	845,500 kWh	56.0	0	0
Low Cost Investments - rapid payback	14,915	332,100 kWh 2,500 m^3	109.3	28,850	1.9
High Cost Investments - longer payback	9,050	229,030 kWh	66.9	15,200	1.7

Source: MilTec Consulting

North East Wales Institute of Higher Education (NEWI)

Our consultant visited NEWI on 24/25 May 2004 and covered 88 per cent of its occupied spaces. We identified potential savings of £24,785 per annum, the bulk of which were accounted for by low cost measures.

	Annual savings				
Key Recommendations	**Financial (£'s)**	**Energy (kWh) Water (m^3)**	**CO2 (tonnes)**	**Investment required (£'s)**	**Payback (Years)**
Building Management System - fine tuning of set points and strategy enhancements	2,810	128,800 kWh	39.2	0	immediate
Academic areas - switch lights off when unoccupied	1,600	32,000 kWh	13.8	0	immediate
Computers - switch VDUs off when not in use	600	12,000 kWh	5.2	0	immediate
Canned drink vending machines - install time programme	535	14,000 kWh	6.0	400	0.7
Library café - replace tungsten lamps with compact fluorescent lamps	20	375 kWh	0.2	15	0.8
Library IT - modify control panel to stop heating primary pump running in summer	245	4,900 kWh	2.1	200	0.8
Student Village new residences - fit miniature circuit breakers to prevent unauthorised appliances being used	1,100	22,000 kWh	9.5	1,200	1.1
Introduce an energy and water monitoring system	4,300	90,000 kWh 1,000 m^3	29.2	8,200	1.9
'A' Block picture lights - convert to compact fluorescent lamps	80	1,600 kWh	0.7	150	1.9
Library & sports building ventilationplants - apply variable speed drives	9,340	378,000 kWh	117.5	20,000	2.1
Sports Hall lighting - apply a latching presence control scheme to allow 50% to be off	1,730	34,500 kWh	14.8	4,800	2.8
Sports Multipurpose room - link air conditioners to the BMS	210	4,200 kWh	1.8	600	2.9
Library lighting - add presence controls to lights near windows	615	12,300 kWh	5.3	1,800	2.9
Library - replace skylight panes with glazed ventilation louvers.	1,600	32,000 kWh	13.8	18,000	11.3
Totals	**24,785**	**766,675 kWh 1,000 m^3**	**259.1**	**55,365**	**2.2**
No Cost Measures - immediate payback	5,010	172,800 kWh	58.2	0	0
Low Cost Investments - rapid payback	18,175	561,875 kWh 1,000 m^3	187.1	37,365	2.1
High Cost Investments - longer payback	1,600	32,000 kWh	13.8	18,000	11.3

Source: MilTec Consulting

Appendix 3

Types of energy survey available through the Carbon Trust

Energy surveys are able to make an application for a free energy survey from the Carbon Trust and these can be tailored to the individual needs of an organisation. They are generally limited to organisations with an annual energy bill in excess of £50,000, although this would include each of the twelve higher education institutions in Wales. The types of survey available are listed on the Carbon Trust's website, www.thecarbontrust.co.uk and are as follows:

Initial Opportunities Assessment

This survey reviews all significant energy use on the site and is the first step to cutting energy costs and consumption for inexperienced organisations. Up to ten recommendations are usually included in the Action Plan, most of which will pay back in less than eighteen months.

Minimal energy efficiency experience is needed to benefit from this survey

Specific Opportunities Assessment

This assessment is intended for organisations that have already implemented a range of energy efficiency measures and wish to build upon their experience. The survey is focussed on a narrow range of energy uses on the site, identified by the client to provide a more in-depth analysis of these areas. In addition, the consultant evaluates the strengths and weaknesses of energy management practices to help the organisation sustain the improvements that have already been made.

Some energy efficiency experience is needed to benefit from this survey

Multiple Site Assessment

For organisations with more than five sites and an accumulative energy bill of greater than £150,000 per annum the Carbon Trust will carry out surveys at a sample of sites in order to obtain an overview of energy saving opportunities that exist across the organisation. An energy management review performed as part of the survey will identify the strengths and weaknesses of energy management practices and help the organisation deliver savings across a number of operations. As part of the multiple site assessment senior management are briefed on the findings.

A good level of energy efficiency experience is needed to benefit from this survey

Combined Heat and Power (CHP) Advice

For organisations who are specifically interested in the use of Combined Heat & Power (CHP). Advice ranges from initial feasibility studies, design, and project implementation advice for both new developments and refurbishments.

Some energy efficiency experience is needed to benefit from this survey

Energy Management Assessment

For experienced organisations that are only interested in improving energy management practices to sustain the improvements already achieved, this assessment evaluates performance across eight dimensions of energy management and enables the organisation to compare their performance against that of other organisations.

Good level of energy efficiency experience is needed to benefit from this survey

Detailed Survey (Feasibility Study)

This survey is a detailed investigation on the feasibility and potential savings from a specific energy saving opportunity, such as replacement of equipment with significant energy consumption - but likely to entail significant capital costs for the organisation.

This survey is only part funded by the Carbon Trust.

Good level of energy efficiency experience is needed to benefit from this survey

Design Advice

Design Advice offers professional, independent and objective advice on energy efficient and environmentally sound building design. Clients are offered free initial design consultancy on a building project - further consultancy, with partial funding, may be available.

Applicable to all levels of energy efficiency experience