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MSc: Sustainable Engineering – Energy Systems and the Environment

Individual Thesis

The Impact of Public Private Partnership on Energy Efficiency within Scottish Schools

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Copyright Declaration

Contents

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Abstract

The United Kingdom has proposed that it will significantly reduce Carbon Dioxide (CO_2) emissions over the next 50years (Energy White Paper, 2003). It is estimated that every year UK schools spend £60million on wasted energy. This equates to 300,000 tonnes of CO_2 emissions (Action Energy, 2003).

The Scottish Executive has set targets to upgrade 300 poor energy performing, dated, Scottish schools by 2009, thus improving the performance of the buildings, optimising energy efficiency and reducing emission levels. For many Scottish Schools, the Scottish Executive has advertised the Public Private Partnership as the way forward. The Scottish Executive has pledged to encourage local authorities in contributing towards reducing energy consumption and emission levels by encouraging them to adopt energy efficiency methods and environmental awareness strategies within its schools through a range of various organisations and support networks.

This thesis investigates what action is currently being taken throughout Scottish local authorities in order to implement energy efficiency methods within schools and their contributions towards sustainable development are discussed. This has involved a wide consultation with 5 Scottish councils, some of who have experienced the effects of PPP schools. 5 case studies, one for each council, have been carried out to determine how energy efficient each council's schools are performing and both the advantages and disadvantages of PPP schools have been discussed, offering where appropriate, future recommendations.

Aim

A number of aims were established at the beginning of this thesis. Adhering to these aims ensured that every area of this thesis remained focussed towards the same goals. These aims were to:

- Identify what Scottish local authorities are doing in the way of helping their schools to become more energy efficient
- Identify how energy efficient these Scottish local authority schools are
- Investigate what funding/guidance is available to local authorities in order for them to achieve a more energy efficient environment
- Discover why there is a need to enter into the Public Private Partnership (PPP)
- Identify how well these new PPP schools are performing

Study Goals

By addressing these aims this thesis can effectively draw conclusions and achieve answers to these two main goals:

- Identify what could be done compared to what is being done by local authorities in the way of implementing energy efficiency in schools

- To compare what local authorities can achieve independently, with what PPP could potentially achieve

1.0 Introduction

1.1 Sustainable Development

Sustainable development has been described as:

> "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Report, WCED, 1984).

The Scottish Executive has outlined targets for the number of Scottish schools they wish to rebuild or refurbish in the coming years. They have also outlined a number of issues stated in the Energy White Paper referring to new and existing buildings and specify performance targets they wish to achieve in the following so many years helping/allowing Scottish schools to contribute towards a sustainable future.
High performance, energy efficient schools will not meet all of these building performance targets and emission reduction levels alone, however they can help to contribute towards a sustainable future and hopefully educate Scotland's young children and communities about the need for and benefits of a sustainable future.

1.2 Energy White Paper

The UK is leading the way amongst the world's developed economies to reduce Carbon Dioxide (CO_2) emissions by 60% by 2050 from 1990 levels, showing significant progress by 2020. If this is achieved it would result in emissions of around 65 million tonnes of carbon (MtC) in 2050. The Scottish Executive are encouraging all of its schools, both existing and new-builds, to contribute towards this goal by reducing their annual energy consumption through use of free energy efficiency programmes and advice, thus also reducing the schools annual CO_2 emissions.

During 2002 almost three-quarters of the UK's primary energy was from oil and gas. This is shown in fig.2 below:

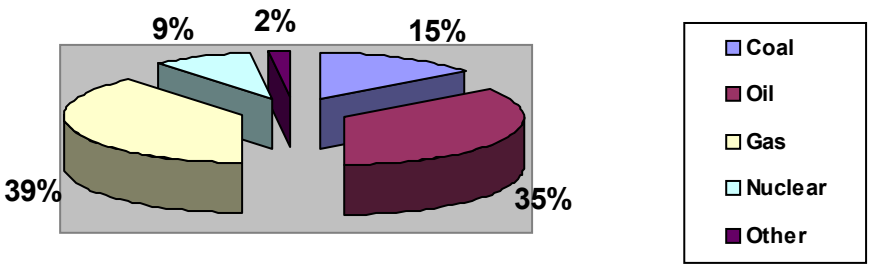

Fig.2: Primary Energy Demand in the UK, 2002

The UK undeniably has an exhaustible fuel resource. The Energy White Paper states that by 2006 the UK will indeed be a net importer of gas, namely from Norway, and by 2010 also of oil. At present almost half of all coal consumed in the UK is imported and it has also been calculated that within the next ten years all of the UK's deep mined coal will be exhausted. Assuming present energy consumption rates, the Energy White Paper calculates that by 2020 the UK could be dependent on imported energy for around three-quarters of its primary energy requirements (Energy White Paper, February 2003). A great disadvantage of this is that the UK may become overly susceptible to sudden increases in prices and may experience disruptions in supply due to political volatility or confliction throughout different areas in the world. One way for the UK to minimise these disadvantages and overcome this type of situation is to make use of the extensive renewable options (mainly wind) and smaller-scale distributed energy sources (particularly combined heat and power), therefore becoming more independent and less dependent on others.

The Energy White Paper states that the most effective, cheapest and safe way to meet all objectives for their new energy policy objectives is through energy efficiency and renewable energy. This way energy consumption can be kept to a minimum and carbon emissions can be slashed. In support of this was the UK Governments announcement in January 2000 announcing their aim for renewable energy sources to provide 10% of all electricity by 2010, whilst aiming to reduce greenhouse gasses by 20% of 1990 levels.

The Government have also pledged to bring forward to 2005 the next revision of the Building Regulations to raise the standards of energy efficiency in new buildings and refurbishments, including all Scottish schools. (Energy White Paper, February 2003)

The Energy White Paper envisages 2020 as very energy efficient with 15-25 million tonnes of carbon emissions cuts. They Government is aiming for an increase in small, local community generation from e.g. small wind sources where there will be an option to sell excess back to the grid. There is hope to include Combined Heat and Power plants, solar heating systems or photovoltaic, where possible, in buildings again with the option of selling excess back to the local distributed network. Assuming these objectives are met, the Government have estimated carbon reductions by 2020 to be between 4 – 6MtC by promoting and implementing energy efficiency in industry, commerce and the public sector (this includes schools) 4 – 6MtC and a reduction of 3 – 5MtC by increasing renewables.

Government expectations require energy efficiency measures to save 10MtC every year by 2010 and by 2020 a further 4 – 6MtC to be saved annually from the business and public sectors. Also, renewables will be required to provide 30 – 40% of electricity generation in order to cut carbon emissions by 60% by 2050.
By adhering to strict building performance targets for all Scottish schools a significant contribution could be made towards these energy and emission targets outlined in the Energy White Paper, therefore helping to build towards a sustainable future through sustainable development within schools.

In response to the objectives outlined in the Energy White Paper, the majority of local authorities presently have a target to reduce their total CO_2 emissions by 1% each year until 2010. They intend to do this by adopting and implementing many energy efficiency strategies within all of their buildings, including schools (Action Energy, 2003). The school contribution may represent only a small proportion of the overall market, however it is an important proportion. This allows the young future of Scotland to develop awareness, learn and involve the community helping to develop more energy efficient and environmental conscious lifestyles that promotes sustainable development.

2.0 Background

2.1 Scottish Executive Objectives

Many of the 32 Scottish councils' schools are now, or soon will be, in great need of refurbishment. With some schools, such as Williamwood High School in East Renfrew shire, dating back to as early as the 1930's it is little surprise that in June 2000 Her Majesty's Inspectors reported that "the school buildings were unsafe in some respects and in very poor condition overall". The Inspectors believed that this "poor environment had an adverse effect on learning and teaching and on the morale of staff and pupils", (HMI Report, 2000). This is a similar story for many older, dated schools in Scotland. The Scottish Executive recognises this and has therefore set targets ensuring that by 2006 a total of 200 Scottish schools will either be refurbished or rebuilt to higher building standards and that by 2009 this total will rise to 300 Scottish schools. 28 of the 32 Scottish councils are now part of the PPP programme. This has increased the total investment from the Scottish Executive to over £2.2billion (Scottish Executive, 2004). With so many schools now requiring some sort of refurbishment upgrade or a completely new building, it would make both financial and environmental sense to implement energy efficiency saving measures in order to reduce running costs and slash emission levels, therefore improving building performance levels to correspond with current legislation as well as helping to achieve energy and emission targets set in the Energy White Paper.

2.2 Wasted Energy

During 2002, Action Energy calculated that £65 billion was spent on energy throughout the whole of the UK; of this 20% was estimated as wasted energy (energy that could not be accounted for). This equates to a loss of around £13billion in that year alone.

At present, throughout Scotland only, it is calculated that £2.5 billion is spent on energy every year. Similarly, from this it is estimated that a substantial percentage is wasted energy, somewhere in the region of 20%, equating to around £500million. (Action Energy, March 2003)

Every year schools in the UK spend around £350million on energy and release approximately 5million tonnes of CO_2. It is estimated that a staggering £60million is

spent on wasted energy. This equates to 300,000tonnes of CO_2 emissions every year from wasted energy (Action Energy, March 2003).

2.3 Energy Benchmarking

The Government has set energy benchmarks in order for a whole range of businesses, organisations and homeowners to measure how energy efficient they are and highlight room for improvement. For both primary and secondary schools the benchmark is measured in kWh (kilo-watt hour) per m^2 of heated floor space per annum for both fossil fuel and electricity. For both primary and secondary schools, without pools, the government have set good practice energy benchmarks for fossil fuel and electricity consumption. These are 113kWh/m^2 for fossil fuel and 22kWh/m^2 for electricity within primary schools and 108kWh/m^2 for fossil fuel and 25kWh/m^2 for electricity within secondary schools.

2.4 Energy Consumption and Cost

For most of the schools in Scotland energy is supplied in two forms: fossil fuel (normally gas or possibly oil, coal or LPG) and electricity. Within these schools energy use is mainly for heating, lighting, hot water, catering and increasingly for IT. This wasted energy is not only wasting vast amounts of money, it also increases the emissions levels unnecessarily. The breakdown for energy consumption for a typical UK school is as follows:

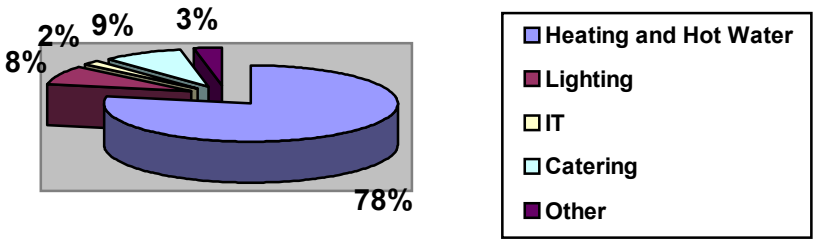

Fig.1a: Energy Consumption (Action Energy, 2002)

Fig.1a clearly shows that over two-thirds of energy consumption for a typical UK school is used in heating and hot water. However, the energy costs for a typical UK school are somewhat different. For example, energy consumption in lighting is only 8% of the total energy consumption. In spite of this, as fig.1b below demonstrates,

lighting is responsible for almost half of all electricity costs and almost a quarter of the total energy costs.

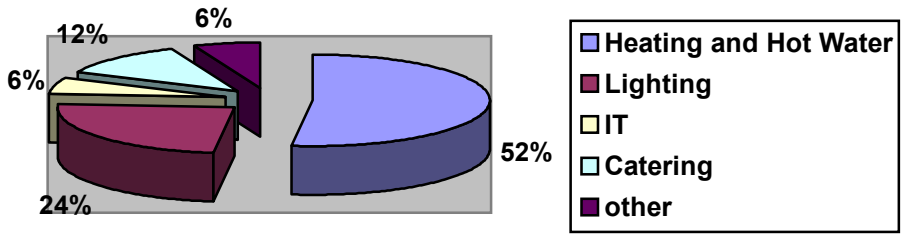

Fig.1b: Energy Costs (Action Energy,2002)

This is purely down to the great difference in cost between electricity and fossil fuels. Even for local authorities who receive a discount on their gas and electricity rates, electricity may be charged at a rate of 6.5p/kWh, whereas fossil fuels can be almost five times cheaper at 1.3p/kWh (Scottish Power, 2004). This makes electricity a very important element to control. It is more often than not the end users (e.g. teachers/staff/children) who are very much in control of electricity usage, therefore requiring the whole school to approach the issue of energy efficiency as a first priority in reducing costs.

3.0 Financing Energy Efficiency

The Scottish Executive has gone to some lengths to ensure that there is available support, programmes and in some cases, where applicable, funding to help educate schools and implement energy efficiency and environmental awareness methods. Some of these drivers for energy efficiency in schools are mentioned below:

3.1 Scottish Energy Efficiency Office

The Scottish Energy Efficiency Office (SEEO), funded by the Climate Change Levy from The Scottish Executive, has been set up to offer advice and support to both domestic and business energy users helping to, where possible, cut their energy bills and ensure their use of energy is optimised in the most efficient ways possible, thus saving their clients money on their energy bills as well as helping the environment. There is a network of six Regional Business Managers throughout the Islands, Highland, North East, Central, South East and South West areas in order to maximise resource efficiency all over Scotland. Energy Advisors within these SEEO's are available to give free energy efficiency advice to a large number of business (anything above 500m^2), leisure/community centres and schools. There is an advice line and website available for all who seek more information on improving their energy efficiency measures. A range of free publications is also available.

The Regional Managers or Energy Advisors would normally approach businesses or local authorities and invite them to attend seminars where they can learn more about transforming their business/buildings into more energy efficient places. No grants as such are given, only free advice and consultations. However, interest free loans are available to help businesses and schools take immediate action in cutting energy bills. They can also apply for enhanced capital allowances to help reduce the cost of improving their equipment. This may be, for example, low energy use photocopiers, sleep function on electrical equipment etc.

The Local Scottish Authorities can qualify for £15million, awarded from the Scottish Executive, through the SEEO. This is then split between the various different areas and payments are to be staggered over 2years. Glasgow Council has a greater population than surrounding local areas and will therefore receive a larger proportion of this £15 million payout, £2 million in total. Edinburgh Council will receive £1.2 million, North Lanarkshire Council £930,000, Renfrewshire Council £507,000 and

East Renfrewshire Council £250,000. Each authority will then allocate grants to the most worthy projects, chosen at their discretion. However, there are some stipulations as to how this money should be spent. All investments made by the local authorities must be used to implement energy efficiency measures, this does not include renewables as the Scottish Executive want tried and tested methods to be put in place in order to maximise savings. Also, all investments must have no more than a 5-year payback period. The reasoning behind this is to ensure maximum savings (money not carbon) can be captured within a short time period. The idea is then that these savings will quickly cover the initial £15 million investment.

Each school is entitled to a free consultation where an SEEO Energy Advisor would perform a walk-round of the school building and from this draw up an energy audit report. This report will help identify the areas in which energy is wasted and thus costing the business to loose money unnecessarily e.g. due to the Climate Change Levy (CCL) or simply an overspend in energy bills.

The SEEO aim to help:

- Cut heating bills
- Reduce lighting costs
- Use less water
- Cut energy use
- Reduce waste
- Minimise costs - save money by minimising waste and reducing energy and water use

Energy consumption and final savings for each school are monitored before and after the consultation. The SEEO hopes to demonstrate that school can:

- Cut their costs – save money by minimising waste and reducing energy and water use
- Improve their bottom line – spend less, save more
- Spend a little, achieve a lot – low cost actions are often all that is needed
- Help and support – is available for free each step of the way

- Help the environment – reducing energy consumption reduces carbon emissions

As long as each school can demonstrate some improvement/good practice they are eligible to continue to ask and receive advice from the SEEO.

The Energy Advisors are also very keen to encourage all schools to become involved in the Eco Schools programme. This is a way for schools to become more energy aware and encourage the children to work towards Flagship status. They believe by educating younger children they can acquire and share new knowledge and adopt 'better' lifestyles for the future.

3.2 Scottish Community and Householder Renewables Initiative

Also funded by the Scottish executive is the Scottish Community and Householder Renewables Initiative (SCHRI). There are SCHRI Development Officers in five Energy Efficient Advice Centres (EEACs) in southern, central and eastern Scotland and in HIE (Highlands and Islands Enterprise) offices in the north. Each year the SCHRI has £0.5million to fund community-based projects in mainland Scotland. The SCHRI Development Officers aim to provide local communities with expertise, support and in some cases grants helping them to take forward renewable energy projects successfully.

Technical assistance funding is available to a wide range of projects during their formative stage. This may include:

- Payment for the cost of a feasibility study
- Providing support to develop a project proposal
- Payment for capacity building

Capital expenditure grants can offer a contribution towards the capital costs of certain projects. This includes:

- Capital costs for infrastructure

- Project management costs associated with the development and installation of projects
- The costs of establishing a partnership with a third party such as a developer

The SCHRI can provide up to a £10,000 grant for technical assistance and £100,000 for capital expenditure. For some projects up to 100% of the total cost can be granted, however match funding is preferred.

Many renewable technologies are eligible for support. These are the main ones:

- Small-scale hydro-electric power
- Wave power
- Wind power
- Solar, water and space heating
- Ground source heat pumps
- Landfill and sewage gas
- Biomass and energy from waste

The SCHRI want to include as many constituted community organisations as possible to qualify for funding. Applications from any non-profit distributing organisation will be considered. This includes local authorities applying for funding on behalf of schools in their area.

The Development Officer for Strathclyde and Central Scotland currently has 5 school projects requesting grants and has been involved with funding for Public Private Partnership (PPP) schools.
The majority of local authorities who have approached the SCHRI for renewable technology funding for their schools have used this to integrate wind turbines and solar panels into the design of the school. Many have used this as an educational learning tool for the pupils, staff and community as well as contributing to the environment.

3.3 Action Energy

Similarly, Action Energy, part of the Carbon Trust, is an organisation set up to advise everyone including private businesses, local authorities and homeowners on energy efficiency. Action Energy often work with the SEEO and businesses such as Scottish Power in promoting energy efficiency through various learning work-shops and seminars to which a broad range of people from various companies and backgrounds are invited to attend.

Action Energy has both a website and free phone help line where access to information, free publications and case studies is widely available for everyone from a variety of different backgrounds, including a wide range of publications for schools. Action Energy provide many stunning facts such as overheating certain buildings by only $1^{o}C$ can actually increase heating cost by up to 8% per year. By publishing such drastic figures Action Energy have found that this seizes the attention of many an energy consumer, hence why they give savings in financial terms as well as emission savings. Action Energy aim to reduce energy consumption where possible, eliminating wasted energy and saving businesses money whilst greatly reducing carbon emissions.

3.4 Scottish Power

Scottish Power is an example of a Scottish business with a commitment to helping promote and implement energy efficiency throughout various Scottish projects. They have been heavily involved in working with schools to provide grants and turbines to some Scottish schools as well as visiting the staff and children within many schools educating them on energy efficiency and trying to actively involve and encourage them to adopt energy efficiency measures.

Customers on Scottish Powers ‘Green Tariff’ have their energy supplied from renewable sources. These customers are also given the option to £10 per month on the company’s green tariff, which is then set aside for such community schemes. The money is given to the Green Energy Trust, which is administered by green energy experts and Scottish Power, which then chooses the best applications to benefit from the funds.

Gerry Magee, the head of environment in Scottish Power's sales and supply division, said: "The green tariffs that we offer to our customers enable them to make a contribution to support these smaller-scale projects and that's where they can make a real difference. They won't put a huge amount of generating capacity on the line but they do help to excite and engage people who see it at a local level the possibilities for renewable generation and the benefits it can have."

This money has been used to fund many Scottish Power Energy Trust school projects including providing grants of £20,000, 6kW turbines and 2kW solar panels amongst other energy efficient methods including upgrading to high energy performing IT equipment.

4.0 Building Assessments

As of January 2006, it will be compulsory for all buildings to have a Building Performance Certificate in order to comply with new EU regulations. This is to ensure that all buildings are performing to high, safe standards and that every care has been taken to ensure they are energy efficient and environmentally friendly. The British Government have also pledged to bring forward to 2005 the next revision of the Building Regulations to raise the standards of energy efficiency in new buildings and refurbishments, including all Scottish schools.

4.1 Building Research Energy Environmental Assessment Method

Building Research Energy Environmental Assessment Method (BREEAM) Offices 2004 is the assessment method that the majority of Scottish local authorities use to determine how energy efficient there schools are performing.

The first area of assessment within the BREEAM is 'Management'. This marks a wide range of areas. This covers areas both in the design and construction phase as well as the performance of the finished building.

It aims to determine wither or not there is an appropriate person appointed from a design team to ensure commissioning is monitored on the client's behalf.

It also grades projects on their commitment to achieve certification for standards above normal industry practice.

Buildings are also commended for the way in which they choose to monitor and where possible minimise their energy and fuel consumption, CO_2 emissions and construction waste.

Points are awarded for minimising pollution to different aspects of the environment where possible.

The second area of assessment is 'Health and Well-being'. This section mainly addresses aspects affecting the people using or maintaining the building.

It grades the safe access to various building components that require maintenance checks.

It also grades attempts made to prevent harm to users and awards care taken in designing for optimum user comfort. This includes various aspects such as lighting, ventilation, floor space, temperature, noise levels etc.

The third area of assessment is 'Energy'. This area covers the monitoring and use of energy and the effects of this.
Points are awarded for all sub metering within the building where major energy consuming items may be located e.g. computer room etc.
Points are also awarded in accordance with the amount of energy lost/saved through various building fabrics.
Points are awarded to correspond with CO_2 emissions as a result of energy consumption.

The fourth area of assessment is 'Transport'. This section considers the total net CO_2 emissions as a result of transport travelling to and from the building. These emissions will be predicted and graded based on the location of the building.
More points will be awarded to a building situated in close proximity to major transport services offering typical public transport connections, than that of a building that is situated in a more out-of-town, rural location.
Extra points will be awarded for those who can provide evidence to support the implementation of a Transport Plan, to ensure there is an option for cycling facilities, based on the number of staff in the building or for those who can demonstrate that there is good access to public transport networks within a specified distance and service frequency.

The fifth area of assessment is water. This area is used to predict the amount of water consumed per person per year. Maximum points are awarded for those who consume under $1.05m^3$ per person per year. Again extra points are awarded for buildings that include a system for monitoring water with a pulsed outlet, for the implementation of leak detection systems and where a shut-off operation can be applied to the water supply for all urinals and WC's.

The sixth area of assessment is 'Materials'. Similarly, this covers many issues starting with the safety of the materials used, assuring that there is no asbestos used in new

buildings and that appropriate surveys have been carried out and all asbestos removed in older buildings. Points are also awarded for designated storage spaces for recyclable materials, ensuring that each specification wither it be floor, wall, roof etc. demonstrates that at least 80% achieves the top BREEAM rating for performance, certain percentage of some building fabrics are from recycled sources or where all timber used is recycled or from a sustainable source.

The seventh area of assessment is 'Land Use'. This area is concerned with the land on which the building will be erected. Points are awarded for ensuring that this land is safe to use and if appropriate any surveys or reports have been carried out beforehand.

The eighth area of assessment is 'Ecology'. Consideration is given towards the ecological value of the land both before building and any change that has impacted the site in anyway during and after building. Points are also awarded from any advice sought out from and acted upon from Wildlife Trusts or the Institute of Environmental Management and Assessment, for the consideration and protection to certain trees, hedges and other natural objects or where evidence is apparent in the protection of long term impacts on biodiversity.

The ninth and final area of assessment is 'Pollution'. Points are awarded where refrigerants have an ozone depleting potential of zero or where refrigerant leak detection systems are in place or where no refrigerants are in the specification for a development. Also, the lower the nitrogen dioxide emissions from burners in the boiler plant, the more points are awarded.
Points are also awarded for rainwater holding or sustainable drainage techniques, where on site separation/filtration treatment is available for use with e.g. oil, where 10%of the heat or electricity consumption is generated from a renewable source or where the use of thermal insulating materials avoid the use of toxic emissions in either manufacture or composition.

The points that are awarded fall into one of two categories; core or design and procurement. By accumulating the core points awarded, namely the points scored within the Health and Well-being, Energy, Transport, Water, Materials and Pollution sections, it is possible to determine the probable Environmental Performance Index (EPI) Score. The Scale is shown in table 1 below:

Checklist Score	**EPI**
0 – 120	1
100 – 150	2
130 – 185	3
165 – 220	4
200 – 255	5
235 – 290	6
270 – 325	7
305 – 360	8
340 – 395	9
375+	10

Table 1: Probable Environmental Performance Index Score

By accumulating both the core points and the design and procurement points from all sections it is then possible to calculate the probable BREEAM rating for a design and Procurement assessment. Again this can be determined from a table like the one shown in table 2 below:

Checklist Score	BREEAM Rating
235 – 405	PASS
385 – 550	GOOD
530 – 695	VERY GOOD
675+	EXCELLENT

Table 2:Probable BREEAM Rating

This BREEAM is actually for offices 2004. However, the educational version (SEAM) that would normally be used is currently being updated. The update of SEAM is apparently long overdue and expected at the beginning of 2005.

4.2 Energy Benchmarking

The majority of Scottish councils also grade their buildings using the Building Energy Performance figures provided from Action Energy. For both primary and secondary schools the benchmark is measured in kWh (kilo-watt hour) per m^2 of heated floor space per annum for both fossil fuel and electricity. These values are displayed in table 3 below:

Annual Energy Kwh/m^2	Primary Schools (no pool)		Secondary Schools (no pool)		Secondary Schools (with pool)	
	Fossil Fuel	Electricity	Fossil Fuel	Electricity	Fossil Fuel	Electricity
Good practice	113	22	108	25	142	29
Typical	164	32	144	33	187	36
Poor practice	224	45	191	41	233	41

Table 3: Annual Energy Benchmarks for schools

All schools are encouraged to aim towards 'Good Practice' status. The vast majority of Scottish councils older schools, particularly within west and central Scotland, are failing to achieve this and are performing at the lower end of the 'Poor Practice' scale.

It is also possible for schools to calculate their CO_2 emissions using their annual energy consumption figures. They can either use the on-line, automatic benchmarking for schools from the Action Energy website or they can use the following factors, again issued from Action Energy, show in table 4:

CO_2 Emission by Fuel Type for Scotland		
	Kg CO_2/kWh	**Kg CO_2/litre**
Electricity	0.52	-
Natural Gas	0.19	-
Gas/Diesel Oil	0.25	2.68
Liquid Petroleum Gas	0.23	1.65
(LPG)	0	0
Renewables		

Table 4: CO_2 emissions for different fuel types

To calculate the schools CO_2 emissions the annual consumption (in kWh) for each fuel type would be multiplied by the CO_2 factor for that fuel. The combined figure for each of these would represent the schools total annual kg of CO_2 emissions.

All of the figures within table 3 were based on consumption data for 2000 schools in England 1999 – 2000. This has caused some controversy throughout various Scottish councils who only have access/use of these figures to benchmark their own schools. It is the opinion of some Scottish councils that the Action Energy benchmarking method is in fact very crude as the figures listed were based upon building consumption rates in England, not in Scotland where it is normally wetter, windy, colder, duller and school operating hours may be longer – due to the new build of community schools. Also, Action Energy does not have a full catalogue list for all buildings. Many different buildings with various consumption rates appear to be grouped under the same category. This again is to the dislike of some Scottish council's, as they do not

believe true, accurate, fair benchmarking, especially for the west of Scotland, is being achieved.

4.3 Water Consumption

Water minimisation can be one of the easiest ways to achieve cost savings. Envirowise is another Government programme set-up to offer UK businesses free, independent, confidential advice and support on practical ways to increase profits, minimise waste and reduce environmental impact. Typical domestic water use throughout the UK during 2002 is shown in fig. 3 below:

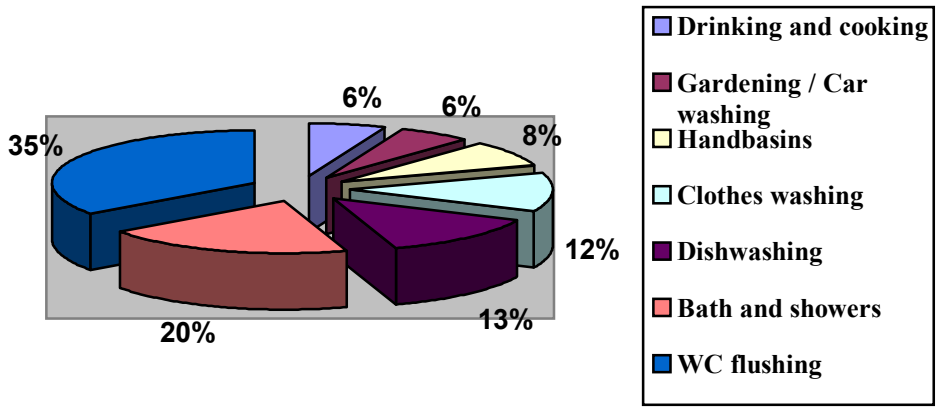

Fig.3: Typical Domestic Water Use for UK, 2002

Over a third of all water use was used for WC flushing. This is an area where schools could benefit from potential savings in cost and water usage. Envirowise have found that companies adopting a systematic approach to water minimisation, with simple and inexpensive measures, can achieve a 20 - 50% reduction in water used (Envirowise, 2002).

Water consumption in schools has also been bench marked by Action Energy. If the use of water is not monitored and controlled it can often prove to be very expensive for schools as they may pay twice for using it, once for the water supply and twice for the appropriate disposal of it. The benchmarking figures for water were produced in order to allow schools to identify what savings could be made if 'Good Practice' figures were met successfully. These figures are outlined in table 5 below:

Water Consumption in m^3/pupil/annum				
School Type	**Primary (with pool)**	**Primary (no pool)**	**Secondary (with pool)**	**Secondary no pool)**
Good practice	3.12	2.63	3.38	2.74
Typical	4.25	3.68	4.86	3.82
Poor practice	5.37	5.31	7.05	5.75

Table 5: Water benchmarks for schools

The Scottish Executive has pledged to invest £5million into Scottish water in a plan similar to that of the £15million energy efficiency investment. Again the hope is to invest money in efficiency projects in order to reduce consumption and achieve savings over no more than a 5year payback period, thus saving more than the initial investment.

5.0 Case Studies

In order to determine how successful and identify what measures Scottish local authorities have taken to implement energy efficiency and environmental awareness within their schools and also determine the effect that the Public Private Partnership was having on the new school buildings, 5 different case studies were considered. These included 5 Scottish Councils, 3 are currently involved with the Public Private Partnership (PPP) and have experienced the new build schools, 2 are still in consultation with private bidders and as yet have no new builds.

5.1 Public Private Partnership

The Scottish Executive has set a target of 200 Scottish schools to be refurbished or rebuilt to higher building standards by 2006, rising to 300 schools by 2009. The Scottish Executive has stated that they cannot invest the full amount of money required to meet these objectives from their budget. Instead they are promoting a new avenue for the Scottish councils to travel when refurbishing or rebuilding their older, dated primary and secondary schools; the Public Private Partnership (PPP).

This partnership is between the council and private bidders. At the early design stages for a school refurbishment or rebuild, private contractors will be invited to bid for the new school contract. This will involve them producing detailed specifications of the new school and allowing the council to have the end say on who will be chosen, based on quality and value for money. The council will still have ownership of the land on which their schools are built, however the school building will now belong to the successful private bidder and will be leased back to the council for an arranged fee over a period of 25 – 30 years. The private bidders will have full control of the building, its contents and the maintenance and upkeep of the building over this agreed period.

The Scottish Executive has advertised PPP as a way forward for schools “fit for the 21st century, equipped to meet modern needs and challenges” (Peter Peacock, Scottish Executive, 2004).

5.2 Case Study 1

5.2.1 Setting Standards

January 2003 saw the opening of the first Scottish primary School to house children from both a non-denominational and a Roman Catholic primary school, a total of 780 children, in the one campus. Work began on the site in October 2001 and was completed in December 2002. The school cost the council a total of £4.25million to build. The School, situated on a hilly embankment, has a 9 metre high, 6kW wind turbine that provides electricity for the schools lights. It also has 2kW solar panels in place to heat the schools hot water. They received a £38,000 grant from the local authority and Scottish Power's Green Energy Trust in support of the renewables. The idea behind the renewable technology was to develop a common interest between the two schools, allowing them to unite, learn and develop knowledge on the benefits that renewable energy could bring, hopefully encouraging the children to adopt better lifestyles for a sustainable future.

Renewable energy, in particular wind energy, has very much been integrated into the teaching curriculum. The children have a learning wing in the schools library where they can monitor, from computer software, the wind speed, direction and gust as well as temperature, humidity and rainfall. They have also set-up their own company within the school to help educate others and promote the benefits of renewable energy. 'The Energy Kids' are the Primary 6 class, a non-profit making company that aim to inform as many people as possible about Renewable Energy. They have been operating since January 2004 and aim to meet 3 afternoons each week. The principle teacher who shares their passion for their own wind turbine guides them.

The children have had a hugely positive response to the wind turbine and already know a great deal about how it works and the benefits it offers to the environment. 'The Energy Kids' have designed games in order for the other primaries and teachers to learn about renewables in a fun way.

They have visited Hag Shaw wind farm to watch and learn how wind farms work and are regularly invite companies such as Scottish power and Ofgem to come and speak with them helping to fuel their knowledge. They often receive gifts e.g. windmills, CD-ROMs and DVDs that can then be shared and enjoyed by the whole school.

The building was designed with the idea of becoming a community a building. With its distinguished wind turbine it has become somewhat of a landmark in its area.

Nearby residents have also been greatly welcoming and are intrigued by the renewable technologies. They have stated that the turbine has increased the attractiveness of the surrounding area, whilst increasing environmental awareness amongst residents.

The school has been built on two floors. The roof decking and wall cladding are mainly metallic silver blending well with the grey/light blue skyline. Inside the teaching areas are wide and open-planned, running along each side of the building. The roof slopes upwards from either end of the building, channelling the noise away from the teaching areas towards a long, raised centre point. This was to ensure that the Speech Transmission Index (STI) was always good or excellent when considering activity noise as background noise levels. The use of natural light is optimised through the use of large panelled areas surrounding the teaching areas and through a large panelled area in the raised section of the roof running the whole length of the teaching areas. Noise pollution has been minimised from the top floor travelling through to the bottom ceiling by heavily carpeting all teaching areas, including the library and learning wings. The school corridors were purposely designed generously wider than in standard schools to ensure that children did not feel threatened or claustrophobic when they are heavily occupied e.g. at lunch, break or change over times. Each floor has its own educational wing, one for each school, comprising of base/activities areas with associated pupil entrance areas, toilets and cloakrooms. However, the central core areas are designed for use by each school on a pro-rata basis and also for the use of the community. The school specification ensured that the school was built to achieve an excellent BREEAM rating. The school have also made a big effort to reduce their energy consumption and carbon emissions rating by ensuring that all their IT equipment has a low energy consumption rating and that it is also installed with a sleep function.

The pupils and teachers from this school strongly believe that their renewable technologies have united the school and the community by raising awareness and developing an understanding for the need of sustainable development. This council have been delighted with the design of this new school building as they believe that it uses modern materials to give a modernistic theme looking forward into the future of educational developments and have therefore benchmarked it as a starting point for their future PPP schools.

5.2.3 Moving Towards PPP

The majority of the council's schools within this area are 1960's built schools and are scoring at the lower end of BREEAM, have poor energy consumption ratings and are not at all described as being energy efficient. 45 of the 120 schools within this area are set to become PPP schools and will be leased back to the council over a 30year period. Building work is scheduled to start at the end of this year.

This council are concerned that when PPP take control of the schools, energy efficiency will take a back seat to the building fabric. The council are very much under the impression that the private bidders think conventionally with the new-build schools and use traditional fuels and equipment. They have found that the private partners are not willing to integrate renewables such as wind turbines or solar panels into the design as they do not offer any incentive to the bidder to do so; they are mainly used for educational purposes and will not benefit the private contractor in anyway.

This council buy the maximum limit of 20% of their total amount of energy from Scottish Power's green energy sources. Scottish Power has enforced this maximum to ensure that they always have enough for those domestic customers wishing to buy their energy from renewable sources.

Energy use is monitored and targets are set for all schools in this area. When their 45 new-build schools become part of the PPP, the council will no longer directly be responsible for their schools energy payments, this will now be down to the private partners. The council will have to forecast what they believe will be the energy consumption for each school, each year, for the 30year period and payment for this must be agreed with the private partners and included in the 30 year contract. Any under spend on energy consumption for a particular month or year by the school will not affect the price that was agreed to be paid in the contract i.e. the private partners will receive this as profit. This has caused some concern, for this council, for a number of reasons. Firstly, it is extremely difficult to forecast energy consumption and agree a fixed price for this over a lengthy period such as 30years when it is not possible to take into account the possibility of a considerable change in energy price or the future developments in technology wither it be low energy consumption products or advances in energy generation. Secondly, this council are concerned that by agreeing to fixed energy payments, they are not creating any incentive for schools or the private bidders to adopt energy efficiency/saving techniques. Also, concern has

risen over the certainty of special discounted rates that this council, as do many Scottish councils, receive from Scottish Power due to the vast amount of energy that they buy in for their hundreds of properties. They fear that the reduction in energy supplied by Scottish Power for their 45 schools, that is over one third of their total energy supplied to schools, will affect their discounted rates, which are currently lower than domestic rates.

5.2.2 The Need For Energy Efficiency

The majority of their schools energy performance ratings concern this council, such is this concern for many Scottish councils. The majority of schools are scoring at the lower end of the scale. There are a few factors that contribute to this, the first obvious one being the lack of energy awareness and practice within these schools. This council feel that their 'off-the-shelf' energy awareness campaigns have failed to make a desirable impact and are now looking to rectify this problem by targeting specific job-roles e.g. school maintenance team, office staff, teachers. They believe that by specifying the type of energy efficiency techniques for each particular person within their job role they will allow that person to become more energy aware and carry out their role in a more efficient manner. They have standard energy policies specifically for education, however they do believe that greater results are achievable by encouraging staff and child involvement and tailoring energy policy plans specific to each school. This is a technique that they have tried to implement within their own working environment and over the past ten years they have made a significant reduction in their energy bills. There are approximately 16,000 staff working for this council and every single person is encouraged to achieve sustainability and energy management through accurate monitoring and targeting and general energy awareness. This has been one of the important factors in contributing to the slash in this council's yearly energy bills form £7.5million in 1993 to £6.3million for 2003. Similarly, the age of the school buildings is another factor that this council's Energy Property Officer believes is affecting the overall energy performance of their buildings. With the majority of schools 1960's built with older, single glazed windows causing draughts and leaks and poorly insulated, often flat roofs failing to retain heat and low cavity insulated walls all greatly contributing to the overall performance of the building.

The Energy Property Officer has also expressed some concern over another important factor that he believes to influence the poor energy performance ratings of this council's schools and that is that the figures recognised as 'good practice' by the Scottish Executive and published by Action Energy were based on the energy performance of English schools. This council would prefer to measure it's own schools against one another as they compare so badly with the 'good practice' results. They are communicating with both the Scottish Executive and the Scottish Energy Efficiency Office to produce updated figures applicable to Scottish schools, taking into consideration the change of climate and the increase in standard hours of use of a school due to community use.

5.2.3 Compromising Quality

There are other concerns for the 45 schools in this council soon to become part of the PPP. These include the responsibility of upgrading and energy efficiency of the building e.g. in 10years time when current building standards are upgraded. Also, the council are not clear if the PPP contract acts as a barrier for the Government demand site sector and fear that they may incur the additional costs of any upgrades.
The Energy Property Officer is not confident that after 30years when these PPP schools are handed back to council ownership they will be in good condition, due to the quality and choice of materials that the private bidders will choose to use during the construction phase. The Energy Property Officer is not confident that this council is getting value for money. He is under the impression that in 30years the council will end up 'back at square one', in the same position and the only person to benefit will be the private contractor.

5.2.4 Conflicting Opinions

There are, however, conflicting views within this council towards PPP. Other members are looking forward to the new PPP schools and are optimistic as to what can be achieved.

Contracts for 5 new secondary schools, 3new buildings with two merging schools and 24 primary schools, 21 new builds with three merging schools, are scheduled to be signed at the end of September in order for construction work to begin in October

2004. It has been estimated that all new builds will be completed within the next four years.

When this council first entered into the private partnership they received PPP documentation and Scottish school estate strategy's stressing that they should not be specific when communicating what schools they want with their private contractors. The council were encouraged only to give a general output specification for their schools. The theory behind this was to allow the private contractors to produce innovative, energy efficient schools designs. This also meant that if the building or a piece of equipment was not functioning as it should, then the private contractors had to take responsibility for this as it would essentially have been their idea and not something that the council had specified. However, in practice this has became a rather lengthy guessing game with private bidders running back and forwards to the council trying to put into working concepts what the council want without them actually saying so.

This council have been led to believe that when becoming involved with PPP it is the private contractors responsibility to produce detailed specifications and concept designs for the new buildings. They invite the bidders to visit their most recent development, mentioned previously, in which they themselves have benchmarked as a starting point for their PPP schools. They wish to continue the use of wide, open corridors, fewer stairwells and large, open-plan, social sections located in the middle of the school. This council's private partners will not include any type of renewable technology in the new schools as they believe it is used mainly as an educational tool and would not benefit the building fabric or them financially in any way. As a result this council are presently in consultation with the SCHRI, seeking funding for implementing energy efficiency methods within their schools. They are ensuring that all wooden furniture used within their new-build schools comes from renewable sources and that there is no PVC cabling used within the school.

The contracts between the council and private contractors can be rather restrictive in the sense that teachers are limited when it comes to personalising their classrooms e.g. children's work must not be directly displayed onto the walls, the use of most adhesives is not allowed, no shelves are to be mounted onto any of the walls. The council have therefore stated the need for pin boards, quality paint and mobile

furniture in their specification allowing the teacher to personalise classrooms and display work resourcefully.
All of the new PPP schools will be fitted with sprinkler systems. The main reason for this is the insurance costs. Over the past few years Scottish schools have witnessed insurance prices rocketing. In an attempt to save thousands of pounds per school every year in insurance payments, this council have ensured that sprinkler systems are now part of their PPP school specifications. They are also ensuring that architects are adopting fire-safety zone layouts within their schools so that in the unfortunate event of a fire, the fire will be isolated as much as possible to one area of the school.
The council have also ensured that a schedule of rates has been agreed between themselves and the private partners. This allows for any additional features, e.g. an extra sink in a classroom, to be fitted at an agreed cost. Not all councils have this agreement and subsequently have had to pay huge amounts of money to make small adaptations to the original school design.

This council's Client Specification Manager responsible for the PPP schools has ensured that a contract has been signed ensuring that all schools will be built to the highest possible BREEAM standards. When negotiating their energy consumption rates for each school with the private contractors, the Client Specification Manager ensured that both the council and the private contractors accepted a certain amount of risk. The council have a price risk meaning that if there is any change in electricity prices they will be responsible for this. The private contractors have a consumption risk meaning that if the school consumes more than the agreed energy consumption, within reason, they are responsible for this. The Client Specification Manager has entered the council into this agreement in a bid to encourage their private partners to become more energy efficient when installing equipment and deciding on the building fabric of the school. The Client Specification Manager would prefer that the council remained in control of all of their schools energy monitoring, targeting and payments, however, he believes that this would not offer any incentive to the private partners to install energy efficient equipment or adopt energy saving techniques when building the new schools. The agreed energy payments between the council and the private contractors are fixed over the 30year period. The Client Specification Manager is trying to protect and ensure that the council will not loose their special, non-domestic, discounted energy rates from Scottish Power by continuing to process payments to

Scottish Power, for these schools energy consumption, from the council and then later the council will be reimbursed by the private contractors.

The Client Specification Manager has stated that for their PPP schools this council typically pays 10% of the capital value of the school every year e.g. if the school cost £5million to build then the council will payback £500,000 yearly instalments over the next 30years. Unlike the Energy Property Officer, the Client Specification Manager believes that this is good value for money. This council has approximately £5million per year to spend on maintenance throughout all of its schools, according to the Client Specification Manager this is nowhere near enough. He believes that it is often the case that running and maintenance costs of their schools are often 5 times the value of the capital costs and that staffing can be 10 times the costs. Therefore the Client Specification Manager is delighted that the maintenance costs of the PPP schools will now be the responsibility of the private contractors.

The Client Specification Manager is eager to have the private contractors sign an agreement ensuring that the building will not require any major maintenance once it has been handed back to the council after the 30-year period and if it does that the private contractors will be responsible for this work. He believes that this will help ensure that the council will be handed back high quality schools.

5.3 Case Study 2

5.3.1 Monitoring, Targeting and Benchmarking

This councils Energy Management department have written energy management reports for all of their 62 schools. They have assessed all of their schools using BREEAM and ensured that all of their buildings are all issued with a Building Performance Certificate. This certificate will grade each individual building from A to G, where A is the best and considered excellent practice and G is the worst rating. Buildings are benched marked and compared against similar buildings e.g. primary schools with primary schools.

They have found that the majority of their schools fall into the lower category ratings. Secondary schools in this area are scoring particularly low with an average energy consumption of 254kWh/m^2/yr, more than one and a half times the benchmark for 'typical' consumption and more than double that for 'good practice'. In order to improve the schools ratings they have set their own targets and issue each school with an individual report outlining energy saving measures that can be adopted. This council not only displays graphs of unit savings in their reports but also outlines the savings in pounds. They find that this is more attractive to their schools.

If e.g. a school is issued with a B rating they will aim to reduce their energy consumption by 2.5% the following year. If a school is issued with a G rating they will aim to reduce consumption by 9.5% with the help of their council. Each report outlines the current monthly consumption (for gas and electricity and cumulative use) in both kWhrs and pounds. This is displayed in graph form alongside the target consumption rate.

This council use degree-days when forecasting gas consumption for heating in the west of Scotland. They do this as the figures provided by the Carbon Trust are based in England where it can be hotter and drier than it normally is in the west of Scotland.

This council's Energy Management Unit set their benchmarks for energy consumption 10% higher than those outlined in the Action Energy publications from the Carbon Trust. They believe that these higher figures are in fact more accurate for the west of Scotland and schools in their area. They also publish carbon reports for all of their schools and show the savings after energy efficiency measures have been adopted. The energy efficient grades that this council have chosen to use are as displayed in table 6:

Energy Efficient Rating	Benchmarking
A	Better than good practice
B	Between good practice and typical
C	Above typical and 20% below the council average
D	Between the council average and 20% below the council average
E	20% poorer than the council average
F	Between 20% and 45% poorer than the council average
G	More than 45% above the council average

Table 6: Energy Efficiency Ratings

At present this council receives 20% of all its electricity from renewable sources. This includes all schools and council buildings. They are hoping to raise this figure to 50% next year. This is helping lower carbon emissions and save money on electricity consumption due to the charges from the CCL.

5.3.2 PPP for the Future

25 from the 62 schools within this area are now set to become part of PPP. This includes all secondary schools and a selection of primary (older, dated buildings in need of refurbishment). They are still in the finalising stages of working with the proposed PPP contractors.

The council's Energy Management Unit has been forecasting what they believe each of the proposed PPP school's yearly energy bill will be. A ball part figure needs to be agreed on between the council and the private contractor and this will be payment for the next 25 years. Any under spend will automatically go to the Private Partners. This is causing much controversy as the council's Energy Management Unit wish to minimise the energy consumption and have the new school adopt certain energy saving techniques. However, the private partners wish to raise this figure as high as they possibly can as whatever the school energy consumption is the private partners are guaranteed a fixed payment, even if the energy consumption rate is much lower than forecasted.

This council remain to be convinced of the benefits of PPP. They believe that in the past schools were built to last, now however they very much believe that their schools will be built around a strict budget, from the cheapest bidder to last a maximum of 25years.

This council's Energy Management Unit has installed Building Energy Management System (BEMS). This system allows the heating and temperature of the whole building to be controlled and programmed from one computer. It has reduced this council's boiler consumption by 20-25%. The system requires many hours to install and initiate, however once up and running it is very rewarding. Rooms are always set at the correct temperatures. By not over-heating/cooling both energy, emissions and money are saved. Where possible the council have asked that this system be implemented into schools. The private partners are again reluctant to integrate this system into new-builds as they view this as very time-consuming to set up, initially more expensive to install than older models and would require them to educate e.g. school maintenance staff in order for them to monitor the software correctly. The council feel that the private partners are overlooking the fact that it would reduce the schools boiler consumption by up to 25% and that it could significantly reduce heating bills. Since the Private Partners will be receiving an agreed fix rate on forecasted energy consumption from the school, this council feel that the private partners are not overly concerned with energy efficient methods to reduce energy consumption as well as saving the school money on energy bills.

5.3.3 Five-Year Energy Efficiency Plan

With the money this council have been awarded from the Scottish Executive, as part of the energy efficiency 5year payback plan, they have chosen 15 properties that they hope to improve. They have focused on this small number of buildings so that they are able to improve the whole building implementing energy efficiency everywhere, top to bottom throughout the building. They believe that this is best for their area rather than choosing to improve e.g. lighting in one building and perhaps boiler systems in another etc. None of the 15 properties are buildings that are to become part of PPP as these schools will be demolished and re-built to PPP standards.

The Scottish Executive will not permit this funding to be used on methods/projects promoting only water savings/consumption as this is viewed as a low carbon producer. The Energy Management Unit from this council wish to overturn this decision, as they believe that there is huge potential to encourage and implement techniques to reduce water consumption in their area.
They would concentrate on automated flush systems that use a considerably less amount of water at regulated intervals, than the standard school flush cisterns that are very much controlled by the children. They would also ensure that tap water is regulated and timed to prevent flooding and leakages within their schools, as these are the areas where they feel that a vast amount of water is being wasted.

5.3.4 Energy Management Reports

Compared with the SEEO energy management surveys and energy audits, this council's reports are much more in depth, with detailed steps outlining what can be saved, financially and economically, exactly what targets should be made and how to implement measures to meet these targets on a monthly and yearly bases. They estimate that their own reports would cost £2000 for a typical survey. This covers everything except the building fabric.

The Investment and Technical Services, Energy Management Unit for this council have been set a goal to reduce energy consumption throughout the council's building stock. They have targeted the poorest energy performing buildings in their area and have subjected them to a detailed energy survey, making recommendations for improvements. The team hope that by promoting and implementing ways in which to use energy more efficiently, it will reduce the council's CO_2 emissions and at the same time promotes sustainability throughout the council.

At present the council are committed to improving energy efficiency and raising awareness to cut down on CO_2 emissions by using a monitoring and targeting system in all of it's schools. Every month schools receive a detailed report highlighting their previous months consumption and energy rating. Targets are also highlighted for the following month and the savings are shown in terms of financial and emission savings.

This is an example of some of the content present in a typical report, carried out in April of this year, for a school in this area with an indoor swimming pool. The school is a two-storey cavity brick construction with operating hours of 8.30am until 5.30pm Monday to Friday and from 5.30pm until 10.30pm two nights per week. During 2003 this school's general electricity consumption was 64kWh/m^2/year, using the energy efficient ratings outlined in table 6 this corresponds to a C rating. Gas consumption for the same year was 480kWh/m^2/year, corresponding to an E rating. The annual cost for electricity and gas consumption for this school during 2003 was £13,582 and £19,078 consecutively. The Energy Efficiency Best Practice Programme have found that by implementing a good energy awareness campaign within a working environment, individuals can help reduce electrical consumption by up to 5% (Energy Saving Trust, 2004). This is an area that council wish to address within many of their schools as they feel that energy efficiency is not wifely practiced by individuals.

This council's survey identified that this school, like many schools, left electrical appliances running out with the school's hours of operations and also during the school's Easter break. By simply ensuring that certain equipment set on standby mode when not in operation the energy consumption, in terms of watts/hour, is drastically reduced. For PC's and VDU the stand by consumption is only a third of what it would be during operational consumption, for printers the standby consumption is around one-fifth of its operational consumption, for photocopiers it is only one-quarter, for fax machines it is approximately one-third and for vending machines standby consumption is as little as one-seventh of the operational consumption. The school could make significant savings by ensuring that when not in use these appliances are switched to standby mode. Also, by ensuring that all IT equipment, electric heaters, water heaters/chillers, extract fans and empty fridges are switched off when the school is closed for breaks could drastically reduce energy consumption helping to improve the schools energy efficiency ratings.

This council have recommended implementing a programme of staff energy awareness training to achieve potential annual energy savings of just 1%. This would allow this school to make annual energy savings of £75, 0.9 tonnes of CO_2 and 0.3 tonnes of Carbon.

This school has two boilers that were installed in the late 1960's, they have since been converted from coal to gas and have energy ratings of 290kW. These boilers' seasonal

efficiency is over a third less efficient than some of the more modern boilers that are capable of producing efficiencies of between 70% and 90%. It would cost around £45,000 to replace these boilers, resulting in an 8-year payback. The council have suggested that by replacing these old boilers the school could reduce their annual gas consumption by up to 30%. This again leads to potential annual gas savings of £5,620, 81.7 tonnes of CO_2 and 22.3 tonnes of Carbon.

The school control the boilers using a "Jel Micro 2000" control panel. The operation settings have never been changed on this panel since the installation engineer programmed it. The heating plant was scheduled to start two hours earlier than required each morning between Monday and Friday and also during all school holiday times when the building id left empty. The council are now ensuring that the school janitor is given proper training to enable him to programme the heating schedule between 7am and 4pm Monday to Friday and allow him to manually over-ride the settings when the school will be left empty during scheduled holidays. This will reduce the hours of operation on the heating schedule by approximately 150hours every year. Assuming the boilers operate at 90% load, a total of 78,300kWh of energy will be saved every year. Assuming council rates for gas consumption at £0.01307 per kWh, this equates to instant annual savings of £1,023, 14.9tonnes of CO_2 and 4.1tonnes of Carbon. Fitting burner management controls to the existing boilers could make further boiler savings. Each burner manager control unit costs around £1,850 and has a payback period of just over 1 year. The Building Research Establishment (BRE) has approved these controls. These units guarantee savings of between 10% and 16% of the annual consumption. This would ensure a minimum saving of 135,502kWh for this school, allowing potential annual savings of £1,771, 25.7 tonnes of CO_2 and 7.0 tonnes of Carbon. These burner management units could be transferred to new boilers and the same performance and energy savings could be achieved from these.

The "Jel Micro 2000" control panel also controls the domestic hot water for the school. Similarly, this was not programmed in correspondence with the schools demand and energy was being wasted. By simply reprogramming instant annual gas savings of 3-5% can be made at no extra cost. The council's energy management unit noticed that the heating pipe work and heating valves located in the school's plant room were in need of an insulation upgrade. By insulating all pipes and valves the school can drastically minimise their heat loss and enjoy annual savings of £398,

6.9 tonnes of CO_2 and 1.9 tonnes of Carbon. The energy management unit have estimated that it will cost £858 to provide adequate insulation to all pipes and valves, giving a payback period of 2.2 years.
Like many schools, this school's internal room temperatures were considerably higher than those specified by 'good practice' from Action energy. These rooms were unoccupied at the time the energy managers measured the internal room temperature and therefore became even warmer and uncomfortable when fully occupied. Action Energy has published figures to shown that by overheating a room by just 1Degree Celsius, annual heating casts can increase by up to 6% (Action Energy, 2003). The council's energy managers have therefore recommended that heater control thermostats should be set in accordance with good practice standards.

This council also promotes the use of energy saving light bulbs in all of its schools. Compared with traditional 100Watt tungsten filament bulbs used in many older schools, energy saving compact fluorescent lamps (CFLs) consume 75% less energy (Action Energy, 1999). Energy saving light bulbs can cost up to six times more than regular light bulbs, however they last approximately 10times longer and have a payback period of around six months. One energy saving light bulb in this school will save approximately £7 per year on annual electricity costs and up to £65 over its lifetime. The council have ensured that the 250Watt high-pressure sodium discharge lamps used for external floodlighting are controlled by intelligent photocell controls. These controls monitor the level of natural daylight ensuring that the lamps are only switched on when additional lighting is required. Care is taken when positioning these photocells e.g. to ensure shadows are not cast over them at certain times of the day allowing a true reading to be achieved.
This council are also promoting the use of sun pipes within their new buildings and are trying to encourage their new private partners to do the same within the new PPP schools. Each sun pipe costs around £400 and helps to maximise the use of natural lighting, thus reducing the need for strip lighting particularly within school corridors and entrance/gym halls, saving both money and emissions on electricity.
(For more information on sun/light pipes visit:
http://hem.dis.anl.gov/eehem/97/970106.html#brands).

This school has an indoor swimming pool. The council's energy management unit found a few discrepancies in the way in which the pool is maintained. 'Good practice' figures from Action Energy state that the school's pool water temperature should be 30°C, that the air temperature in the pool hall should be 1°C higher at 31°C and that the relative humidity level should be between 55-65%. However, the school's pool temperature was actually recorded almost 5°C higher than this and the relative humidity level was recorded at 48.5%. Also, the school were not making use of the pool cover. All of this has had an adverse effect on the building fabric within the pool area. By resetting the pools control panel to 'good practice' levels the council estimate that the school could make annual savings of £706, 10.2tonnes of CO_2 and 2.8tonnes of Carbon. An additional annual saving of £250 could be made if the pool cover is utilised when the school is closed and when the pool is not in use. This greatly reduces the reduction in evaporation and therefore reduces the energy needed for heating the pool.

The energy management unit have found that in their schools, the school roofs account for up to 25% of the total buildings heat loss and walls can account for up to 35% heat loss. They recommend that where possible these roofs should be upgraded with additional insulation. With the majority of older schools being designed with flat roofs it is only possible to add insulation when the roof is being recovered, normally every 15-20 years for flat roofs with bitumen felt roof covering. The energy management unit found that this school was mainly fitted with suspended ceilings and that these had been correctly insulated to a depth of 150mm. Significant heat losses are transmitted through glass due to its poor insulating properties and with glazing accumulating approximately 70% of the net wall area of the school, this is an area that needs to be addressed by this school.

All the external doors from this school were constructed with either metal or timber. The doors were mainly standard size and the majority did not fit their frames tightly resulting in draughts and heat loss. In some of the classrooms, even though the heating had been on continuously for several days, the temperature was recorded as only 15°C. The draughts coming from the external doors had a lot to do with this. The energy management unit have also highlighted this problem and recommended that the school draught-strip all poor door fittings and windows and suggest that in the

future upgrade to the building fabric it will be cost effective for the school to have insulation levels upgraded where possible.

The energy management unit discovered that this particular school made use of three different types of water chillers, all with very different energy consumptions. They have a bottle fed water chiller that also provides hot water, which consumes 1,200Watts. This is more than ten times the mains fed water chiller and over five times what the bottle fed chiller uses. It was also noted that these water chillers are left on permanently, 24 hours a day, during holidays and when the school is not in use. By installing digital timers, at a small cost of £40, this school could reduce water chiller operating times by 15 hours each school day and 24 hours each school holiday. This accumulates to annual savings of £256, 3.1tonnes of CO_2 and 0.9tonnes of Carbon. This information on water chillers should be widely available to all schools, highlighting the potential savings as the majority of, if not all Scottish schools now have a constant supply of water, from chillers, for pupils.

The energy management unit were concerned that this school's 50mm water meter would not have been sufficient for use with the installed fire fighting equipment and have since had the unit upgraded to a £287, 80mm water meter at no extra cost to the school. They have also agreed a reduced charge for the meter due to the lower annual water consumption rate of the school and now only pay the equivalent of a 30mm meter. This was certainly a worthwhile investment on the council's behalf as annual savings have amounted to £3,700.

The energy management unit has also focused attention to the water wasted every year in school toilets. In the male toilets they have fitted Passive Infrared (PIR) Urinal controls at no extra cost to the school. PIR controls cost the council £2,250 to install, however they have a payback period of less than 2 years. These controls are designed to reduce water consumption by automatically flushing only once they have been used and therefore saves on water consumption during unoccupied periods, nights, weekends and holidays. This control also operates the lighting for the toilets and only switches on when the toilets are occupied. The school are now estimated to make annual savings of £1,238, 3.4tonnes of CO_2 and 0.9tonnes of Carbon. The energy management unit have also suggested the use of WC cistern dams in the female toilets. These are particularly effective at reducing water consumption in WC's that are used frequently. The WC cisterns throughout this school's toilets have

approximately 13litre capacities and this could be reduced to around 7-9litres with WC cistern dams. This would allow annual savings of £272. WC cistern dams cost around £235 resulting in the payback period for each unit to be 0.9years.
Water leakages, even though they may appear too small, can cause significant annual losses within schools as water is effectively going straight to the drain. The energy management noticed that there was a leak in this school's hose reel that led to swimming pool. By repairing this nozzle the school incurred annual savings of £850, 0.2tonnes of CO_2 and 0.1tonnes of Carbon. This would cast £10 to resolve and the payback period would be an immediate result.

This council's energy management unit are responsible for carrying out similar energy management reports within all of their schools. This report has outlined potential annual savings totalling to over £16,500 and 149.9tonnes of CO_2. They have estimated that it would cost approximately £52,000 to implement all of these energy efficient methods, with an average 3.1-year payback period.
This council could help fund most of these energy efficient methods with their £507,000 grant from the Scottish Executives 5-year energy efficient payback plan. They could not however use this money to help replace the boilers within this school as they have an 8year payback period. This is very unfortunate, as this would have allowed the school to enjoy their biggest savings both financially and environmentally, (annual savings of £5,620 and 81.7tonnes of CO_2). This also requires the council to make the highest £45,000 investment. The council is struggling to invest such large amounts of money to all the schools that require boiler upgrades.

5.3.5 Integrating Renewables

This council are making good use of the grants available to help fund renewable initiative projects. They are currently in discussion with the SEEO and SCHRI to help fund 50% of their latest wind turbine project for one of their schools. They are hoping that with the help of people like Scottish Power and their Green Energy Trust this funding will raise to 75%. This would allow them to a 6.5meter high, 2.5kW turbine at one of their school campuses. A larger 6kW turbine would involve a larger capital cost and would therefore prove too costly for this council. The 2.5kW turbine is available in three different options:

- ‘Direct Heating’ that allows the user to space or water heat through specially designed heaters. However, this can only be used to generate low-grade heat energy.
- ‘Battery Charging’ that would be useful for schools who are subject to frequent power-cuts.
- ‘Grid Connect’ that enables any surplus of energy to be exported to the grid.

There are high maintenance costs associated with the ‘Battery Charging’ option and seasonal changes involved in the ‘Direct Heating’ option. Therefore ‘Grid Connect’ was the preferred choice.

Wind speed software was provided from the Energy Technology Support Unit to allow this council to accurately calculate the average annual mean wind speed on the considered site. This considered site is 55meters above sea level and it has been calculated that there is a potential wind speed of approximately 7.1m/s here. The swept area of the turbine blades will be 9.62m^2. This equates to an annual electricity production of over 8600kWh and an annual saving of over 3700kg of CO_2 (Wind Turbine Project, 2004).

The council hope to also install a computer program that will allow the children and staff at the school to monitor generation from the turbine. They feel that this will be an important educational tool enforcing the Governments strategy for renewable technologies and helping both staff and children understand the need for a sustainable development. A mini weather station is also to be installed at this site to allow the children to monitor rainfall, sunlight, temperature and wind-speed. The council plan that this will become an invaluable resource enabling the children to study their local environment through this interactive learning.

This council use a local, well-established engineering firm to manufacture their wind turbines for use in their schools. They have noted the high reputation of this firm and have chosen quality over quantity. They are also signing contracts with this engineering firm to ensure that the firm will be responsible for maintenance of the wind turbines. This is a sensible choice as appropriately qualified employees are then able to identify any potential faults and can ensure that the correct action is carried out to resolve these. Not all councils have these contracts in place and once funding has

been provided and the wind turbine is installed there is some uncertainty as to who exactly is responsible for the maintenance and performance checks.

5.4 Case Study 3

This council has 4 complete PPP schools and another 12 underway. The schools have been operating since 2002 and as far as the council are concerned, there have been no startling results concerning energy efficiency or innovative building designs.

Like the majority of Scottish councils, this council also use BREEAM when assessing all of their buildings. They have also found that there is a lack of Scottish standards enclosed in these assessment reports. The Energy and Sustainability Manager for this council firmly believes that from the BREEAM marker scheme, excellent marking for short-term build will never be possible.

5.4.1 Energy Consumption Agreements

Before any contract was awarded, the council estimated the number of units per year of energy that will be used, based on past school reports for this area. The bidders then negotiated prices, including the construction work for the building and the energy repayments for the school over the next 25 years, which would be drawn into a contract between themselves and the council. The council then had to agree to a certain yearly, energy consumption rate. This figure was kept to a ball part figure in order to prevent the council paying much more than required in energy bills. This took some negotiating as the private bidders were looking to raise this figure as high as possible, as previously mentioned they would keep the difference from any under spend from the councils agreed energy payment. Again, this is an area where the council are not happy and would prefer to be in more control of their energy consumption forecasts and payments. This council experienced no great problems in monitoring and forecasting energy consumption within their schools, however, they do have great difficulty in forecasting wasted energy use. For example, lights/heating/hot water that are constantly left on at weekends or holidays. This is why they require the PPP contract to agree not to step outside an agreed bandwidth for payment of this energy use. Of course implementing energy saving measures such as energy efficient BEM Systems would eliminate this wasted energy at times when the schools are out of use as it can be programmed. However, this requires a larger, initial investment that the private bidders are not willing to invest.

Also, this council fail to identify any fairness in that if they consume less energy than forecasted within a particular month, they still have to pay for surplus energy. Again, the council is raising questions as to where the incentive is to promote energy efficiency within these buildings.

5.4.2 PPP performance

This council have said that they have tried to learn from other council's dealings with PPP. They feel that some have rushed into PPP and have very poor quality buildings with no end of contract maintenance agreements in place as a result and that others have opted for the cheapest option and as a result have been left with half-built schools as their private partners have went into liquidation. This council has ensured that contracts have been signed for all new build PPP schools ensuring that after the 25 year handover period they will continue to have a 5 year maintenance free period. This is to prevent them from receiving schools that they have paid for over 25 years being returned to them requiring huge amounts of renovation or upgrade work.

This council remains to be impressed from their new build schools. They feel that the overall design and the materials that have been used are of fairly poor quality. They do not believe that their schools have been built to last. Instead of classrooms they now have communal, open plan, teaching areas where portable storage units are used to segregate different classes. The idea behind this was to create a more relaxed, unthreatening atmosphere for pupils where the use of natural light and ventilation could be maximised throughout the one area. However, this council feel that the bidder has went for open plan schools not to be innovative or creative in any way, but to simply save money on construction by adopting a very basic interior. The council have said that there have been no significant changes in improving energy efficiency within their PPP schools.

The private bidder owns all rights to these school buildings and can therefore decided what should or should not happen to them. This council have found the contracts very restrictive and believe that there is too much control from the private ownership. Some teaching areas are not to be personalised and private bidders have prevented the use of shelves or blu-tack on the walls in some of their buildings as they feel it may

damage the building fabric. This council feels that their buildings were not built in mind to be schools and that education has taken a back seat.

So far they do not believe that they are getting value for money from their schools. The Energy and Sustainability Manager for this council has stated that at the beginning, PPP promised to bring innovation to their new schools, he strongly believes that it hasn't.

5.5 Case Study 4

This council has 25 primary schools and 7 secondary schools. 4 of these schools are now PPP schools. Again, this council is similar to others in that it also grades all its buildings using the BREEAM until the SEAM, educational version, is updated. They have also found that the majority of schools in this area were performing at the lower end of the scale. Over the past three years this council have taken valuable steps in turning this situation around. They targeted the poorest performing buildings and have spent £100,000 over these past three years implementing a variety of measures within their schools to optimise energy efficiency and improve the schools overall performance. By simply fuel switching their schools that were using oil to gas/electricity they have made savings of £300,000 per year. This money can now be put to better use and help implement other energy saving methods. This council have targeted all the small areas little by little in order to slowly move their schools towards higher energy performance ratings.

These schools and this council did not have the appropriate funding to tackle major problems within all of its schools e.g. providing new, more efficient boiler systems or double-glazing whole schools. This meant they targeted and tackled the smaller areas first. By re-vamping the controls within their schools e.g. new optimisers and ensuring such things as thermostats were placed in the correct location, not above radiators like they had been in some schools, allowed more accurate readings and better heating and energy control and PIR systems, that normally cost just over £2,000 to install and have a 2-year payback period, were installed within toilets switching systems to automatic flush, helping increase water savings.

All schools were encouraged to monitor their energy consumption and set themselves monthly targets. As Scottish Power provides all gas and electricity for these schools, each school could monitor their energy consumption on-line for free via the Internet. This helped raise awareness throughout schools in this area.

5.5.1 Five-year Energy Efficiency Plan

This council have been awarded £250,000 over a period of two years from the Scottish executives 5year payback energy efficiency scheme. At first they are very positive about this and felt that there was now no excuses for all Scottish local authorities not to get funding for energy efficiency projects now. However, as

previously stated, this council did not and still have not had a great deal of money to invest into expensive, probably long-term benefit energy saving projects. This has meant that they have heavily invested into lots of smaller energy saving schemes, the majority under 5year payback. They feel that they would have benefited more if the Scottish executive had allowed this money to be spent on long-term investments e.g. installing BEMS or exploring the option of ground source heat pumps. This council believe that this could have helped build towards a future for sustainable development.

5.5.2 Latest PPP Developments

With some schools in this area dating back to the 1930's, it is not surprising that the buildings are low energy performers and are drastically in need of a makeover. This council first embarked on PPP 2years ago. They had seen this as an attractive solution to upgrade their older schools, as the Scottish Office can no longer offer substantial amounts of money at low interest rates.

The council were greatly disappointed and unimpressed with their first PPP primary school that was built in 2002. It was not the school they had hoped for. This was partly down to the council embarking on a new area and partly due to their private contractor's lack of experience in building PPP schools. As a result of this they have now entered into a partnership with a reputable engineering firm who have successfully completed 14 PPP schools and whose current construction education order book stands at £441 million to build their latest secondary school for 1750 pupils. Construction work is scheduled to start at the end of this year.

This council also acknowledge the importance of good relations and communication between all parties involved with the building of a new PPP school. They evidently have a strong relationship with the educational authority that allows them to identify the primary and secondary needs for each school that they build. The local and the educational authorities worked together to produce a detailed specification for the whole building, ensuring that the private contractors new exactly what to build in order to meet the needs of the council and the school. This new school will also be built to the highest BREEAM and energy performance ratings. Unlike other councils, many of this council's employees worked together extensively on this specification, including energy managers and architects, for almost two years. They felt that by doing this they left nothing to chance and new exactly what they would get from their

private contractors. They also felt that this minimised a lot of time and effort, usually spent at the beginning of a project, relying on the private partners to produce a specification and report trying to satisfy the needs of the council and school.
The council also produced exemplar designs for this school that showed they wanted to achieve a high quality, cost effective deliverable solution that would satisfy the requirements of the council and planning authorities. In order for the council to achieve the school they wanted, they believed it made more sense both economically and practically to rebuild rather than refurbish. This council believed that by building this new school it was important to enhance the learning environment and have the ability to support a strong educational ethos through inclusion and building the school with community use very much in mind. They also wanted to improve on the aesthetics of some of the first open-plan PPP schools and improve the overall functionality and performance of the building by ensuring that there were generous circulation areas within the school and that the use natural ventilation, where possible, was optimised, ensuring that there was also control of solar gain/natural light and that internal air temperatures and carbon dioxide levels were monitored. The council very much wanted to drive sustainability into the 'whole-life' solution of this new school.

Room data sheets were produced for every single room type within the new school building e.g. standard classrooms, gymnasium, and staff bases. This school had around thirty different room types. This specified exactly what properties this room had to have including the room and surface temperatures, the amount of natural daylight entering the room and the layout of the room in order to maximise natural cross-flow ventilation. Specifications for all furniture, equipment and fittings were detailed here. Everything from the number of chairs to the power consumption of electrical products was specified. Life-cycle expectancies for all furniture, equipment and fittings are given and range between 10 – 30years, the roof and staircases were exceptions with 40 years expectancies. The private contractors, throughout the 25year contract, would therefore be required to supply appropriate replacements. This specification also stated that where wooden interiors or products were used, every effort had to be made to ensure that they came from a sustainable source (for every tree used another was planted in its place). Similarly, for the use of paint and any adhesives used care had to be taken to ensure that they were as non-toxic and less harmful to the environment ass possible.

Special architectural requirements were also detailed in these room data sheets. This ensured that some classrooms were south facing with windows the full length of the wall, covering at least 50% of the wall, in order to achieve good distribution of natural light. Windows also had to be glazed and positioned in a way that they offered some privacy and relieved the users from the disruption of external noise. The room and layout was also acoustically designed to allow the teacher to be heard from any part of the room. This insures that all walls, ceilings and floors are thermally and acoustically insulated from adjacent rooms and corridors above and below and that each room is within indoor ambient noise levels when occupied. The school will also be fitted with waterless urinals in order to maximise the potential savings in cost and water usage.

This council believe that they are now going to achieve a higher quality school than they ever could have without PPP. They feel less restricted on the school design working with PPP than when they were before borrowing money from the Scottish Executive to build their schools. They no longer have a fixed number of rooms and specific floor to person space, which they found very restrictive. They no longer have to tightly control the size of their schools as they did before when they were budgeted to £10/child/m^2 and in order to achieve more classroom space other areas had to suffer and cut down on circulation. This council also believes that they will now achieve a high quality finish on their new school, unlike before where they may have had to choose cheaper carpets and flooring when building to a tight budget. They believe that by producing a detailed specification at the early stages of the design process ensuring the use of high quality materials, they are reducing maintenance and running costs and therefore making it easier and cheaper for the private contractor to maintain.

This council had to produce an Environmental Statement as the proposed development site for this new school falls into the category of 'Urban Development Projects' in schedule 2 of the Environmental Impact Assessment Regulations for Scotland, 1999. The development site covers 7.93 hectares and the new school building has an area of 17,500m^2.
This statement concluded that the new school would have no real effect on traffic and transportation, negligible significance on water and drainage, low/negligible significance on air quality, low/ negligible significance on land use and infrastructure, negligible significance on geology and soils, low significance on cultural heritage,

low significance on ecology and an overall positive beneficial impact to sustainable development.

5.5.3 Education Influences Design

The most recent PPP development for this council is a new build secondary school. It would have cost £8million to refurbish the existing school building in order for it to meet the minimum building requirements. It was then decided that a new school building, built to high building standards would therefore be the best choice. The pupils will be relocated to an area close by and construction work is due to commence at the end of this year. This school was informed that it would become part of PPP 3years ago and the specifications and concept designs for this school have taken the last 2years to finalise.

The Head Teacher from this school has been an integral part of the design process. Right from the very beginning he has attended consultations with the property and technical officers, energy managers and architects from the council. He felt that this was rather a unique situation as it has allowed education workers to take the lead in decision-making, normally in other councils it has been the architects.

The present school has a very low energy performance rating due to its dated structure and poor control of energy distribution. At present this whole school's heating is controlled by one thermostat.

The total cost to build the new school will be around £32million. The council will sign a contract for a 25year period to pay the private contractors for the use and upkeep of the building. As yet no contract has been signed and the payments continue to rise by 0.25% every month until it is signed. The council's Energy Manager predicts that over the 25year contract the council will have paid for this school at least 4 times over.

The head teacher is confident that after the 25year contract period the school will still be of a high standard. Life expectancy and replacement/upgrade dates for all aspects of the building have been outlined in the specification and an independent contract has been signed for these.

Other councils have experienced difficulty when teachers have displayed educational material on their classroom walls. Some private contractors have been very restrictive and have not allow school staff to mount children's work or shelves onto their classroom walls as the feel this may damage the building fabric. In order to avoid this

type of situation the school have outlined in the specification exactly how many display boards they wish to be included in each room.
The final specification was so in-depth and paid attention to such fine detail that the architects could not better the final design model for the new school. 15 concepts were adapted from the original design to be tried and tested and all came back to the original design.
Sprinkler systems have proved to be a cost effective solution for this school as they drastically decreased the cost for insuring this building. Second level protection will be present in computer rooms or exam paper storage rooms. Sprinkler systems will not be positioned in computer suites or exam paper storage rooms.
The positioning of all the school's windows will affect both the thermal and acoustic model, hence the school's thermal model could not be separated from the school's acoustic model and it has been a very complex process for the design to provide an effective solution for both models. Some classes e.g. the biology classes have to be facing certain directions, in this case south-facing in order for certain plants to grow. This has all been taken into consideration when designing this building.
The head teacher and council believe that in order to maximise this school's potential it was essential that it would be open for community use. This would result in operating times increasing from 8am until 10pm, Monday to Friday and most of the weekend hours. This would effect the overall energy consumption for the school and new estimates have had to be forecasted to include this in the 25year contract. This again has caused conflict between what the council consider to be 'good practice' annual energy consumption and what Action Energy has stated. This school is open far longer hours and is located in a colder, wetter environment than those surveyed for Action Energy's benchmarks. Also, the wear and tear, cost, access and safety of the school building and it's contents will be affected from longer hours of community use and this too had to be taken into consideration when designing the layout of the school and specifying replacement/upgrade dates for certain building fabrics or equipment.

5.5.4 Managing Energy

The council's energy managers estimated the annual energy consumption for this new school. It was first thought that the annual gas and electricity consumption would be 136kWh/m^2 and 24kWh/m^2 consecutively. These figures did not take into account the

extra school opening hours for community use and were amended to 155kWh/m^2 for gas and 30kWh/m^2 for electricity consumption. This pushes these limits outside of the 'good practice' range. Based on gas and electricity being supplied from Scottish power at a price of 1.3p/kWh and 6.5p/kWh consecutively and calculating the floor space of the new school to be 17,500m^2, the annual consumption cost will be approximately £3,500 for gas and £3,400 for electricity. The annual emissions total for gas and electricity can be calculated using the CO_2 emissions figures from Action Energy, given as 0.52kgCO_2/kWh for electricity and 0.19kgCO_2/kWh for gas. This gives an annual emissions total of CO_2 for the new school as 788,375kgCO_2. Water consumption for the new school has been estimated at 2.64m^3/pupil/year, this is estimated consumption for pupil, staff and any visitors. This figure is better than that outlined as 'good practice' from Action Energy and can be attributed to the recycled use of rainwater for automatic flush systems in toilets.

At present there is a specified minimum operating temperature within the school, however there is no maximum limit. The new school's specification has outlined both a maximum and minimum working temperature. The upper limit has been agreed to be within a set number of degrees of the ambient temperature otherwise air conditioning units would have had to have been located throughout the whole school and this would not have been energy efficient, therefore some allowance has been made.

Months were spent ensuring that the specifications and designs for the new school complied with the Disability Discrimination Act, 1995 and the Special Educational Needs and disability Act, 2001. This included certain rooms displaying parallel visual alarms to signify fire alarms or class changes. All doors in corridors had to be suited to someone e.g. in a wheelchair ensuring that they were either light enough to open or lock in an open position. The positioning of these doors would also affect the thermal balance within the school building and again this was explored for every area.

The corridor that runs past classroom entrances, otherwise known as 'the street', has been purposely widened to allow large numbers of pupils to move safely and efficiently from one class to another. The head teacher felt that this street had been previously built too narrow and encouraged pupils to feel threatened and uncomfortable in such a condensed area. The large number of moving bodies moving through one area also increased the temperature in this area and created a great deal of

noise to those located beneath and to the side of this street. However, the new wider street has caused the designers some problems when trying to order fire doors to this new width. Some of the doors are so heavy that pupils will struggle to open them. The new school will adopt many energy efficient measures including optimising the flow of natural ventilation, maximising the use of natural daylight as well as making use of drain water to automatically flush the toilets. The head teacher believes that such high standards for the new school would never have been achievable if it wasn't for the financial backing of PPP.

5.6 Case study 5

This final council not only have the largest number of schools in their area, 197 primary and 29 secondary schools, they also have the greatest number of PPP schools. Considering that it costs approximately £10,000 per year per school in maintenance they have found this challenging when dividing their strict maintenance budget amongst such a large number of schools.

This council entered into the PPP in 2000 and have since witnessed 29 of their secondary schools, 10 new builds (1 merging) and 18 refurbishments and 1 of their primary schools become part of the PPP programme. This will affect somewhat 30,000pupils.

5.6.1 Upgrading To PPP Schools

This council issued a report in 1997 stating that they wished to finance the upgrade of all of their 29 secondary schools and 1 primary using PPP. They believed that this was their only option in completing the most efficient upgrade of these schools, within tight timescales, to the standard they wished to achieve.

The council are contracted to make annual payments of over £41million to their private contractors for these PPP schools over the next 30years. The initial investment from the private contractors for the refurbishment and construction of these schools at an agreed fixed price of £225million. By the summer of 2002, the planning and construction phase for this project was complete. The private contractors now moved into the operations and maintenance phase of the project. This phase is to focus on upgrading the quality of teaching accommodation and information and communications technology (ICT). The council have chosen to greatly emphasise on ICT as a major development to help further education in all of their schools. The upgrade of ICT is only contracted for the next 12 years. The private contractors have stated that this is due to the rapid rate at which technology is changing. The private contractors have estimated to have spent £15million in ICT over the past two years. All of the schools ICT equipment has been scheduled for an update after the first 6 years of the project.

The private contractors have also pledged to consider lifecycle management for the new schools. They plan to invest around £200m over the life of the 30-year contract on the replacement of windows, roofs and boiler plant as and when they reach the end

of their economic life. The contractors view this investment as essential to ensure that every school building remains warm, wind and watertight for the duration of the contract and beyond. There has been very little consideration given to energy management.

The council have not been entirely happy with the service they have received from their private partners. In June of this year the council deducted almost £35,000 from their quarterly £10.3million payment. This was in response to the council citing a total of 6,454 problems within their schools including inadequate cleaning, poor ground maintenance, heating, lighting and poor ventilation. Within the first 3months of this year complaints from the schools had rose by 12%. All but two of the council's PPP secondary schools have reported difficulties with heating, lighting and ventilation systems. The council have saved approximately £10,000 per year per school on maintenance since PPP have taken control of this area. However, standards have slipped as a result of this new contract.

Some council members feel that this project was rushed and as a result the standard of quality, materials and equipment within the schools has suffered. The council appear to have gone for quantity rather than quality.

The council initially believed that they were receiving significant value for money from their private partners as they pledged to deliver 12 new school buildings when the original brief issued by the council stipulated that two new schools should be built within the budget. This appears to have been a very rapid process considering other council's spend 2years on developing a specification only for one secondary school.

5.6.2 Raising The Standards Of Non-PPP Schools

The construction manager for this council believes that quality of these schools has suffered and that the council are most definitely not receiving value for money.

The construction manager for this council has been heavily involved in the construction of 5 new primary non-PPP schools within the past few years. He strongly believes that these schools are built to the same standards, if not higher, than their PPP schools. The concept designs for each of these 5 schools were drawn by the council's own architects and 58% of the total construction of these schools were carried out by council workers with the rest of the construction work going to competition for the best value contracts, this was for areas where the council workers did not have the relevant experience e.g. roofing. The construction manager believes

that as a result of having the council workers so heavily involved within a council project they are working to higher standards and achieving better quality than what they would from dealing with private contractors. Also, by re-using their best plans from their most recent school buildings this council have managed to reduce their design costs by up to 5%. Having the council architects draw the concept plans and designs for these schools allowed them to maximise the use of natural daylight and make use of natural ventilation throughout their schools.

One of the council's most recently finished new-build, non-PPP schools opened in August of this year and saw the move of around 200 children from an old 1904 almost derelict school, whose top floor was out of commission and would have cost £1.8million alone to rectify this. All classes within this new school building are generously spaced with $70m^2$ of floor space for 30 pupils. Also, all classrooms within this school have been designed to be north or northeast facing as this provides a better natural lighting within each class and there is no need for blinds on any of the windows. This school has been fitted with T5 energy efficient lamps that react to the level of daylight in a particular area and can also be controlled manually, they are almost 10% more efficient than the T12 lamps currently being used and last considerably longer (Action Energy, 1999). These lamps have been programmed to dim to 1% rather than fully switching off to later switch back on, this also helps to save on energy. All glazing on the south elevation is glazed to maximise solar gain, thus helping to reduce heating costs.

This school has been built on two floors. Chimneystacks run from top to bottom through each of the classrooms underneath the windows. This allows vents to be opened or closed to maximise or shut-off the free flow of air from outside of the building. Having a door on the opposite side of the wall from this chimneystack allows the air to cross-flow throughout the classroom into the long, wide corridor that runs past the classroom doors, otherwise known as the 'street', ensuring these areas are well ventilated. CO_2 sensors are present in every class and automatically trigger the ventilation systems if required. The Institute of Environmental Sciences (IES) has published figures stating that ventilation-modelling airflow in primary schools should be 8l/sec/person. This council have found this unachievable due to teachers opening and closing windows within the school. The chimneystack the council have incorporated into this design provides a background of 3l/sec/person.

This council have estimated that it would cost between £70 - £100,000 to install sprinkler systems into their school buildings. This is an option that this council have chosen for their latest schools. The main reason for this was not the threat of fire, as all of their new schools are designed in such a way that in the event of a fire it will be contained to one area without easily spreading throughout other areas or the whole school. The main reason for installing sprinkler systems was the dramatic effect that it had on the insurance payments for the school building. This council have saved thousands of pounds in insurance payments by simply fitting these sprinkler systems. However, not every council believes in doing this. There are those who believe they cause more damaged than good. This fear stems from sprinkler systems that have been activated in the past unnecessarily, causing hundreds of thousands of pounds worth of damage to schools IT equipment. This council have noted this point and have strategically placed sprinklers throughout the school to protect classrooms, dinner and gymnasium halls and the 'street' with minimum damage caused unnecessarily to IT rooms. They have also placed more control over the activation of these sprinkler systems ensuring that not just anyone can activate them by simply sounding the school fire alarm. The school maintenance staff has fixed controls at the school entrance/exit for this as well as mobile handsets. All heating, lighting, ventilation, water, gas, electricity and sprinkler systems for the whole school are monitored using a Building Management System (BMS) system. This system cost £60,000 to install and the council have stated that this is definitely a worthwhile investment for them as it will save them thousands every year in wasted heating, electricity and water bills. Time control methods are used to control the heating ensuring energy is not being wasted when the building is not occupied. Optimiser controls are used to start the heating system within the school at various times to ensure that, whatever the conditions, the building reaches the desired temperature when occupancy starts. Also Temperature control methods are used to a specific room is heated or cooled to the correct level depending on its occupancy levels. Thermostats, occupancy sensing user interactive controls can all be used to monitor the temperatures within the schoolrooms. For lighting, different control systems are used. Zoning control systems are used ensuring that lights are switched on in zones corresponding to the use and layout of the illuminated areas, in order to avoid lighting a large area if only a small part of it requires light. Also, occupancy-sensing controls are used in areas that are occupied intermittently. These sensors can be used to

indicate whether or not anybody is present and switch the light on or off accordingly. Detection systems are based on ultrasonic movement or infrared sensing either based on time control or a required level of luminance or use of lighting. This school also makes use of light level control. This consists of switching or dimming artificial lighting to maintain a light level measured by a photocell. Here, it is necessary to give value to ambient daylighting. The council's electrical engineers have ensured that the classroom and corridor lights are dimmed to 1% rather than switched off. This is for both safety and energy efficiency reasons.
The option of PV roof coverings was also explored in the design of this school, however it decided that it was not feasible as the payback was very poor.
The council are now working on implementing the re-use of rainwater to flush the schools toilets and help maximise water savings.

This school building cost an overall £4.5million to build, around two-thirds of this was provided by prudential borrowing. Over £1million of this came from lottery funding and was used to build a large gymnasium with four full-size badminton courts, a fully-mirrored dance hall, a workout/health room and an outdoor, all weather pitch. This has helped to promote and encourage this schools children and the local community to adopt healthier lifestyles by providing them with extensive use of these facilities.
This school is situated next to a large pond and is surrounded by many large oak trees where various wildlife species have made home. The children are encouraged to respect and learn from their surrounding environment. Every care was taken by the council to preserve and protect this environment when building this new school.

The construction manager firmly believes that when building schools, PPP have shareholders looking for profits, whereas the council have stakeholders looking for quality.

5.6.3 Private Partners

This private contractor is responsible for the rebuild of this council's 10 secondary schools (including one school merging), the refurbishment of 18 secondary schools and the rebuild of 1 primary school with a total pupil population of 30,000. The

contractors have stated that their key purpose is “to create and maintain a first class secondary school estate”.

PPP also offered significant value for money benefits in this project, most particularly in that 3ED was able to deliver 12 new school buildings when the original brief issued by the Council stipulated that two new schools should be built within the budget.
The original brief issued from this council was to build was to build two new schools, yet their private contractors pledged that they would be able to deliver 12 new schools within budget, 1 primary and 11 secondary schools. The private contractors believe this council chose them as they “offered a better solution than any other bidder” and also “offered significant value for money”. This council may now query the latter.

The private bidders have stated that if the council had continued to use conventional methods to build their schools it would haven taken this council 25years to invest the amount of money that was invested in just over 2years through PPP. The construction of the 1 primary and 11 new secondary schools and the refurbishment of 18 secondary schools were completed for the fixed price of £225million. The private contractors are investing £15million over the first 2years of the project on ICT equipment and a further £3million per year on providing managed service for ICT. They have also stated that they plan to invest a further £200million on lifecycle management throughout the 30year contract. They will use this to replace windows, roofs and boiler plants as and when they reach the end of their economic life. This brings the private contractors estimated total investment to £530million.
This appears to be a huge lifecycle management investment considering that this council estimates annual maintenance cost for each school at around £10,000. This would equate to a saving of £9million over the 39year contract. The council have agreed annual payments of over £41.2million, equating to over £1.2billion over the 30year contract. During this time they will save approximately £9million on maintenance costs throughout their PPP schools. The estimated interest rate from a corporate lender, considering a small amount of risk associated with this loan has been estimated between 7-8% (Halifax, 2004). If this council had to take out a corporate loan for the construction work for their 30schools at 8%interest their yearly re-payments would be £19.8million – less than half of what they are at present, even with maintenance this comes to £20.1million yearly re-payments.

6.0 Conclusions

This thesis has shown that the use of energy efficiency in schools can significantly affect the schools performance on a number of levels e.g. energy performance grading, financial performance, environmental performance, child development and performance. Case studies 1 and 2 in particular have demonstrated that by improving energy efficiency awareness and practice within schools significant reductions can be made on the amount of wasted energy from schools each year in Scotland. Therefore, this reduction in energy consumption has a positive impact on the total emissions levels and helps contribute towards the objectives highlighted in the Energy White Paper, helping to build towards a sustainable future. Although some local authorities are taking steps forward and making noticeable progress, more action is required to achieve better energy and environmental results from all schools throughout Scotland. The Scottish Executive could also help more by reviewing the 5-year energy payback plan and considering environmental benefits, not just financial. There is also pressure, from many Scottish councils, for the Scottish Executive to issue energy and environmental performance benchmarks accurate for comparison with Scottish schools performances, not figures that have been based on English schools.
The Public Private Partnership has been identified as a way forward in financing Scotland's new schools for the future. Past involvement, shown in case studies 1, 2 and 3, has shown that lessons are to be learned and mistakes rectified from this new partnership. Forecasting and agreeing to energy consumption payments is an area that many council members are unhappy with and could be revised for future PPP developments.

6.1 Monitoring, Targeting and Grading Energy Consumption

More Scottish council's could benefit from monitoring, targeting and grading each of their schools energy consumption. The 5 case studies have shown that council's who have taken the time to closely monitor each of their schools energy consumption, mainly gas and electricity, can set realistic monthly targets, that are achievable, for each of these schools. By grading the schools, to demonstrate the school's energy efficiency rating, the school can then identify just how well or bad they are performing. Some council's have chosen to send simple graphs breaking down the monthly energy consumption and cost targets to each of its schools. This clearly

demonstrates what savings can be achieved within the school and helps to raise energy efficiency awareness. Some council's adopting this technique have shown that every year a typical school can make savings of around 20% on energy consumption, consequently increasing the schools energy efficiency rating bringing them closer to Action Energy's 'good practice' benchmark.

6.2 Energy Reports

Energy reports should be carried out in all schools highlighting areas that need improvement and suggesting recommendations for this with financial and environmental savings included and payback periods. However, it is also important to help schools identify exactly where they can make these energy savings. Some council's have demonstrated that by inviting Energy Managers to conduct in-depth energy management reports on each of their schools they can help some schools make annual savings in the region of £15,000 and almost reduce CO_2 emissions by 150tonnes, with the vast majority of actions giving immediate savings or under 3year payback periods.

The SEEO also offer a free energy management report for all Scottish schools. Council's who do not have the adequate resources, wither this be the lack of appropriately qualified employees or financial restrictions, should be aware that this option is open to all of its schools and should be encouraged to take advantage of this. Granted, the SEEO energy management report may not be as informative as the reports some council's carry out. The SEEO could revise their reports and include, where possible, some calculations indicating annual savings, reduces in emissions, payback periods and outline the costs to implement some of their recommendations. This would be easier for schools to identify which areas they can and would be most beneficial for them to invest in. This would allow the SEEO to present their recommendations in a more attractive manner, thus providing a more worthwhile service that produces more effective results and further helps schools in becoming more energy efficient.

6.3 Energy Efficiency Training for Everyone

For a school, or indeed any business, to run efficiently it is imperative that everyone using the building is involved in the process. In the past some council's have tried to implement 'of-the shelf' energy efficiency strategies. This has not raised energy

effeiciency awareness in the manner in which it was hoped, mainly due to the information that was available was in-fact too general and not specific enough to any one-person/individual. Office staffs have very different duties than e.g. the children and will therefore be concerned with different issues and methods when implementing energy efficiency. It is important then that the council must recognise this and tailor packages that will be more specific to a certain job or position within the school. Office staff may be educated on the energy savings that can be achieved by switching certain equipment e.g. photocopiers and fax-machines to stand-by mode or by programming such machines as water-coolers to correspond with the building operating times. The importance of timing hot-water and heating only for the building's hours of use could be high-lighted to the Janitors and maintenance staff, ensuring energy is not wasted e.g. heating a building that is not occupied. Teachers and children could be educated to appreciate the importance of achieving a thermal balance throughout the school building e.g. care should be taken when heaters are on that windows or doors are not left open. The importance of energy efficiency could be built-in to the learning curriculum to help educate both staff and children on the importance of energy efficiency and the need for sustainable development. Some schools have found that by allowing the children to develop an understanding of the importance of efficient energy use and the effect that this can have on their environment, the children are actually more accepting and understand the reasoning behind certain decisions e.g. in the case of one of the most recent PPP high schools, the children were desperate to have a swimming pool built into the new design. The Head Teacher discussed with the pupils the additional annual energy requirements their school would need, the levels of CO_2 this would produce as a result and the extra cost this would incur. The pupils could then identify with these issues and therefore understood that in-fact this would not have been a good, energy efficient decision and instead have agreed with their Head Teacher to make use of their local swimming pool, when possible during Physical Education periods. Energy efficiency training and raising environmental awareness for everyone develops an awareness of the importance of these issues. This encourages all those involved to develop better life-styles for the future through creating an understanding for the need of sustainable development.

6.4 Energy Benchmarking for Scottish Schools

In all 5 case studies, all Scottish councils have stressed that there is a need for energy consumption benchmarks to be set for Scottish schools, based on data from Scottish schools. As previously mentioned, Action Energy's energy consumption benchmarks have been set based on the performance of English schools. Scottish weather, particularly in the West, is typically wetter and colder than most parts of England resulting in Scottish schools requiring more heat, particularly during the autumn and winter months. Also, standard hours of school use are much more than those used by Action Energy; a typical English school was stated to operate between 1500-1600hours every year, however since many Scottish schools are now being used for community use, their standard hours of use are considerably higher. A Scottish school opening 8.30am until 4.30pm five days a week, with three lets during weeknights, increasing the schools hours of use to around 5.5hours each night and with possible weekend lets, would result in the school's hours of use increasing to over 2200hours every year, thus significantly increasing the school's annual energy consumption. This is over a third more hours than Action Energy have used to benchmark energy consumption rates within all schools.

In order to allow a fair comparison between schools, the Scottish Executive should enforce that the 'good practice' figures published by Action Energy are revised for Scottish schools taking these two factors into careful consideration.

6.5 Long-term Investment

The Scottish Executive is providing Scottish Local Authorities with a combined total of £15million of funding, over two years, allowing them to promote energy efficient projects, with a 5-year or less payback period. The 5-year payback period has been chosen in order to allow financial savings to be met quickly, therefore allowing these savings to then be used to help fund more energy efficient projects. Councils with large numbers of poor energy performing buildings requiring a great deal of work are delighted with the funding as now they can upgrade e.g. lighting, office equipment, toilets etc. in the hope of quickly reducing the buildings annual energy consumption, CO_2 and Carbon emissions. However, there are some council members who feel that they have used past yearly budgets extensively in promoting similar energy efficiency projects. They have chosen to implement such projects with shorter payback periods as the investment cost are normally lower for these projects and the financial savings

can be enjoyed quicker. It would make more sense, in this type of situation, to then allow the funding to be put towards long-term energy efficient projects. Even thought the initial investment may be higher, the rewards can often be greater. For example, in one of the case studies mentioned earlier, the council's Energy Managers report has shown that for some schools the equipment that could be improved on most is the school boiler system. By investing £45,000 this school could enjoy annual savings of £5,620 and huge annual emission savings of 81.7tonnes of CO_2 and 22.3tonnes of Carbon. However, the payback period of this is 8years, thus the money from the Scottish Executive cannot be used here. This was the biggest energy, financial and emission saver this school could make. If the idea is to promote sustainable development and meet targets outlined in the Energy White Paper, then it is essential that the Scottish Executive addresses the bigger picture and encourages such projects for long-term development. The Scottish Executive has focussed attention on financial savings here rather than environmental. The majority of councils are capable of investing in the lower-cost, fast-payback energy efficient projects, it is the more rewarding, higher cost, longer-payback period projects that they need financial help with.

6.6 Energy Consumption and Payments

As shown in the case studies, some council's involved in the PPP are paying millions of pounds every year for their new schools. Even when considering maintenance savings on these schools, payments are double what they would be compared with corporate loans based at 8% interest. These councils appear to have very little control over the high-rate of their annual payments. The case studies have shown that in certain instances the private partner increases annual repayments at fixed increments for every month the contract between them and the council remains unsigned. More control over these rates could be advantageous for the Scottish councils entering into the PPP.

Also, members from all of the Scottish councils mentioned in the 5 case studies have expressed some concern over forecasting and agreeing energy consumption rates with their private contractors for their PPP schools over a 25 or 30-year period. Some council members believe that it is almost impossible to forecast energy consumption and agree on fixed energy payments so far into the future due to the uncertainty of evolving technologies and power consumption rates of advancing equipment. Other

council members believe that their biggest problem is not forecasting the energy consumption, but forecasting the energy waste. These members believe that it is unrealistic to believe that their schools can achieve 100% efficiency, due to human error and technology efficiency ratings. They are now having difficulty determining how much energy consumed by their schools will in fact be wasted energy. Some council's have negotiated energy contracts with their private partners ensuring that each of them accepts a certain amount of risk. The council have a price risk meaning that if there is any change in electricity or gas prices they will be responsible for this. The private contractors have a consumption risk. This means that if the school consumes more than the agreed energy consumption they are responsible for this. This energy consumption figure is not an exact figure and therefore allows the school to rise a little above a certain limit without being penalised. This contract was brought about by the council in an attempt to encourage their private partners to be more energy aware when building the school and installing equipment. The council hopes that this will encourage the private partners to build to and install high-energy efficient equipment in an attempt to lower the energy consumption rate.

The most startling element in this whole energy agreement is that there appears to be no incentive for the schools, from all of the council's mentioned who are involved in the Public Private Partnership, to become more energy efficient over their 25 or 30-year period. If the school had to adopt further energy efficient methods and lower their energy consumption to below the forecasted levels, they would not make any financial savings, instead the private partners would profit as they would keep any under-spend for that particular school month or year.

There are many members in all of these councils who would much prefer to remain in charge of their own energy forecasts, monitoring and payments. This is understandable given that some of these councils are managing to achieve overall 20% annual energy reductions in some of their schools by carrying out energy management reports and implementing short payback energy efficiency methods and are therefore saving the council money on the school's energy payments as well as having a positive impact on the environment by significantly reducing CO_2 emissions. However, this removes all incentives for the private partners to invest in energy efficient buildings and technologies for the school's use, as they will no longer receive any energy consumption payment for the use of this equipment. There are those who are under the impression that this would allow them to choose a bidder

who will concentrate more on the quality of design and building fabric of the school. Nevertheless, the private partners have shareholders and their number one priority is profit.

It would make more economic and environmental sense to have the private contractors responsible, to some extent, for the school's energy consumption payments. This would allow the council to negotiate higher efficiency ratings in all of the school equipment as the private partners will be responsible for the upkeep and energy payments from these. However, the school should also be encouraged and rewarded if they fall below certain consumption levels previously agreed with the private partners. There is no incentive for the school to lower their energy consumption if they will be charged for payments well above what has actually been consumed. The school's children and staff should be acknowledged every time they improve energy efficiency and the council should agree that only a percentage of the payment should be made to the private contractors. This way everyone has to accept some responsibility for his or her energy efficiency.

6.7 Integrating Renewables

By implementing energy efficiency awareness into the school curriculum, wither this be through the use of renewable technology, the case studies have proved that children and staff within the school are developing a deep knowledge of the importance, the need and the benefits of building a sustainable environment. This has been spread throughout the communities and has resulted in some parents becoming involved in their children's school projects. Schools that have integrated some sort of renewable technology into the school design e.g. wind turbines and/or solar panels have found that the staff, children and surrounding communities have been by large positively responsive. It has helped to raise the issues of energy efficiency and sustainable development throughout these communities as well as having a positive impact on the environment; some schools are making annual energy savings over 8,600kWh and over 3,700kg CO_2 emissions.

At present there is no evidence of private contractors within PPP being overly eager to install renewable energy technologies into their new schools. Basically the bottom line is that if it does not make some sort of financial saving/investment then they will not consider the design. If the Scottish Executive and local councils could work

together to promote and encourage the use of building integrated renewables in more of their schools then they could be used as a valuable, educational resource helping children to develop and adopt better lifestyles for the future whilst having a positive impact on the environment at the same time.

7.0 Recommendations and Future Work

In order for Scottish local authorities to improve the energy performance within their schools it is essential that they receive appropriate funding and guidance, primarily from the Scottish Executive. They must work together and understand each others needs in order for them to achieve the same goals in driving towards a sustainable, energy efficient future for Scottish schools. Review of the 5-year energy efficiency payback plan is one way to move forwards. Reviewing each council's needs on an individual basis, considering not only financial but also emission savings could generate greater, long-term savings for certain Scottish councils.

Also, the Scottish Council could work on providing 'good practice' energy benchmarks for Scottish schools. The case studies undertaken in this thesis have shown that some councils will not grade and compare their schools energy performance and consumption data with the figures published from Action Energy, based on English schools, as they are scoring so badly in comparison. Monitoring and targeting energy consumption for each individual school, as shown in case study 2, can be an effective way of highlighting and reducing energy consumption. By publishing accurate energy bench marking figures, applicable to Scottish schools, this situation could hopefully be rectified.

The Public Private Partnership has been identified as a way forward for Scottish schools by the Scottish Executive. This is still a relatively new development for Scottish schools, with some local authorities still very much in the design and contractual development stages. As seen from the case studies, lessons are to be learned from past PPP projects. Consideration should be given to quality over quantity, ensuring that when the council are at the first stages of PPP they choose a private contractor who has some relevant experience in this area, this is to their advantage as shown in case study 4.

It is also important that consideration is given to the agreed energy payments over the 25 or 30 year contractual period. This is an area that all councils within the case studies have expressed some discontent over. A balance has to be created allowing both parties to accept a certain amount of risk. It makes both economic and environmental sense for the private partners, in large, responsible for the school's energy consumption payments. This still allows the council to negotiate higher

efficiency ratings for all of the equipment installed in the school as the private contractors will be mainly responsible for these energy consumption payments. It is important that both partners work together in developing the best possible designs for these new schools in order to drive forwards and raise current standards.

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