



Road to zero carbon Final report of the Zero Carbon Task Force

January 2010



'We have a clear moral responsibility to future generations to make it [zero carbon] happen. We can no longer sit back and wait for the science to catch up with us – it would be a dereliction of duty if we did.'

Ed Balls, Secretary of State for Children, Schools and Families, June 2008

'This is not going to be straightforward but if there is one sector that must show the way then it should be schools, at the heart of our communities, especially given the scale of the replacement programmes.'

Robin Nicholson, Chair of Task Force, June 2008

To get radical improvements, we need to take advantage of what Task Force Member Bill Bordass calls the multiplier effect:

'Halve the demand – review standards, improve insulation, reduce air leakages, use daylight more; make sure things are switched off when not needed.

Double the energy efficiency of the installations that meet this reduced demand – buy efficient equipment, install more efficient heating, lighting, equipment and control systems.

Halve the carbon in the fuel supply by measures both on and off site, and you are down to one-eighth of the emissions.

With demand reduced and efficiency increased, investment in renewable and other green energy sources will go much further and be more cost effective.'

Contents

Foreword	02
Executive summary	03
Recommendations	06
PART 1	
Background and progress so far	09
The Zero Carbon Task Force	09
The zero carbon challenge	13
What is being done already	17
Progress since the ZCTF interim report	22
Making it happen – the roadmap	28
5 steps to zero carbon	28
1. Engage with LAs, schools, young people and others	30
2. Reduce energy demand	37
3. Drive out waste through better design	39
4. Decarbonise school energy supplies	43
5. Neutralise any residual emissions	46
Supporting the journey to zero carbon	48
Demonstrate what works	48
Monitor and evaluate	50
Refurbish and retrofit	53
PART 2	
Beyond the Zero Carbon Task Force	56
Implementation plan	56
Annexes	
Annex A: Zero Carbon Task Force terms of reference	68
Annex B: Membership and key contributors	70
Annex C: Schools visited	72
Annex D: Modelling Zero carbon schools	73

Foreword

As the world faces ever greater challenges in tackling climate change, I am confident that this report and the work of the Task Force will be seen as a significant contribution to our national efforts towards a lower energy Britain and that our approach can be adapted to suit other sectors. Schools are crucial in achieving lower energy ambitions, not least because of so many students' enthusiasm for helping to protect the future of the planet. And it is not just the students; it is their families, their homes and their communities that surround the schools.

Some members of the task force have fought long and hard to get the construction industry to learn from the, often poor, performance of the buildings we have designed and built. Let us hope that the whole industry can now adopt performance measurement as normal behaviour and reduce the unacceptable level of energy used and carbon emissions that buildings currently generate.

Schools can and are doing a great deal to reduce their carbon demands but the delivery of zero carbon schools depends on many outside factors, including the management of ICT, the decarbonisation of the energy supplies and the community distribution of heat and power.

Achieving low or zero carbon calls for a concerted approach. Our report is intended to point the way forwards for a range of sectors to engage with these challenging issues. We hope our recommendations will be welcomed and adopted wholeheartedly. We look forward to revisiting progress on a regular basis.



Robin Nicholson,
Chair of Zero Carbon Task Force
December 2009

Executive summary

The Secretary of State for Children, Schools and Families established this Zero Carbon Task Force to advise on how England can achieve the ambition for new school buildings to be zero carbon by 2016, to develop a roadmap to zero carbon and to make recommendations for implementing the roadmap. We were asked to advise on whether the timescale of 2016 is realistic, and to identify any limits – any specific school types and locations where zero carbon cannot be achieved.

Achieving zero carbon in practice will require the following to be addressed:

- **Engagement**, leading to behaviour change and reduced energy use
- **Knowledge and skills** in the design and construction industries
- **Feedback** on the true energy performance of schools, particularly from those already required to meet the 60% carbon emissions reduction target and from pilot schools
- **Access to renewable energy and low carbon supplies**, including off-site measures and community schemes
- **Sufficient investment**

Challenges to achieving zero carbon

Construction cycles

We have concluded that the three to four year construction cycles for schools are too long to allow us to overcome the technical, financial and social challenges that need to be addressed if we are to deliver zero carbon schools across the board from 2016. However, we believe that zero carbon can be achieved in some circumstances, such as in rural settings with access to renewables and in city centres where there are low carbon community energy schemes.

Technical challenges

The technical difficulties around achieving large carbon reductions are significant. Measures which save carbon can impact on ICT provision, acoustic performance, thermal comfort and other environmental standards.

Financial issues

Financially, low carbon buildings is a new and developing market, with information about capital costs emerging slowly, uncertainty about lifecycle costs and benefits, and rapidly fluctuating energy prices.

Behavioural change

The design and construction of schools with the potential to be low or zero carbon is only a first step. Their operation and the behaviour of occupants must also be addressed if they are to perform as intended. Buildings, too, need to be designed to ensure that they are appropriate for the users and their ability

to manage a building. Some schools will have access to specialist energy management support, whilst others will not.

We reaffirm our support for the ambition that all new public sector buildings will be zero carbon from 2018. The Department for Children, Schools and Families (DCSF's) pilot projects will contribute to learning not only in terms of technology but also of management and delivery mechanisms.

We recommend the following:

- At least four **pilot zero carbon schools** should be operational in each government region before 2016, to demonstrate how zero carbon can be achieved and to provide learning for future projects.
- A series of **step-changes towards zero carbon new schools** should be introduced, beginning with a target of 10kgCO₂/m² p.a. for new schools from 2013, as suggested in DCSF's consultation on a carbon management strategy for schools. This corresponds to a reduction of ~80% on 2002 building standards, which is a challenging development of DCSF's current requirement to reduce emissions by 60%.
- **Processes** should be introduced to **ensure that energy and carbon are a priority** from the inception through to the operation of school projects, and that the **energy and carbon performance of schools is monitored and published**.

Refurbishment and retrofit

Our brief was to focus primarily on new build schools. We have fulfilled this brief and our report sets out the challenges that need to be addressed to achieve the goal. However, achieving zero carbon for new build is just one part of the picture. If DCSF's aim is to significantly reduce carbon emissions across the school sector and make progress towards carbon targets, then action will be required that impacts on all schools, not just new build.

Addressing the use of and demand for energy in schools, supported where necessary by capital investment for refurbishment or retrofit measures, will have a far greater impact than a single focus on new build.

We therefore further recommend that:

- DCSF should **review the options for carbon savings** that can be achieved through a programme of **refurbishment and retrofit**.

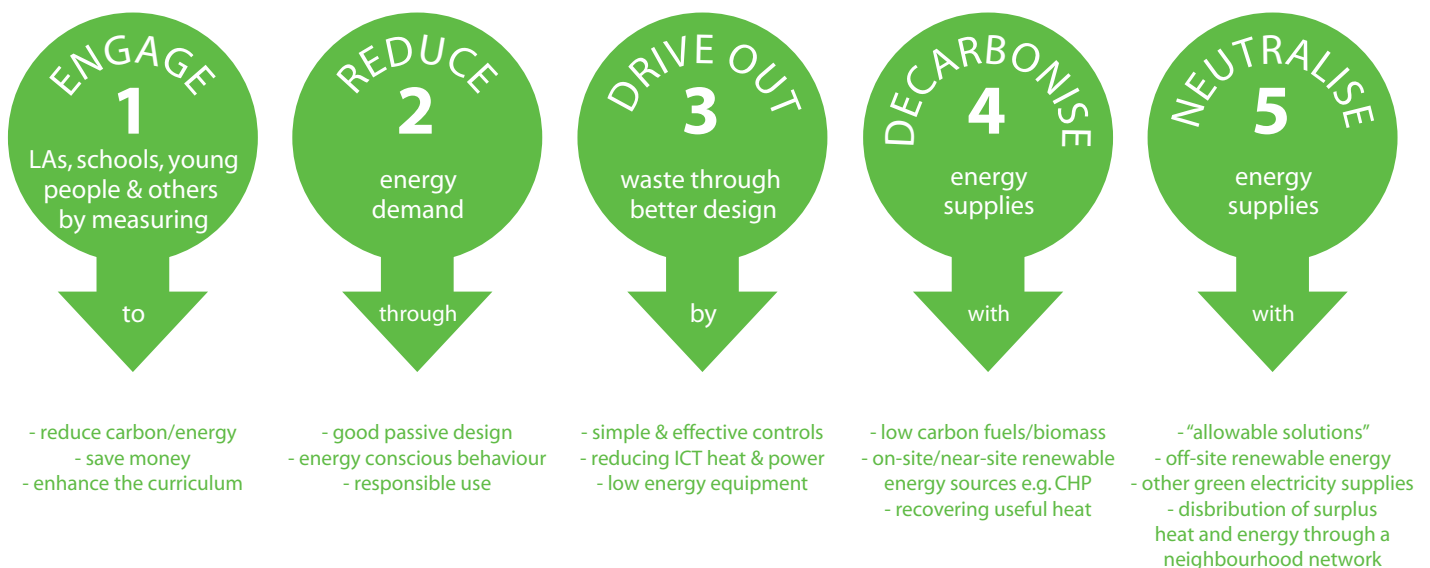
Much can be done to reduce energy and carbon use in schools without any additional capital investment. With the active engagement of students and staff and an understanding of how and where energy is being used, all schools can reduce their energy use. But this requires leadership from headteachers, governors and other decision makers, with appropriate support and guidance from local authorities.

The way forward

Low and zero carbon will only be achieved if action is taken across a range of fronts. The order in which these should be tackled for all schools, and not just those being rebuilt, is represented diagrammatically below:

THE ENERGY > CARBON ‘HIERARCHY’

“Halve the demand, double the efficiency, and halve the carbon in the supplies, and you are down to one-eighth of the emissions”
Task Force Member Bill Bordass



Recommendations

Recommendation 1: DCSF works with Partnerships for Schools (PFS) to determine how best to maximise the reduction in carbon emissions across each local authority area during the planning of capital developments.

Recommendation 2: PFS works with the Commission for Architecture in the Built Environment (CABE) to help build knowledge within local authority clients on the issues of low carbon design both for Building Schools for the Future (BSF) and for the Primary Capital Programme (PCP). And that PFS develops the role of the client design adviser to ensure that this is satisfactorily addressed at the earliest stages of school (and other) building projects and is safeguarded throughout the design and construction and into the operation of buildings.

Recommendation 3: DCSF maximises the potential to engage all schools in energy/carbon management as the Carbon Reduction Commitment (CRC) is rolled out and carbon budgets are introduced.

Recommendation 4: DCSF explores how energy awareness and management can best be built into school staff training and continuing professional development (CPD), and works with responsible bodies to agree programmes of training and CPD for school leaders, teachers and facilities management staff.

Recommendation 5: PFS requires designers of schools to consider the curriculum opportunities in their designs and develops guidance (or draws on an existing resource such as that being developed by CABE and partners) that makes the curriculum and cross-curricular connections for them.

Recommendation 6: PFS works closely with the Department for Business, Innovation and Skills (BIS) and the stakeholders identified within its Strategy for Sustainable Construction to ensure that consultants and contractors working on new school projects have the necessary skills to deliver low carbon schools.

Recommendation 7: Becta engages with the ICT industry to agree specific radically reduced requirements for the energy/carbon performance of ICT services in schools.

Recommendation 8: Becta works with the ICT industry to develop a methodology to measure the actual operational energy performance of ICT service providers.

Recommendation 9: DCSF engages with local authorities and schools in changing behaviour through an active social marketing/behaviour change programme linked to capital retrofit or refurbishment funding wherever possible.

Recommendation 10: Becta continues to develop and disseminate tools and guidance on energy efficient ICT.

Recommendation 11: Becta develops professional qualifications for ICT technicians which support energy conservation and power management.

Recommendation 12: PfS immediately reviews its BSF processes, procurement methods, standards and requirements that impact on energy/carbon to ensure they reflect the highest and most cost effective standards that can be achieved, and are addressed at every opportunity. PfS considers how these requirements might be applied to the Primary Capital Programme and other school building projects.

Recommendation 13: PfS undertakes a regular cycle of such reviews, no less than every three years, so that processes and requirements reflect learning, technological and other advances that will support the step changes to zero carbon.

Recommendation 14: PfS ensures that consideration of carbon is part of CABE's assessments of BSF projects.

Recommendation 15: Becta refreshes its functional requirements, technical specifications and standards to reduce the energy requirements of ICT services, and that accreditation processes and procurement of ICT are based on these criteria.

Recommendation 16: Becta considers the development of an energy rating system that applies to schools' ICT services.

Recommendation 17: PfS commissions the development of a methodology and a supporting compliance tool (decision tree or similar) to ensure that factors that are most likely to contribute to the delivery of low or zero carbon schools are addressed.

Recommendation 18: PfS develops guidance on the options for low and zero carbon energy supplies that can be applied to schools of different sizes in various locations.

Recommendation 19: Renewable energy systems and other low and zero carbon energy sources are classified as 'permitted developments' for planning purposes for schools, allowing them to be installed without the need for planning permission.

Recommendation 20: PfS identifies and monitors the outcomes of research into new low carbon energy sources that can be adopted for buildings, and works with suppliers to keep abreast of developments in the market for low carbon products.

Recommendation 21: The Department for Communities and Local Government (CLG) considers the potential for further 'allowable solutions' that permit credits for:

- retrofit and refurbishment improvements for existing school buildings
- carbon savings that are realised through the provision of coordinated off-site ICT services
- nominated renewable energy systems that are installed on sites other than the school but which are owned by the local authority.

CLG continues to explore the use of a Community/Green Fund to help develop renewable energy infrastructure and allowable solutions.

Recommendation 22: At least four zero carbon pilots in each of the nine government office regions are constructed by 2015 so that information on their first year of operation is publicly available by 2016. DCSF identifies a funding stream in its capital programme from April 2011.

Recommendation 23: DCSF continues to provide additional funding to enable schools in BSF and the Academies programme to achieve a 60% reduction in carbon emissions, and that actual performance against this target is monitored.

DCSF identifies funding to support a step change from 2013, with revised processes and the ambition of achieving a new target provisionally set at 10kgCO₂/m².

Recommendation 24: DCSF and PfS engage with local government and schools to consider:

- how energy data available from smart meters and other sources can be utilised to enable comparisons of energy performance between similar schools
- how best to use performance feedback as part of a package of measures to encourage schools to reduce energy use.

Recommendation 25: PfS develops a post-occupancy evaluation (POE) process for all schools within BSF and a methodology for in-depth energy study which it applies annually to a sample of schools. Findings to be placed in the public record.

Recommendation 26: DCSF/PfS gather and publish data on the energy/carbon performance of all schools to monitor progress as we move towards 2016/zero carbon.

Recommendation 27: DCSF targets a programme of energy reducing refurbishment work (linked to behaviour change) to cut emissions in existing schools. Measures will build an understanding of the level of carbon savings that are achievable in practice and how DCSF capital programmes can best deliver reductions in line with carbon budgets.

Recommendation 28: DCSF encourages CLG to incorporate specific energy efficiency recommendations for schools into the Display Energy Certificate (DEC) assessor software tools that are owned by CLG.

Recommendation 29: A named, senior champion is identified in DCSF at Director level and a champion in PfS at a similar level; and that consideration is given to the need for the Sustainable Development Commission to have an overseeing/monitoring role.

Recommendation 30: DCSF reconvenes the Zero Carbon Task Force every year for five years to receive a report on progress.

PART 1 – Background and progress so far

The Zero Carbon Task Force

The Zero Carbon Task Force was established in early 2008 by Ed Balls MP, the Secretary of State for Children, Schools and Families, with a remit to advise on what needs to be done if we are to reach the goal that all new school buildings will be zero carbon by 2016 (see Annexes A and B).

Our definition of a zero carbon school building develops that devised by the Department for Communities and Local Government (CLG) for housing and is tightly focused on the use of the building – carbon emissions from the energy used by all activities across the school sites, around the clock and not just those arising from education during standard hours. Our priority throughout has been to address energy use as a first step and then carbon.

CLG's definition of zero carbon for housing

In July 2007, CLG's Building a greener future – policy statement defined zero carbon:

'After taking account of

- emissions from space heating, ventilation, hot water and fixed lighting
- expected energy use from appliances
- exports and imports of energy from the development (and directly connected energy installations) to and from centralised energy networks,

the building will have net zero carbon emissions over the course of a year.

Our remit does not extend to carbon emissions associated with transport to school, schools' procurement of goods and services, waste or embodied energy of materials used in the buildings. These wider sources of carbon emissions from schools have been quantified by the Sustainable Development Commission (SDC) and Department for Children, Schools and Families (DCSF) and, together with building energy emissions, will be addressed in the Department's carbon management strategy to be launched in spring 2010. Our work has been focused on the technical issues arising from the design and construction of energy efficient buildings.

In March 2009 we published our interim report¹, setting out our initial findings and making a range of recommendations for action. This final report sets out what we have been doing, what steps are required and what conditions necessary to deliver zero carbon schools by 2016.

¹ <http://www.sd-commission.org.uk/publications.php?id=388>

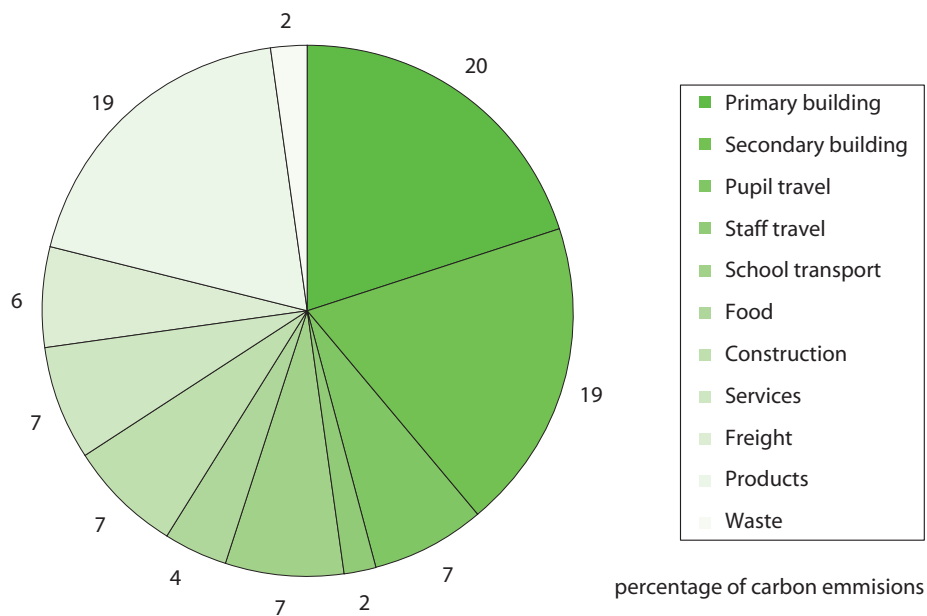
Why we need to take action

There is overwhelming evidence that climate change is an urgent issue. The combustion of fossil fuels – either directly as a source of heat or indirectly as a source of electricity – result in emissions of carbon dioxide. Greenhouse gases, carbon dioxide in particular, are the main cause of climate change.

Today almost half the UK's carbon emissions are due to the energy used to heat, light and run buildings. Even with low carbon electricity supplies and a mass refurbishment programme for existing buildings, ultimately achieving the existing commitment will depend on reaching zero carbon for new buildings.

Schools account for around 2% of UK greenhouse gas emissions, roughly the same as all the energy and transport emissions of Birmingham and Manchester combined. This is equivalent to 15% of the country's public sector emissions.

The SDC's carbon footprint for the schools estate estimates that, for England, the sector emits 9.4 million tonnes of carbon dioxide equivalent each year. Energy use in school buildings accounts for 37% of this – a total of 3.5 million tonnes of carbon dioxide equivalent each year². The chart below shows a more detailed sector breakdown of the schools' carbon footprint:



² <http://www.sd-commission.org.uk/publications.php?id=388>

Consultation and gathering evidence

Since our establishment we have consulted widely and drawn expert opinion from a range of sources. We received over 100 responses to a formal 'call for evidence' and published the results in early January 2009³. Respondents included representatives from the construction and building professions; local authorities (LAs); ICT, energy and heating companies; schools and parents; unions and professional associations. We were impressed by the enthusiasm of respondents, but found overall a lack of hard, robust and validated data.

We have sought and obtained specialist advice from numerous individuals and organisations. These include presentations to the Task Force from the electricity supply company e.on, the Further Education Task Force, the Chartered Institution of Building Services Engineers (CIBSE), the SDC and Becta⁴. We have held discussions with the Carbon Trust, the Zero Carbon Hub, representatives of the steel construction industry, energy companies, other government departments and others.

A specialist workshop with key ICT companies, led by Becta and Intellect, provided valuable input and helped clarify our views on what needs to be done to manage the significant source of carbon produced in schools through the use of ICT. A similar workshop with major construction companies discussed the range of challenges that need to be addressed if we are to design and build zero carbon schools.

A workshop was held at Logica's Innovation Centre which allowed us to hear about recent developments within the metering industry and to see at first hand the meters and energy management tools that are suitable for schools. At that event there were opportunities to see some live examples of ways to collect, display, manage and report on energy use and carbon performance.

We have sought the views of children and young people through DCSF Children and Young People's Panel and the Sorrell Foundation Students Board.

School visits

To inform our work, we visited 15 schools (see Annex C) to explore how the low energy features and practices are working, to learn from schools' individual experiences about what works well and less well, and to establish the potential for the wider roll-out of good design and practice across the school sector. Different types of school were visited – urban/suburban, new/refurbished, primary/secondary – mainly selected for their strong approach to sustainable development. The schools used a variety of sustainable measures, such as energy efficiency, renewable and low carbon energy supplies, different approaches to management and user behaviour, sustainability within the curriculum, and the building as a teaching tool.

³ <http://www.dcsf.gov.uk/consultations/index.cfm?action=conResults&external=no&consultationId=1565&menu=1>

⁴ British Educational Communications and Technology Agency – <http://www.becta.org.uk/> – the government agency to ensure effective and innovative use of technology throughout learning

There were some excellent examples of schools using the sustainable features of their buildings for learning, embedding sustainability into the curriculum and encouraging energy efficient behaviour. We found cutting edge designs that have the potential to be highly energy efficient, as well as innovative low carbon energy sources.

In terms of what has worked less well, a number of schools visited used more energy than expected, due variously to:

- building simulation models which do not cover all energy use (for instance, which consider regulated energy⁵ only, or which do not model energy used out of normal school hours)
- inaccurate, inappropriate or over-simplified modelled energy use
- imperfect or unintended system performance or user behaviour.

These confirmed the concerns we highlighted in our interim report – that most low energy schools currently fail to meet their anticipated performance. And this is the case for most new buildings.

Some schools expected to achieve reductions through ambitious renewable energy systems but were not granted planning permission.

5 energy currently covered by Building Regulations and used by fixed building services (lighting, heating, cooling and hot water) but which excludes appliances and other equipment used by the school (external lighting, lifts, security and ICT equipment, catering, etc.)

The zero carbon challenge

Achieving zero carbon is immensely challenging and there is no quick fix. We used modelling to determine how zero carbon can potentially be achieved in five different school scenarios, with different school building types in a range of locations (see Annex D). The findings show that zero carbon is technically difficult to achieve, and where it can be achieved, it is expensive and may impact on other standards such as acoustic performance, summertime overheating or the type and level of ICT provision.

Zero carbon is likely to be more difficult and costly as more extended school services come on stream, which may require longer opening hours and the wider use of ICT. Both are likely to increase electricity demand, leading to higher energy demand and carbon emissions.

Sources of renewable energy systems

DCSF's guidance on the use of renewable energy in school buildings⁶ considered five sources of renewable energy systems that could be included on school sites. Limits to the potential carbon reductions that each of these could contribute to a typical school were estimated and these are summarised in the table below.

Pros and cons of renewable energy systems

Technology	Maximum CO ₂ savings	Advantages	Disadvantages
Solar water heating	6-8%	<ul style="list-style-type: none"> • Low maintenance 	<ul style="list-style-type: none"> • Limited energy use • Require south facing or horizontal space
Photovoltaics	Limited by cost/available space	<ul style="list-style-type: none"> • Low maintenance • Highly visible 	<ul style="list-style-type: none"> • Very high cost • Require south facing or horizontal space
Wind turbines (mast)	Limited by available space	<ul style="list-style-type: none"> • Cost effective • Highly visible 	<ul style="list-style-type: none"> • Potentially intrusive • Planning permission required
Wind turbine (building integrated)	<20%	<ul style="list-style-type: none"> • Cost effective • Visible 	<ul style="list-style-type: none"> • Ineffective in some areas /circumstances • Additional structure required • Planning permission required

6 <http://www.teachernet.gov.uk/docbank/index.cfm?id=11927>

Technology	Maximum CO ₂ savings	Advantages	Disadvantages
Ground source heat pump	<20%	<ul style="list-style-type: none"> • Low maintenance 	<ul style="list-style-type: none"> • Large ground areas may be required
Biomass	<60%	<ul style="list-style-type: none"> • Suitable for district systems 	<ul style="list-style-type: none"> • Space required for delivery/fuel storage • May increase running costs

The technical challenge

There are particular challenges associated with technically achieving zero carbon schools:

- It is difficult to design, construct and maintain energy efficient buildings and few within the construction industry have practical experience of delivering low carbon buildings.
- There are practical barriers to overcome in order to deliver energy efficient buildings – for example, buildings are often not well enough insulated or sufficiently air-tight, though standards are improving.
- Most schools cannot meet their own energy demands from on-site renewable energy systems, due to lack of space or resources (such as space for solar collectors/ground source heat pumps, or access for biomass storage and deliveries/availability of wind); or the lack of sufficient funding for less site specific but more expensive renewable energy systems (such as photovoltaics).
- The off-site opportunities for renewables are limited in most areas and cannot be significantly developed before 2016. Where there are opportunities there is likely to be considerable demand from other developments also seeking to be zero carbon.
- Zero carbon schools are most likely to be achievable where there are local sources of low or zero carbon energy. There are some examples of community heating schemes but very few schools will be able to benefit from them. Access to low carbon electricity is even less likely in the period to 2016.
- Once built, occupants need to understand how zero carbon should work in the building and how it should be managed.

Costs and affordability

The capital costs of achieving zero carbon schools are not accurately established but can be expected to be significant. Previous work commissioned by DCSF found that where zero carbon can be achieved using on-site renewables, the additional capital cost will be in excess of £200 per square metre of school – an uplift of around 10% on typical school construction costs.

Our modelling of five school buildings (see Annex D) concluded that zero carbon schools could not be delivered cost-effectively using on-site measures. More than 20 energy efficiency options for school building designs and seven low and zero carbon (LZC) energy sources were considered in this study. The modelling demonstrated that technically there is scope to reduce carbon emissions through energy efficiency measures by up to 12-14kgCO₂/m² relative to the 2006 building regulations requirements, but some of these measures are not financially viable (including the highest levels of floor and roof insulation).

Most LZC energy sources were not economically feasible, even allowing for the financial benefit of feed-in tariffs, which will be introduced in April 2010. Solar thermal systems were shown to have a slightly positive net present value but can only achieve modest carbon reductions. For secondary schools, there was a strong case for gas fired combined heat and power (CHP) based on lifecycle, and photovoltaics could be shown to be marginally cost effective when the benefit of feed-in tariffs was considered.

For a typical school, achieving zero carbon could mean significant additional capital costs, depending on the school type (primary or secondary) and its site. The recent consultation document *Zero carbon for new non-domestic buildings*⁷ took into account the diversity of non-domestic buildings and showed that there is great variation in terms of capital costs for different types of buildings in different contexts (for instance, rural versus urban, or where there are opportunities for linking to other buildings – or for standalone buildings).

The Treasury's Green Book⁸ requires that public investment decisions consider the whole lifecycle of new programmes and projects, taking account of their benefits, and that investments are not made solely on the basis of capital costs. However, our experience indicates that these principles are not always followed.

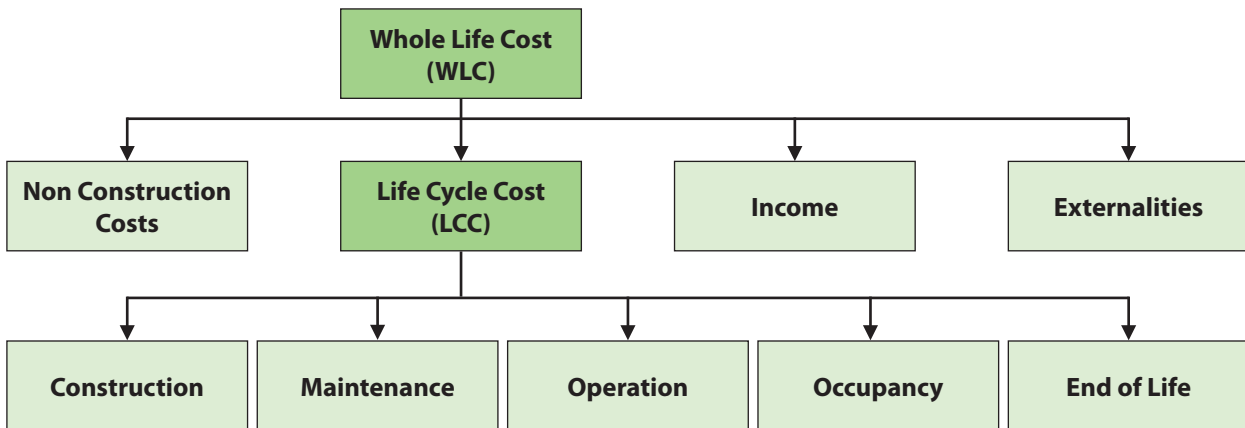
Often whole life and lifecycle cost information is simply not available, and where available it can be accounted for in different ways. There is further uncertainty about how costs might change as demand increases in future, and a backdrop of erratic energy prices means that it is difficult to explore lifecycle costs. Consideration of energy savings alone may not justify the capital outlay. A February 2009 analysis of costs for zero carbon homes indicates that there is a net whole life cost rather than a benefit.⁹

7 <http://www.communities.gov.uk/publications/planningandbuilding/newnondomesticconsult>

8 http://www.hm-treasury.gov.uk/data_greenbook_index.htm

9 http://www.cyrilsweett.com/pdfs/carbon_footprint_housing_september_08.pdf

The difference between whole life costs and life cycle costs for construction projects



Source: Willmott Dixon

Economies of scale may lead to a more attractive community-based solution for some technologies, such as wind or biomass. However, the initial cost for such community-based systems is much higher than for a dedicated system serving only a new school. Funding from other sources such as major energy suppliers or energy services companies (ESCOs) may be a solution to this. It must be recognised that investment costs are high, the market is small, and traditional ESCO terms/conditions may not be suitable.

Other benefits

Stern viewed carbon reduction as investment to avoid the risks of very severe global consequences in the future,¹⁰ recognising that postponing action now will only make the necessary measures more costly in the future – the full economic benefit of carbon mitigation is wider reaching than the value of the energy saved. This is currently addressed by including a shadow price of carbon¹¹ in economic appraisals. This establishes, in theory, what we should be willing to pay now to avoid the future damage caused by incremental carbon emissions.

There are further benefits to schools which cannot be quantified in cash terms. These include the learning that arises from testing new ways of reducing emissions and the opportunities for teaching and learning that low and zero carbon buildings can offer. There are potentially wider benefits, such as children influencing their family's behaviour, and the impact that measures in schools might have for future generations and throughout their lives.

¹⁰ http://www.hm-treasury.gov.uk/d/Executive_Summary.pdf

¹¹ http://www.decc.gov.uk/en/content/cms/what_we_do/lc_uk/valuation/shadow_price/shadow_price.aspx

What is being done already

The UK is responding strongly to the challenge of climate change and the Government has put in place legislation which will require an 80% reduction in greenhouse gas emissions by 2050 and 34% by 2020. The latter requirement may rise following the December 2009 Copenhagen climate change conference. Delivering reductions on this scale will require every part of the economy to play its part.

Individual Government departments are being assigned shrinking five-year carbon budgets in line with these reduction levels and must ensure that their 'sector' reduces emissions accordingly. DCSF is to take responsibility for ensuring that there is an adequate reduction in emissions relating to buildings' energy in children's services, including schools.

The Government has also introduced policies and measures to enforce, incentivise and help promote energy efficiency across all buildings, whether new, refurbished or existing.

New buildings

In December 2007, DCSF introduced a requirement that all new school buildings will reduce their carbon emissions by 60% in relation to a school built to 2002 standards. This should reduce annual emissions through educational activities at schools in core hours to less than 21kgCO₂/m².

A 60% reduction is the most radical short-term target within government, with the potential for huge savings in carbon emissions across the school estate. It means that strategic school building programmes are now leading the way in the commitment to reduce carbon emissions and will soon be providing details of what can be achieved in practice.

Funding of £110 million over a three-year period was identified to test the requirement in around 200 schools within Building Schools for the Future (BSF) and the Academies programme. New schools built under the Primary Capital Programme (PCP) are expected to meet the 60% requirement from within existing funding streams.

A simple piece of software, the 'carbon calculator', was produced to allow users to estimate annual carbon savings and capital costs and demonstrate how they plan to achieve the 60% reduction.

Performance against this reduction will be monitored in different ways for schools that are delivered within BSF:

- The payment mechanism for contractors providing school services through the private finance initiative (PFI) includes an interim operational target of 27kgCO₂/m² for core hours. This target is expected to be revised downwards as information becomes available on the actual performance of newly constructed schools that have received additional funding for low carbon measures.
- Local authorities are currently responsible for monitoring the difference between predicted and actual energy use as a key performance indicator to assess the effectiveness of the Local Education Partnership (LEP). These schools should still be complying with DCSF carbon emissions policies.
- Bespoke arrangements are locally decided for schools procured through other routes – such as local authority frameworks – but again, these locally-monitored schools should comply with DCSF carbon emissions policies.

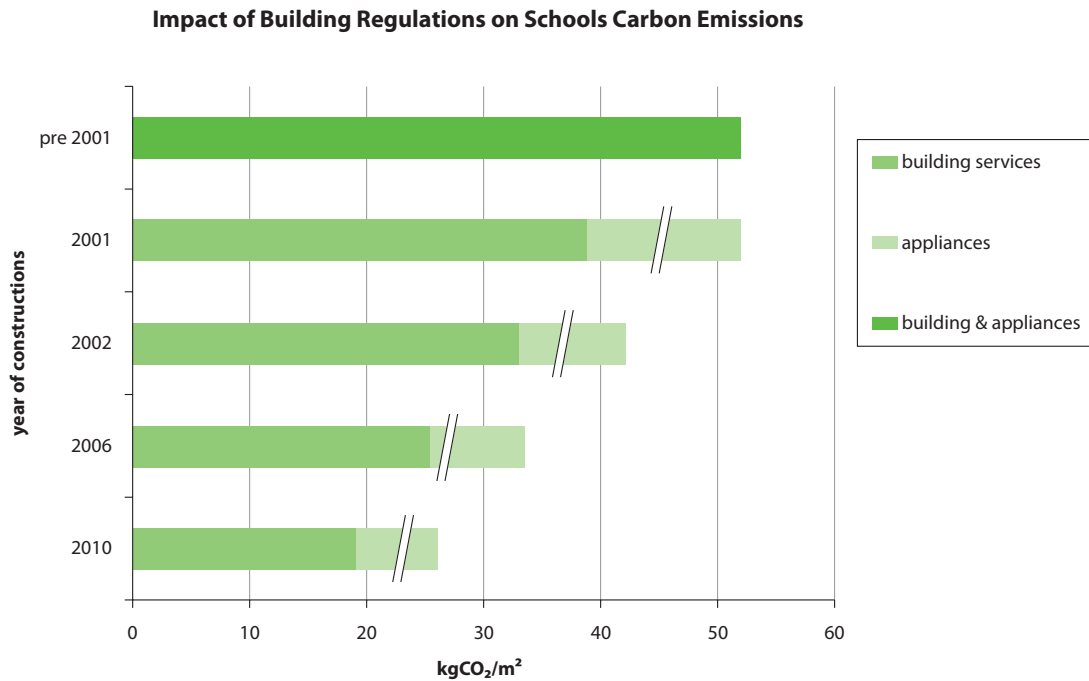
A 60% reduction equates to around 250 tonnes of carbon dioxide a year for each secondary school. This will save 50,000 tonnes for all new secondary schools planned over the next three years, rising to over one million tonnes over the next 15 years.

Yet this is still not enough. We need to get new schools to zero carbon as quickly as possible in the most appropriate way and maximise refurbishment opportunities to reduce emissions.

Part L Building Regulations set minimum requirements for energy efficiency and limits on carbon emissions for new buildings¹² covering fixed heating and hot water systems, lighting, cooling, ventilation systems, and LZC technologies. Part L was revised in 2002 and again in 2006, the combined effect of which has been to raise energy efficiency standards and reduce carbon emissions by around 40% over a four year period, although their degree of enforcement varies from planning authority to planning authority. Part L is due to be revised again in 2010, to require a further reduction of 25%.

The following table sets out the intended impact on carbon emissions of recent and proposed changes to building regulations. It shows that carbon emissions attributable to building services have been strongly addressed. However, energy used by appliances is not covered through regulation, and is less well understood, highly variable and potentially wide ranging.

12 <http://www.planningportal.gov.uk/england/professionals/en/1115314231806.html>



Since October 2008, **energy performance certificates (EPCs)** must be produced for new school buildings. These are based on modelled energy use 'as designed' and do not include energy used by appliances. Each EPC has an accompanying recommendations report which lists effective measures to improve the energy rating of the building.

In November 2009, the Government published the consultation on **zero carbon for new non-domestic buildings**¹³. This consultation set out proposals for working towards the Government's ambition that all new non-domestic buildings should be zero carbon from 2019, with the public sector leading the way from 2018.

Planning policy statement 22 (PPS22) states: 'Renewable energy policies in emerging development plans' allow a local planning authority to require that a proportion of a new development's energy needs are served by renewable energy systems. This proportion is set at 10-20% in most areas (often referred to as the 'Merton rule', named after the London borough that, in 2003, required new buildings over a certain size to reduce their carbon emissions by 10% through the use of on-site renewables).

¹³ <http://www.communities.gov.uk/publications/planningandbuilding/newnon domesticconsult>

Refurbished buildings

Part L Building Regulations¹⁴ set requirements for refurbishment of existing buildings, including schools in some circumstances. When they are adapted, extended, refurbished or replaced, minimum efficiency standards apply to services (such as heating and lighting), fittings (windows and doors) and thermal elements (walls, floors and roofs).

With the revised Part L in 2006, works of a certain type also trigger 'consequential improvements' to existing buildings over 1000m² – when building works such as an extension add to the building's carbon footprint, this triggers a requirement to invest in additional cost effective improvements in the existing building.

Other initiatives

A new set of **national indicators** for local authorities and local authority partnerships was announced in 2007. National indicator NI185 requires local authorities to measure progress in reducing CO₂ emissions and data on individual schools' energy performance will be reported through this indicator.

Display energy certificates (DECs) have been required since October 2008 for schools larger than 1,000 m² (likely to exclude at least some primary schools). Unlike EPCs, these certificates contain carbon ratings based on actual energy use, including energy used by appliances. They are accompanied by a report which identifies measures that could improve ratings. DECs are electronically 'lodged' via a website but the data is not currently available in a format which readily allows comparison of the energy performance of school buildings.

From April 2010 local authorities will be required to publicly report schools' energy use under the **Carbon Reduction Commitment Energy Efficiency Scheme (CRC)** – a new carbon 'cap-and-trade' scheme, which incentivises them to provide energy efficiency support to their schools.

Schools' financial benchmarking allows schools to compare spend in various categories, including total energy spend per student.

DCSF has consulted on possible carbon reduction targets across the whole of the operations of the school estate. The Department has committed to developing a **carbon management strategy** across the whole of the operations of the school estate and is carrying out a consultation that will inform that strategy.

It is anticipated that the strategy – including a **carbon management plan**, which integrates with cross-sectoral UK-wide initiatives – will be published in spring 2010. We would expect our recommendations for action in this report to be reflected in the plan.

14 <http://www.planningportal.gov.uk/england/professionals/en/1115314231813.html>

Sustainable development strategy

DCSF has a wider sustainable development strategy, which addresses all aspects of sustainability in schools. Through the concept of eight 'doorways' (sustainability themes) schools can establish their sustainability practices. Our work is a key strand of that wider strategy and supports in particular the 'buildings and grounds' theme.

DCSF has also adapted the Building Research Establishment's Environmental Assessment Method (BREEAM) for schools and other educational buildings, and requires all major new build and refurbishment projects to achieve a minimum rating of 'Very good'. Some schools are achieving BREEAM 'Excellent', and one (Hope Academy) is aiming for 'Outstanding'.

St Luke's School, Wolverhampton

St Luke's School is one of the first BREEAM Excellent schools in the country and is also Energy Performance Certificate A rated. It is a new Church of England two-form entry primary school with a 30-student nursery attached.

The exterior is largely timber (Douglas fir), with cedar shingles on the roof. The structure is laminated timber and much of the lining is timber when not white plaster, which gives an overall warmth. The building is orientated east/west, with pitched roofs sloping up to the north to give high-level clerestory lighting. Along the south side is a well-used continuous (3.6m) wide covered extension to the classrooms, providing 'free' outside space for each classroom and shade to the south-facing windows. Panels of coloured glass contribute to the ecclesiastical feel of the hall.

The building is naturally ventilated – the high-level windows give cross-ventilation and all classrooms have ventilation shutters alongside the windows. Ground floor south-facing classrooms have large sliding windows to the verandah. The biomass boiler (with gas back-up) feeds into underfloor heating and there is a photovoltaic display, for which the caretaker has been provided with training and support by the boiler manufacturer/installer. When asked what they liked about their new school, students replied 'magic lights and magic taps in the toilets'.

Progress since the ZCTF interim report

We are very pleased that DCSF has responded so positively to the findings in our interim report and is already making progress in taking forward the recommendations for action.

Immediate actions

We recommended three immediate actions:

- the offer of a **display meter** to all schools to support learning and, alongside a campaign to raise awareness, enable them to better understand energy performance and take action to reduce their energy use
- funding of **demonstration projects** to test a range of new low and zero carbon solutions
- **research** to scope the potential for reducing energy and carbon use during school refurbishment projects.

Meter offer and raising awareness

The display meter offer will be launched by DCSF alongside this report and funding of up to £12 million has been earmarked to provide for the meter and its installation. Each meter will be accompanied by an introductory pack for schools, containing a clear manual for using the meter, guidance on how it can be used to manage energy and engage students, and signposting to other sources of useful information.

The offer of a display meter is a very positive step, not just towards making energy performance visible, but also in engaging large numbers of schools. Carbon Trust experience indicates that advanced metering, if properly used as a demand management tool, reduces energy consumption (and costs) by between 10% and 15%.

Initially, the focus will be on measuring total electricity use at each school, with information displayed locally. However, the metering is capable of being extended to other utilities such as gas and water and to additional sub-meters. The meters will be capable of transmitting their data automatically to a data centre to allow, in the near future, comparisons of energy performance between similar schools in real time.

DCSF is supporting a social marketing activity to contribute towards behaviour change and embed in schools a culture of energy and carbon awareness. The programme of activity will encourage all schools to adopt good practice and build a sense of urgency and priority for taking action. As there is evidence that, in general, primary schools are already more engaged with the sustainability agenda

than secondary schools, the awareness raising initiative is targeting secondary school heads and governors (as the main decision makers) to encourage energy conscious behaviour by all occupants and to ensure that this is fully embedded in the future.

Demonstration projects and One School Pathfinders

DCSF has provided a new fund of £10 million for local authorities to set up projects that will test new ways of reducing carbon emissions in schools. The 14 successful projects were announced in March 2009 and feedback is being provided through quarterly updates submitted by each local authority to DCSF and PFS.

The findings will be made available as soon as possible after March 2011, when all the projects will be complete. Feedback will be available sooner for projects with earlier completion dates, and interim findings will be published as they arise. Summary details of the projects and their progress can be monitored via Teachernet.¹⁵

Montgomery Primary School, Exeter

Montgomery Primary School will be the first UK school to be built to the Passivhaus standard – a set of energy efficient construction techniques commonly adopted in Germany, Austria and Switzerland. Measures include heat recovery from ventilated air, very good levels of air-tightness, triple glazing and insulation twice as thick as that normally encountered in the UK. The school will be heated mostly by the heat generated by the students themselves.

All electricity demand (and any additional heat) will be provided by on-site photovoltaic panels. Energy supplies will be limited to mitigate wasteful building operations. The project will help set benchmarks for new schools by redefining what is possible by also being the first zero-carbon school in the country.

Extensive training on the building's operation will be delivered for occupants and the building will provide curriculum material for key stages 1 & 2 as well as ensuring first hand experience and opportunities to learn about energy conservation and energy generation. Each class will have the capacity to monitor energy use and influence their own environment.

¹⁵ http://www.teachernet.gov.uk/_doc/13710/ZC%20Exemplar%20Projects.doc

Ashmount Primary School, Islington

Ashmount Primary School is to be part of a carbon neutral (and possibly carbon negative) development. Design features include passive ventilation, biomass heating and combined heat and power (CHP) to serve a district heating network. This network will supply low carbon heat and hot water to a neighbouring housing estate, reducing the estate's CO₂ emissions to offset remaining emissions from the school. The project also includes recycled building components, which will have further carbon impact.

Renewable energy systems will be linked with a weather station to provide learning opportunities. An observation gallery will allow students to view the biomass heating plant, CHP and services once they become operational. Cutaway sections will be installed to make insulation visible.

The project will undergo extensive post-occupancy evaluation to determine what has and hasn't worked well, and to ensure a smooth transition from the end of construction into the operation of the school.

One School Pathfinders (OSPs) have been set up to allow some local authorities to rebuild one of their secondary schools before they formally join the BSF programme. Three of these projects (Bideford College, Devon, Queen Elizabeth School in Dorset and Richmond School, North Yorkshire) have been provided with additional funding specifically to support embedding sustainability throughout the curriculum so that learning can be shared more widely. Other projects will be encouraged to share lessons learned. Findings from the OSPs will also be published as they arise.

Research

Post-occupancy evaluation

In our interim report we highlighted the importance of finding new and better ways of gathering information on schools' energy and carbon use, and using it to reduce carbon emissions. We recommended the development of a structured approach to gathering and sharing information on how schools are performing in practice through POE – feeding back and sharing information so that other projects can benefit from the learning.

PfS has piloted a POE methodology for a selection of schools, and the 'Soft Landings' framework, which helps building users during their initial occupation of school buildings, will be trialled on a sample of BSF schools. Elements of these pilots will be applied to newly built schools within BSF and are likely to consist of visits to the school, data collection, questionnaires completed by a cross-section of the school community, interviews with key people and a final illustrated report informed by the expert view of the researchers.

The approach adopted will need to be regularly reviewed to ensure that lessons are learnt about new practices soon after they are adopted and that trends in energy/ carbon performance are closely observed as we move towards 2016 and zero carbon.

Carbon reductions in refurbishment projects

DCSF commissioned AECOM, on our behalf, to investigate potential for carbon savings during refurbishment projects. The work covers major and minor refurbishment and also considers retrofit measures that can be adopted within existing schools. The AECOM findings and our recommendations for action arising from our consideration of their report are covered in more depth below (pages 53-55).

ICT

A specialist workshop with key ICT companies, led by Becta and Intellect, was held in March 2009. This provided valuable input and helped clarify our views on what needs to be done to manage the significant source of carbon produced in schools through the use of ICT.

The report¹⁶ of this workshop recognised that there are several complex approaches that could achieve similar emissions reductions for the various bespoke ICT applications adopted in schools. It identified a number of basic actions that can be applied to almost all existing systems to improve efficiency – such as the implementation of centralised power-down facilities or changing default settings on equipment.

Prior to this workshop, Becta had produced information on a range of topics, including a school ICT electricity-use comparison tool¹⁷ and guidance on environmental sustainability¹⁸, and was in the process of updating its framework for ICT technical support (FITS) to include 'energy conservation'¹⁹.

Positive links with Ecotowns

The Ecotowns exemplar projects announced by CLG in July 2009 provide a tremendous opportunity to showcase the highest sustainability standards, and potentially provide test beds for zero carbon school buildings. It is important that schools in these developments meet exemplary standards, with the aim of achieving zero carbon. We understand from CLG that there may be some primary schools completed before 2016 from which useful lessons can be learned.

Scoping study

We have helped DCSF to commission a study to investigate how primary and secondary schools in urban and suburban locations might become zero carbon. The purpose of this study was to provide indicative capital costs and estimates of the associated carbon reductions for a range of measures, and to examine how dependant these are on school type and location.

16 <http://www.teachernet.gov.uk/docbank/index.cfm?id=14570>

17 <http://www.becta.org.uk/schools/carbonfootprint>

18 http://schools.becta.org.uk/index.php?section=re&catcode=ss_res_env_02

19 <http://becta.org.uk/tsas/index.cfm?refsect=ntss&bcsect=default&fits&id=f01010>

The main findings are summarised in the Annex D to this report and broadly concluded the following:

- It is not possible to achieve zero carbon through on-site low carbon measures for each school, regardless of its type or location.
- The potential reduction through energy efficiency measures alone is limited to ~42% of energy use covered by 2006 building regulations (approximately 33% of the anticipated total energy used by a typical new school building).
- Secondary schools have proportionally higher energy demand than primary schools but could achieve greater reductions because more low and zero carbon technologies are viable than for primary schools.
- It may be possible for schools in other locations to achieve zero carbon, but this will require low and zero carbon technologies that provide both heat and power.
- Most forms of renewable energy and other low carbon sources are not currently economical when their lifecycle costs are considered.

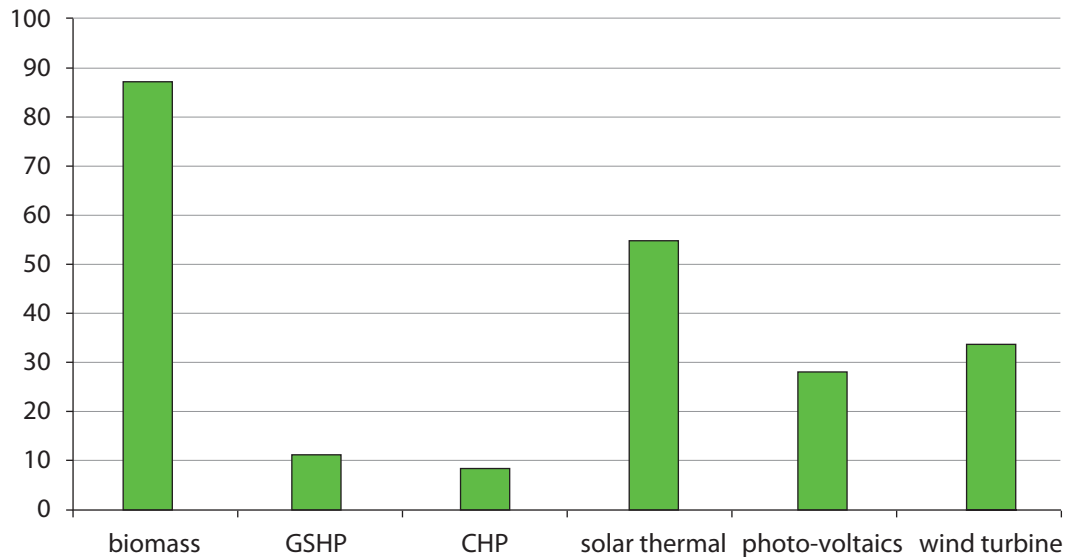
Carbon calculators

DCSF has now received completed carbon calculators for approximately 70 new schools. These indicate that, generally, the 60% reduction can be achieved at ~£50/m², although estimated costs at the design stage are wide ranging. The highest costs for achieving the reduction increase significantly with the amount of cooling provided, reinforcing the need to design schools to avoid cooling in all but the most heavily loaded areas. These indicate that low energy lighting with daylight and occupancy control, together with low energy ICT, are being almost universally included within new schools.

The carbon calculator includes some low carbon technologies. Their take up is shown in the chart below. Although the calculator allows users to propose their own solutions, from the proposals received very few teams are identifying new solutions (fewer than 10% of projects). We do not know whether this is because there are few affordable real solutions or whether it indicates a lack of creativity/initiative on the part of designers.

Where alternative solutions are proposed, the potential savings are relatively modest – fabric insulation and ventilation heat recovery indicating estimated carbon savings no greater than 5%. The exception is the proposed use of biofuel CHP in two schools, where it is estimated to reduce emissions by more than 50% – but there are concerns about the source of and emissions associated with the growth and production of biofuel.

LZC energy supplies



The common choice of biomass reflects its effectiveness in reducing carbon emissions at relatively low capital cost. Yet we are concerned that it may not be appropriate in all cases where it is being installed.

The Government's consultation on its heat and energy saving strategy²⁰ highlights the important role for biomass in contributing to UK heat supply – it is a very effective source of low carbon heat, even when emissions associated with its transportation are considered, sometimes over long distances (including its import from overseas).

Biomass in the form of woodchip or pellets is currently an underutilised resource and the types of wood fuel used for schools are typically by-products of forestry. Its availability is not an issue over the short to medium term. However, there is not enough biomass to serve all the UK's heat demand. Its ready availability as a low carbon source reduces the carbon impact of improving thermal insulation through other measures to reduce demand. There are ethical arguments against importing fuel to reduce UK emissions which raise concerns around its widespread use over the longer term.

We recognise that the carbon calculator is designed to be simple to use and to provide an early approximate indication of the relative effect of various measures. It was not meant to accurately model a school's energy use. We propose that the outcomes of schools that have been designed to achieve the 60% are closely monitored by PfS to establish how effective it has been in achieving reductions, and how it can be improved.

²⁰ <http://hes.decc.gov.uk/>

Making it happen – the roadmap

5 steps to zero carbon – how zero carbon can be achieved

The hierarchy for tackling carbon emissions in buildings has been developed and refined since its introduction in our interim report. We propose five steps for reaching zero carbon, each requiring clear leadership:



- reduce carbon/energy
- save money
- enhance the curriculum

Engage with LAs, schools, young people and others

The essential first step is to **engage LAs, schools, students and others**. It's about generating interest and the will to save energy, ensuring that occupants of school buildings understand:

- how simple day-to-day activities cause carbon emissions
- the importance of reducing carbon emissions
- simple actions they can take to reduce their energy use
- how to use display meters to learn about energy and how it is often wasted
- how this data can be used throughout the curriculum.

For new, refurbished and existing schools this will require clear briefing and energy targets. This key first step calls for strong strategic direction from LAs and designers, with clear leadership from headteachers, governors and other key decision makers.



- good passive design
- energy conscious behaviour
- responsible use

Reduce energy demand

Low and zero carbon energy supplies are expensive and/or difficult to achieve, so it is essential to **reduce energy demand** as much as is practical through simple, no-cost measures. For building occupants, this might require some simple changes in behaviour – such as switching off lights and PCs when not in use.

For building designers it means taking advantage of 'passive' features of school building design:

- Orientation
- Passive ventilation
- Daylight
- Thermal insulation and air-tightness
- Utilising thermal mass



- simple & effective controls
- reducing ICT heat & power
- low energy equipment

Drive out waste through better design

It is crucial that schools and designers **drive out** waste, ensuring that everything within the school that uses energy is as energy efficient as possible. Low energy products should be chosen and standby facilities should be enabled wherever they are provided.

For new and refurbished schools, over-complicated controls should be replaced with effective ones that users understand and that encourage energy efficient behaviour. The building's services should be as efficient as possible:

- Low energy ICT
- High efficiency boilers
- Low energy lighting
- Energy efficient pumps and motors
- Heat recovery



- low carbon fuels/biomass
- on-site/near-site renewable energy sources e.g. CHP
- recovering useful heat

Decarbonise school energy supplies

Decarbonising energy supplies is a key factor. There are limits on what can be achieved through energy efficiency alone – initial studies suggest that, for building services, a maximum possible reduction of 20-40% could be achieved relative to current building regulations. So it is important that energy demands are served using the lowest carbon supplies available. For equivalent amounts of energy, electricity has a higher carbon content than fossil fuels but is often the only suitable energy source – for example, lighting and ICT.

- Optimising electricity use
- Low carbon fossil fuels/biomass
- On-site renewables and CHP
- Community energy schemes
- Local renewable energy supplies



- "allowable solutions"
- off-site renewable energy
- other green electricity supplies
- distribution of surplus heat and energy through a neighbourhood network

Neutralise energy supplies

For most new schools, it will not be possible to eliminate carbon emissions solely through the above measures, so neutralisation is crucial to address residual emissions. This might be achieved through other 'allowable solutions' proposed within the CLG consultation on the definition of zero carbon homes and non-domestic buildings.

- Exporting low carbon energy to neighbouring properties
- Developing low carbon energy infrastructure
- Retrofitting energy efficiency measures in existing school buildings as 'allowable solutions'
- Using low carbon off-site ICT

Engage with LAs, schools, young people and others



Engage with local authorities and designers

It is critical to engage with local authorities and designers early in the procurement and design process.

Considering energy efficient developments at the earliest stages of planning

BSF requires local authorities to think in depth, from the outset, about how they will transform education. It is extremely important that DCSF and PfS take the opportunity to extend this thought process so as to harness opportunities to drive down carbon emissions from schools and promote sustainable behaviour among students and communities.

The Primary Capital Programme (PCP) also requires local authorities to consider how the capital investment will support sustainable development and reduce energy and carbon use. There are a number of ways in which this could be achieved to a greater or lesser degree:

- Ask local authorities to deliver on an **agreed percentage reduction** in carbon emissions across their school estate as part of their capital delivery programme. Authorities would be free to determine the mix of new build and refurbishment but ultimately would be required to achieve the desired level of carbon reduction. This approach would mean that DCSF and PfS could map the impact of the schools capital programme on its carbon budget.
- Provide a significant and early role for 'allowable solutions' (in line with those agreed with CLG) that embraces **refurbishment** as a means of achieving zero carbon through creating emissions reductions across the wider schools estate.
- Identify and earmark funds within the schools capital budget specifically for **retrofit and refurbishment** projects aimed at carbon minimisation.
- **Raise the profile of carbon** during the early stages of BSF projects by:
 - ensuring that the need to reduce carbon emissions is prominent within the BSF funding agreement
 - confirming that it has been adequately addressed during the design process by including specific requirements within CABE (the Commission for Architecture in the Built Environment) reviews
 - ensuring that it is safeguarded throughout the process by supporting the development of local authority client skills and knowledge

- developing the role of the client design adviser to shepherd low carbon measures throughout the briefing, design and construction, and then into the operation of school buildings.

Recommendation 1

DCSF works with PfS to determine how best to maximise the reduction in carbon emissions across each local authority area during the planning of capital developments.

Recommendation 2

PfS works with the Commission for Architecture in the Built Environment (CABE) to help build knowledge within local authority clients on the issues of low carbon design both for BSF and for the PCP. PfS develops the role of the client design adviser to ensure that this is satisfactorily addressed at the earliest stages of school (and other) building projects and is safeguarded throughout the design and construction and into the operation of buildings.

Engage with schools

DCSF needs to continue to look for opportunities to raise and increase awareness of the measures that schools can adopt to help them become more sustainable and reduce their energy and carbon use. The Audit Commission has suggested that energy saving measures can cut fuel bills by 10% and a well thought out action plan can double this figure²¹. A lack of awareness of the potential cost saving is a key barrier to its realisation.

Our visits to schools highlighted many examples of good practice. But not all schools are engaged – and there are few incentives for local authorities to support schools in managing their energy. There is a wealth of information and resources available to schools and a range of initiatives that promote sustainability, such as the Eco Schools award programme, the ASDAN Environmental Award, the Ashden Awards for sustainable energy and 'Green Day', which is promoted by CABE. DCSF needs to ensure that schools are aware of what is available and help them to get involved.

²¹ see Energy and water management: a guide for schools, <http://www.dcsf.gov.uk/valueformoney/index.cfm?action=GoodPractice.Default&ContentID=19>

Bowbridge Primary School, Newark

When a new building was planned for Bowbridge Primary, the intention was that it should be 'as near carbon neutral as possible'. Students were involved in developing the brief for the project and visited the new building weekly while it was being constructed. The building was occupied in September 2008 and students now have responsibilities, through the school's 'E-Team', to ensure that it is run in an energy efficient way.

Bowbridge is a leading school in Education for Sustainable Development and subjects are taught in a cross-curricular way based on lots of practical experiences. For example, students have been involved in producing videos and audio broadcasts about their school and global issues, such as global warming, as they study literacy.

Raising awareness throughout all schools

The Government has introduced new measures to raise awareness and generate incentives to help achieve its legally binding carbon reduction targets.

The Carbon Reduction Commitment Energy Efficiency Scheme (CRC)

Schools' energy use will be included within the new CRC, which puts a price on carbon emissions to incentivise energy savings and penalise increased energy use. Local authorities will be required to participate in the scheme, and many local authorities will pass on the rewards and penalties among schools within their portfolios. Schools' annual energy use will be publicly reported within the local authority's Comprehensive Area Assessment as one of the national indicators.

Carbon management plan

As the carbon management plan is developed, DCSF needs to look for further opportunities to raise and increase awareness of the measures schools can adopt to help them become more sustainable and reduce their energy and carbon use, and to consider how energy saving by schools can be incentivised.

Teacher training and Continuing Professional Development (CPD)

Longer term, the most important way to increase energy awareness among staff is to build course elements on energy into teacher training and CPD.

Influencing decision makers in schools

There needs to be a particular focus on influencing the decision makers in schools, working with the National College for Leadership of Schools and Children's Services (NC) and other bodies to support heads, governors, school managers and others with a role in facilities management, to champion energy efficiency. Making their schools more sustainable and reducing their carbon footprint and energy use as far as possible should be understood to be a business aim as well as a sustainability aim, and become part of their business planning processes.

Recommendation 3

DCSF maximises the potential to engage all schools in energy/carbon management as the Carbon Reduction Commitment is rolled out and carbon budgets are introduced.

Recommendation 4

DCSF explores how energy awareness and management can best be built into school staff training and continuing professional development (CPD), and works with responsible bodies to agree programmes of training and CPD for school leaders, teachers and facilities management staff.

Engage with young people**Embedding energy and carbon efficiency in the curriculum**

In our interim report we described the significant potential that energy efficient, low carbon buildings have to support teaching and learning. Sustainable design features that can be made visible to students, with systems that can be monitored, can help develop awareness and understanding of, and respect for, the environment. They can also secure students' commitment to sustainable development at a personal, local, national and global level.

There are examples, particularly in primary schools, of schools making very effective use of the sustainability features of their buildings for learning, raising awareness and influencing behaviour change. In its curriculum planning guide for schools' *Sustainable development in action*, the QCA states:

'Schools should be models of sustainable living and learning. Sustainability can be built into the fabric of the school building in a way that links learning to living – for example, through energy monitoring, composting, or the use of renewable energy sources. This can motivate young people to play a full part in the life of their school and the wider community, enabling them to take responsibility, reducing, reusing and recycling.....'

The majority of respondents to our call for evidence thought that features of buildings could contribute to the curriculum – for instance, through real time display of information, case study teaching materials, and through collaboration during school design. We are very pleased that DCSF has supported our recommendation to offer a display meter to schools, for example, providing a practical tool that allows students and other school users to see the immediate impact of their actions on energy use. We hope that all schools that do not already have such a resource will take up the offer.

We understand that CABE, with the Specialist Schools and Academies Trust and the National Primary Headteachers Association, will be publishing a new resource, *Our school building matters*, which offers ideas and activities on student engagement for use by teachers and designers in both primary and secondary schools.

However, architects and designers need to understand the vision for learning and how to incorporate designs that can be used for teaching and learning. This needs to be addressed in schools of architecture and within professional development/ mid-career training.

The King's School, Peterborough

The science facilities at The King's School were refurbished as part of Project Faraday¹. The new facilities provide ingenious ways to help students learn about energy use:

Thermal insulation – As part of the refurbishment, an existing window was converted into a cavity-filled wall. The wall was divided into four sections, each of which was filled with different types of thermal insulation. Temperature sensors (thermocouples) were fitted to the inner and outer faces of the brick courses, and the monitored data provide information on the relative effectiveness of each material.

Renewable energy – A solar array generates electricity for the classrooms (~2.5kW under ideal conditions) and is used to learn about alternative energy. A permanent display provides details of the electrical power, the accumulated output and CO₂ saved. An output from the unit can be interfaced with a standard PC to monitor and log performance.

On the roof are another smaller solar panel and a wind turbine. Their outputs are fed into a computer, which also monitors the wind speed and incident radiation from an on-site weather station. These allow students to see how the performance of these renewable energy systems varies with environmental conditions.

Energy monitoring systems – All electrical devices are monitored using a domestic energy monitor, which is linked wirelessly to a display panel and computer, allowing the effect of any electrical appliance on the total energy consumption to be monitored. Similar monitors are wired into key distribution boards around the facilities, for comparing energy usage.

Heating is controlled by a building management system (BMS), which can be interrogated via a panel situated within the laboratory. Data are also available remotely via a website.

Recommendation 5

PfS requires designers of schools to consider the curriculum opportunities in their designs and will develop guidance (or draw on an existing resource such as that being developed by CABE and partners) that makes the curriculum and cross-curricular connections for them.

Consider how teaching and learning is delivered

There may be significant opportunities to reduce schools' carbon footprint by radically re-thinking the ways in which the curriculum is delivered.

For example, by:

- adapting timetables to minimise space utilisation
- making use of outdoor covered spaces for teaching
- changing the school day so that occupancy matches the availability of daylight and free heat/'cooling'
- learning through ICT and in community spaces other than school buildings.

We have not explored these options in depth but DCSF may choose to do so if it wishes to take a more radical approach. An exploration of the cost benefits, energy management and savings of more radical educational scenarios might usefully be undertaken.

Engage with others

Educating the construction industry

In our interim report we identified that the construction industry does not yet have the skills for the widespread delivery of low carbon buildings – and that few people have practical experience of low carbon buildings. However, larger companies are beginning to employ sustainability specialists, which is a welcome development.

Knowledge sharing

The Government's strategy for sustainable construction²² has set a number of targets to improve the skills and knowledge within the industry to deliver more sustainable buildings.

In its September 2009 progress report, the Department for Business, Innovation and Skills (BIS) identified that the UK Green Building Council is working with stakeholders to address the continuing need for information, advice and guidance.

22 <http://www.berr.gov.uk/whatwedo/sectors/construction/sustainability/page13691.html>

There are further measures which could specifically address carbon emissions from school buildings:

- DCSF has worked with London Metropolitan University to develop a mid-career Schools Design CPD course for all those involved in the design and procurement of school buildings²³.
- The Royal Institute of British Architects (RIBA) school client forum enables discussions between procurers in the education sector and the architectural profession.
- The Chartered Institute of Building Services Engineers (CIBSE) operates a school design group – amongst its terms of reference is the aim to develop a strategy for healthy and sustainable schools.

Design standards

In 2009 minimum design standards (MDS) were introduced for school projects within BSF. A CABE panel assesses schemes against 10 assessment criteria²⁴ to reach an overall design quality rating. These criteria specifically include consideration of the proposed environmental strategies and the contribution of the design towards minimising energy use and carbon emissions for the school.

Recommendation 6

PfS works closely with the Department for Business, Innovation and Skills (BIS) and the stakeholders identified within its strategy for sustainable construction to ensure that consultants and contractors working on new school projects have the necessary skills to deliver low carbon schools.

Educating the ICT industry

Performance standards

There is a need to engage the ICT industry in the development of agreed performance standards, incentivising those levels of performance and developing robust measures to ensure compliance.

For industry stakeholders, this requires consideration of the standards that purchasers are seeking and metrics that providers are prepared to accept. Incentives should be designed to improve the energy efficiency of technical components and equipment produced and supplied by the industry, building on existing low-carbon ICT contracts.

Gathering information

The ICT industry also has a potential role to support energy information gathering (using ICT to monitor and manage energy) to improve operational performance of ICT systems and services that are in place.

23 <http://www.architecture.com/Files/RIBAHoldings/PolicyAndInternationalRelations/ClientForums/Schools/CPD/Schools%20CPD.pdf>

24 <http://www.cabe.org.uk/design-review/schools/criteria>

Recommendation 7

Becta engages with the ICT industry to agree specific radically reduced requirements for the energy/carbon performance of ICT services in schools.

Recommendation 8

Becta works with the ICT industry to develop a methodology to measure the actual operational energy performance of ICT service providers.

Reduce energy demand



- good passive design
- energy conscious behaviour
- responsible use

Ensuring clear leadership

There is ample evidence that the occupants of schools have a significant part to play in reducing energy consumption and strong leadership is key. Simply ensuring that lights and equipment are turned off can make a huge difference when it comes to reducing energy use and carbon emissions.

Engaging schools through awareness campaigns and providing energy management information is an essential first step but ultimately it must result in appropriate local action.

Ashley Church of England School, Walton on Thames

The head of this Victorian village school has a passion for sustainability and there is a real enthusiasm for it throughout the school. This 300 student primary school has successfully installed solar energy systems, low energy lighting and a clean fuel biomass boiler run on wood pellets as part of a refurbishment project that has reduced heating energy by over 20% and electricity use by 78%. The school has the long-term aim to become zero carbon.

The children and staff at Ashley use energy monitoring software to change behaviour – and every class has an energy monitor to support this. If the school meets its energy target over five school days, the children receive £10 from the headteacher as reward for their efforts. There are regular carbon-free Fridays, which involve a community picnic, and innovative teaching requiring no energy use. The school also operated for an hour without using any energy at all!

Even at home, families are rising to the challenge – and the Ashley 100 Club has been set up for families who aim to keep their energy consumption below 100kWh for the week.

Changing behaviour

We know that many new and efficient buildings do not realise their predicted efficiencies, often through occupiers failing to maximise the building's low emissions potential. Securing energy minimising behaviour is therefore central to achieving low emissions ambitions and is worthy of specific attention by DCSF. Carbon savings can best be achieved where behaviour change is combined with the potential to make low cost savings through retrofit or refurbishment.

Recommendation 9

DCSF works with local authorities and schools in changing behaviour through an active social marketing/behaviour change programme linked to capital retrofit or refurbishment funding wherever possible.

Managing ICT

It is reported that electricity consumption in new schools is increasing because of the growing use of ICT for teaching, and that the pursuit of ICT-rich learning environments potentially conflicts with the zero carbon goal. However, there is no firm evidence on the proportion of schools' electricity use that can be attributed to ICT, and where high electricity use has been investigated, the most significant component is poorly controlled or poorly managed lighting and other equipment²⁵. Nevertheless, a significant amount of the energy used by ICT in schools is unnecessary – a result of inexpert management of the equipment.

Reducing the carbon footprint

The carbon footprint of ICT equipment in schools could immediately be reduced by measures such as enabling power saving facilities, selecting low energy equipment and signposting to guidance produced by Becta, the Carbon Trust and others.

Ashley Church of England School, Walton on Thames

Ashley School's original desktop computers consumed 300 watts when in use, whereas the replacements, selected after thorough research by the headteacher, consume just 15 watts. The school has 15 laptops, so if they are used for six hours during a school day, they would use 1.35kWh. This compares 27kWh for the original laptops.

If 1kwh of energy costs 10p, then the new laptops only cost 13.5p to run over a six hour day, rather than £2.70 – multiplied over three 12-week terms, the cost is £24.60 versus £486.00.

Providing advice and guidance

Sound advice and guidance for institutions, particularly through those providing technical support, is essential to ensure that low energy ICT becomes the norm – there are more than 20,000 technicians operating in schools without a professional association or access to formal CPD.

Recommendation 10

Becta continues to develop and disseminate tools and guidance on energy efficient ICT.

Recommendation 11

Becta develops professional qualifications for ICT technicians which support energy conservation and power management.

Drive out waste through better design



- simple & effective controls
- reducing ICT heat & power
- low energy equipment

Setting more challenging requirements for school building standards

The national initiatives set out in 'What is being done already' above are important levers for driving improvements in carbon and energy use. Proposed changes to Part L Building Regulations will deliver phased improvements in energy efficiency standards for new non-domestic buildings, beginning with a further 25% improvement in 2010, with the ambition of a trajectory to zero carbon by 2019.

However, while these initiatives are very welcome and helpful in setting out the approach to achieving zero carbon, they will not go far enough fast enough to influence our goal for schools. They do not address all the energy uses within school buildings. We need to look at other levers and opportunities for making progress in the school sector, for future-proofing schools so that renewable energy systems can easily be introduced at a later date, and by ensuring that low energy schools are not prone to future overheating.

Using the carbon hierarchy

For new buildings the 'carbon hierarchy' can be applied, an early action of which is to design out unnecessary equipment and services – for example, by maximising daylight and natural ventilation.

Providing clear guidance and signposting

There is a wealth of valuable design information that currently resides in numerous locations (such as the Carbon Trust, DCSF building bulletins and professional institutions). This requires collating and updating to provide clear guidance and signposting to further information via a single point of reference for good and low carbon design.

Reviewing processes

Measures to reduce energy use are currently prone to 'cost cutting' as the scope of projects is re-worked to match available capital budgets. Reviews of processes and procurement methods should ensure that energy/carbon is addressed and that low carbon features of designs are retained when schools are built.

There is a question to be asked about the extent to which common practice and current design standards limit the potential for carbon reductions. For example, exposing concrete slabs within teaching spaces can help to limit overheating and the need for mechanical cooling, but can compromise the acoustics standards that are currently applied to schools.

Although schools may be below a comfortable temperature for occupation at the start of the day, a well insulated and air tight building will warm up very quickly once occupied. There may be opportunities to increase the efficiency by reducing the size of heating plant and equipment if occupants are prepared to tolerate cooler temperatures at the start of each school day.

Howe Dell Primary School, Hatfield

Howe Dell School is a new building which opened in September 2007 when the school moved to a new site. It includes a children's centre and a community hall.

The project was intended to test a range of technologies. It is highly insulated, with heat recovery from ventilation systems. A heat store captures solar radiation (via playground surfaces) during summer for use as a heat source during winter, and there are several renewable energy systems at the school (wind turbine, photovoltaics, solar thermal and ground source heat pump combined with inter-seasonal heat storage).

The school curriculum follows the principles of education for sustainable development – 'almost an experiment in how green and sustainable a building can be'.

Whitecross High School and Specialist Sports College, Hereford

This 900-place replacement secondary school opened in June 2006.

The buildings were designed to be low energy, with an aspiration to be in the upper decile of energy performance without the use of on-site renewables.

Features include high thermal mass, mechanical ventilation with heat recovery, substantial daylight in most areas, 'intelligent' lighting (daylight and occupancy control), high levels of thermal insulation, air-tightness (3.8m³/m²/hr) and low energy equipment (such as limited ICT rooms and trolleys of wireless laptops).

Unusually for a single school project, it was delivered through a 25-year PFI contract. This ensured that lifecycle costs were considered as the project developed. Responsibility for energy use is shared between the school and the PFI provider.

Refocusing Building Schools for the Future processes

There are more than 25,000 schools in England (of which just over 3,300 are secondary schools), which contribute around 15% of carbon emissions from the public sector. The planned upgrade of these schools through BSF will result in 50% of all secondary schools being rebuilt, 35% being significantly refurbished and 15% receiving minor refurbishment in the next 15 to 20 years. PCP will result in 50% of primary schools (~9,000) being rebuilt or refurbished over a similar period of time.

These two capital investment programmes provide an ideal opportunity for the schools sector to set an example – and to deliver carbon emission cuts of the magnitude necessary to contribute towards an overall cut in UK emissions of 80% by 2050.

Maximising opportunities

We need to fully exploit the opportunities provided by BSF to influence the design and construction of schools so that the current requirements are met and every opportunity is taken to raise the bar beyond that target.

PfS as the delivery agent for schools capital programmes has a key role to play in ensuring that carbon and energy use are given prominence throughout the BSF processes. PfS is already monitoring schools' compliance with the requirement to meet a 60% carbon emissions reduction, and there are opportunities to go beyond that level. PfS is also in a strong position to influence local authority consideration of energy and carbon reduction in the PCP.

Recommendation 12

PfS immediately reviews its BSF processes, procurement methods, standards and requirements that impact on energy/carbon to ensure they reflect the highest and most cost effective standards that can be achieved, and that they are addressed at every opportunity. PfS considers how these requirements might be applied to the Primary Capital Programme and other school building projects.

Recommendation 13

PfS undertakes a regular cycle of such reviews, no less than every three years, so that processes and requirements reflect learning, technological and other advances that will support the step changes to zero carbon.

Prioritising carbon/orientation in CABE minimum design standards criteria and escalate carbon within design review processes

Utilising CABE

CABE has a key role in ensuring that design standards are achieved within BSF. It also has the expertise to assist authorities delivering PCP. CABE enablers will continue to provide strategic advice to local authorities at the 'readiness to deliver' stage. Further support during procurement will be delivered by client design advisers. CABE's minimum design standards (MDS) require consideration of 'resources' to ensure that proposals for school projects deploy convincing environmental strategies which consider orientation, ventilation, daylight, and energy/services strategies.

CABE is also mapping where the key decisions to help secure design and sustainability aspirations are with each of the BSF procurement stages, through a web-based resource. This will be developed to reinforce carbon within CABE's MDS.

Recommendation 14

PfS ensures that consideration of carbon is part of CABE's assessments of BSF projects.

Rationalising ICT

Producing standards for ICT

There are various technologies which can reduce demand for electricity for ICT in schools and off-site data centres. These apply both to new schools and in refurbishment. We consider that the take-up of such technologies could be enhanced by drawing up a range of standard design strategies and models. Progress should be monitored regularly to help identify any barriers that limit the take-up of these standards in schools.

Developing an energy rating

Ultimately, the development of an energy rating (similar to the A to G ratings that are established for white goods and were recently introduced for buildings) should be considered for ICT. It should be based on the performance of actual services in a school-by-school basis to assess the performance of various systems in use. There should be some form of incentivisation and challenge to improve.

This could result in an increase in remotely hosted services, as these are likely to be more efficient (although there is a lack of data on the energy/carbon performance of off-site data centres), a rapid increase in the procurement of more energy efficient components and greater all-round professionalism within the provision of ICT services.

Recommendation 15

Becta refreshes its functional requirements, technical specifications and standards to reduce the energy requirements of ICT services, and that accreditation processes and procurement of ICT are based on these criteria.

Recommendation 16

Becta considers the development of an energy rating system that applies to schools' ICT services.

Decarbonise school energy supplies



- low carbon fuels/biomass
- on-site/near-site renewable energy sources e.g. CHP
- recovering useful heat

Building the availability of suitable energy supplies

As identified within the carbon/energy hierarchy, zero carbon can only be achieved if schools have access to suitable renewable or other green energy supplies. Our work on modelling schools in five different scenarios shows that the ease of decarbonising energy supplies (in terms of what is technically feasible and affordable) varies depending on local circumstances. However, there are some general principles that can be applied to help determine which low and zero carbon supplies are likely to be most effective (for example, to link up with low carbon community energy schemes where these are available).

Identifying appropriate solutions

There is a need for an agreed methodology which helps determine which low or zero carbon energy supplies are best suited to individual school projects. This will help users to identify which solutions are most apt for each type of school and the factors that contribute to the success of each solution. They will then be able to set priorities based on effectiveness in reducing carbon emissions, costs and

affordability. The methodology will also help identify potential barriers such as planning, and how to overcome them.

It should be supported by guidance on low and zero carbon energy supplies – covering their design, maintenance, capital and lifecycle costs, operation, carbon intensity of various supplies, planning and other issues. This should then be written into output specifications for BSF waves or individual schools, so that there is sufficient funding for more expensive technologies where appropriate.

Sharing energy supplies

Recommendation 17

PfS commissions the development of a methodology and a supporting compliance tool (decision tree or similar) to ensure that factors that are most likely to contribute to the delivery of low or zero carbon schools are addressed.

Shared energy systems such as those provided by district energy networks have the potential to meet the low carbon energy needs of some schools. Indeed, in some cases, schools themselves might act as catalysts from which such networks can develop.

Exploiting networks

Lack of experience in assessing the suitability of shared energy systems, in commissioning and operating them and in evaluating them for planning and building control purposes, has meant that currently just 2% of UK heat is provided by district heating networks. Their viability is generally limited to areas with high heat demand (typically $>3,000\text{kW}/\text{km}^2$) and projects of different types (such as schools and sports facilities) being coordinated.

Creating opportunities for district schemes requires careful planning, appropriately joined-up approaches to funding, and close links at central and local government level. Overall, the Department for Energy and Climate Change (DECC) estimates that, nationally, the potential for community heating could be as high as 20%. A lower percentage may be applicable to schools.

DECC's consultation on a heat and energy saving strategy identified a number of barriers to the up-take of such schemes. DECC has published its initial response to this consultation, which indicates that respondents generally support its strategy and highlights the need for a wide mix of financial and other tools to help encourage change.

We welcome these initiatives and encourage local authorities to exploit wherever possible shared energy networks, whilst recognising that they will not provide a solution for many schools.

Recommendation 18

PfS develops guidance on the options for low and zero carbon energy supplies that can be applied to schools of different sizes in various locations.

Using on-site renewables

Dealing with planning constraints

During our school visits we found that local planning restrictions were one of the factors that resulted in higher than expected carbon emissions at some schools. Some schools have set out ambitious plans for reducing their carbon emissions and identified how these might be achieved. However, they have not been progressed because of barriers introduced by general planning requirements or specific local objections.

Case study

A newly built primary school has incorporated many sustainable design features such as solar photovoltaic panels, ground source heating and effective natural ventilation. The final piece of the jigsaw to get to an almost carbon neutral position is a 25m wind turbine (to generate 50kW). Unfortunately there has been an on-going struggle to get planning permission for this for the last two years.

The plan was to place the turbine in a slight dip in the corner of the site. However, after a series of environmental tests by the planning authorities the school did not get the necessary planning permission – generating the perception that the existing planning rules relate more to wind farms rather than to individual turbines. The school (supported by their LA) put forward plans for a smaller turbine (15-20kW). This will no longer get the school close to carbon neutral, but will still be a significant step in the right direction. However, as the revised planning proposals will have to undergo the same environmental tests as for the previous proposal, planning permission may again be refused.

Recommendation 19

Renewable energy systems and other low and zero carbon energy sources are classified as 'permitted developments' for planning purposes for schools, allowing them to be installed without the need for planning permission.

Optimising research and development

There is an enormous amount of research and development into low and zero carbon supplies that can be adopted within buildings. The Technology Strategy Board²⁶, in particular, has a range of research funding streams on the theme of low impact buildings, and many universities are carrying out relevant research. Manufacturers are beginning to develop their products to meet market demand, and the development of low carbon alternatives is a useful market differentiator for manufacturers, suppliers and contractors.

There is a need to identify key developments from these and other sources and to consider how they can be applied to schools.

Recommendation 20

PfS identifies and monitors the outcomes of research into new low carbon energy sources that can be adopted for buildings, and works with suppliers to keep abreast of developments in the market for low carbon products.

Neutralise energy supplies



- "allowable solutions"
- off-site renewable energy
- other green electricity supplies
- distribution of surplus heat and energy through a neighbourhood network

Energy efficiency and low carbon energy supplies are the priorities within the energy/carbon hierarchy. These steps will significantly reduce the carbon emissions of school buildings but there will usually be residual carbon emissions to address in order to meet the zero carbon standard.

Applying 'allowable solutions'

CLG introduced the concept of 'allowable solutions' within their consultation on a definition of zero carbon for homes and non-domestic buildings – measures which deal with the emissions that cannot be dealt with on the site of the development.

Of the proposed allowable solutions, we consider that the following can legitimately be applied to schools:

- Carbon compliance beyond the minimum standards required by building regulations
- Where, as a result of the development, low carbon or renewable heat (or cooling) is exported from the development itself
- Off-site renewable electricity is connected to the development by a direct physical connection

As we move towards 2016 and further allowable solutions are introduced, consideration should be given to the following:

- Retrofitting works to transform the energy efficiency of existing school buildings
- Credits for carbon savings that are realised through the provision of coordinated off-site ICT services provided for educational purposes in schools

Recommendation 21

CLG considers the potential for further allowable solutions that permit credits for:

- retrofit and refurbishment improvements for existing school buildings
- carbon savings that are realised through the provision of coordinated, off-site ICT services
- nominated renewable energy systems that are installed on sites other than the school but which are owned by the local authority.

CLG continues to explore the use of a Community/Green Fund to help develop renewable energy infrastructure and allowable solutions.

Supporting the journey to zero carbon

Demonstrate what works

Build zero carbon pilot projects

Evidence we have seen indicates that by 2016 it will be possible to deliver examples of how zero carbon schools can be achieved in differing situations. However, we consider that the wholesale delivery of zero carbon new schools from 2016 is not achievable – the timescales are simply not sufficient to allow us to learn about the performance of new technologies and ways of influencing behaviour over time, or the financial implications of achieving zero carbon. Construction timescales are such that if new schools in all circumstances are to be zero carbon from 2016, then we need to know by 2012 how they can be achieved.

We are encouraged by the levels of ambition that some local authorities and other organisations are setting for their school buildings. The pilot projects in Exeter and Islington, aiming to be complete by March 2011, have clear strategies for achieving zero carbon in urban areas. This builds on the ambitious levels of carbon reductions held by local authorities for the OSP sustainability demonstration projects.

One School Pathfinder sustainability demonstration project

The goal for the project at Bideford College, Devon, is to achieve carbon neutrality in operation. The new school buildings are being constructed using known technological and construction energy reduction practices, including the following:

- All classrooms are north facing to allow for maximum daylight utilisation and reduced heat gain.
- Concrete mass leads to heat absorption into slab during day and night-time release as air cools down, thus reducing the need for increased night-time heating.
- All rooms are single depth design with a 'sunspace' corridor to the south, allowing for reflected light to enter classrooms to the rear and providing natural heating to corridor zones.
- Passive ventilation is used in the majority of spaces.
- Intelligent BEMS (building energy management systems), allowing for detailed zone management.
- There is interactive information display and curriculum use throughout.

One School Pathfinder sustainability demonstration project (cont'd...)

- Sustainable urban drainage systems (SUDS) including includes rainwater harvesting for flushing toilets.
- Over 90% of roofing is sedum, to control water run-off and increase biodiversity.
- All heating and hot water are via a woodchip biomass boiler, with woodchip from sustainable sources.

Accelerating zero carbon pilot projects

A minimum of four zero carbon pilot projects should be established in each government region. These should be operational before 2016, so that experience of how they perform in practice can be witnessed locally. Two of these should be new build and, to show how zero carbon can be achieved in schools of different sizes, there should be one primary school and one secondary. Two should be refurbishment projects, also one primary and one secondary.

To enable a secondary school to be built and operational by 2016, planning and design decisions will need to be made no later than early 2012 (slightly later for a primary school new build). Sites for projects will therefore need to be identified and a funding stream established in 2011. Funding to support the development of the pilot projects will need to be factored into DCSF's consideration of its capital funding programme from April 2011.

Recommendation 22

At least four zero carbon pilots in each of the nine government office regions are constructed by 2015 so that information on their first year of operation is publicly available by 2016. DCSF identifies a funding stream in its capital programme from April 2011.

Create a step change in emissions reduction targets

Introducing a new target

DCSF has already set a target for new school buildings to achieve a 60% carbon emissions reduction.

However, a series of step-changes is required as we move towards zero carbon, the first being the introduction of a new target following PFS' review of standards set out in Recommendation 12.

We propose that this begins with a target of 10kgCO₂/m² p.a. for new schools from 2013 as suggested in DCSF's consultation on a carbon management strategy for schools. This corresponds to a reduction of ~80% on 2002 building standards.

Recommendation 23

DCSF provides additional funding to enable schools in BSF and the Academies programme to achieve a 60% reduction in carbon emissions, and that actual performance against this target is monitored.

DCSF identifies funding to support a step change from 2013, with revised processes and the ambition of achieving a new target provisionally set at 10kgCO₂/m².

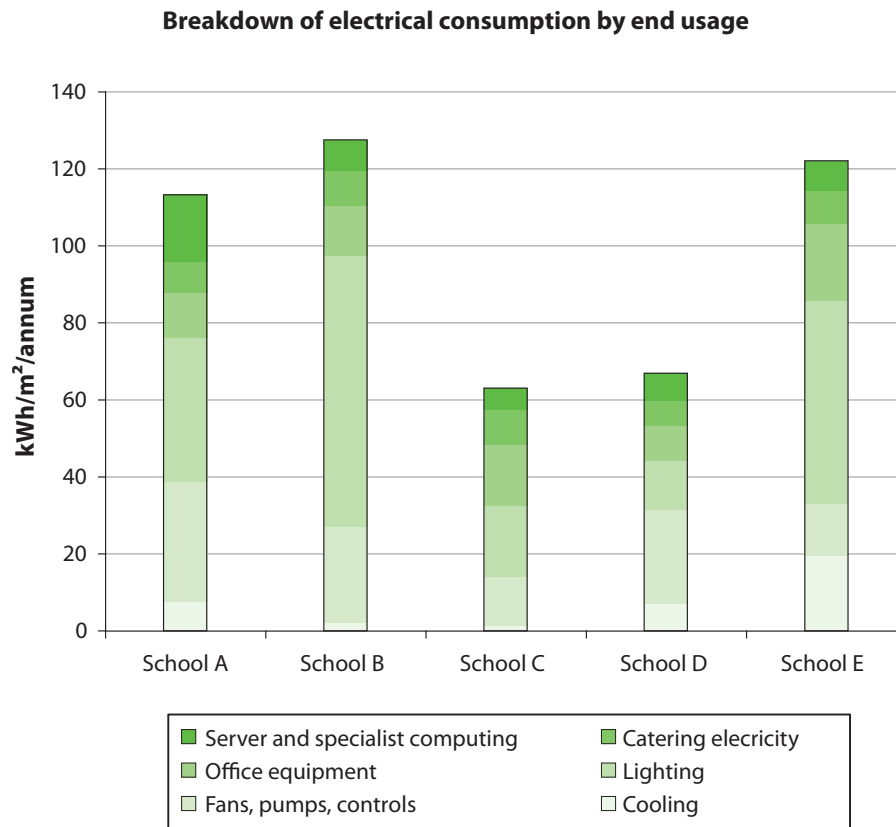
Monitor and evaluate

Improve information gathering and sharing

In our interim report we highlighted the need for new and better ways of gathering and sharing information on schools' energy and carbon use. Better information is essential if schools are to make informed decisions to improve their energy/carbon performance, if the most effective measures are to be targeted within school capital programmes, and to highlight potential differences in the ways in which schools are procured. This extends to the principles applied to the 'Soft Landings' framework, which over the initial occupation period helps occupants to understand how their buildings are intended to be operated.

Post-occupancy evaluation of academies

Buro Happold carried out a study of five academies during 2005/6 and found that there are great variations between the energy performance of buildings built to the same regulations at the same time (see chart below). Heating performance was good when compared to benchmarks, but electricity use was very high. This reflected both intensive IT usage, but also in most cases very poor lighting controls, and a 'default to on' set-up for many features. The best example used much less than half the worst for lighting, in spite of having similar operating hours.



See Building Services Journal, Nov 2009
<http://content.yudu.com/A1hres/CJNOV09/resources/39.htm>

Information is also needed to evaluate the impact of low carbon solutions that are applied to new build schools from now through to 2016/zero carbon. Effective post-occupancy evaluation of schools is needed so that lessons can be learned about what does or doesn't work, and then disseminated so that other projects can benefit from the learning.

Making more of display meters

The investment in display meters for the main electricity supply in schools is a practical measure to help schools monitor their own energy use. We would like to see this extended so that:

- the data available from these meters is collated to allow schools to compare their performance with similar schools – in much the same way as the cost comparisons that can be made within the financial benchmarking website for schools²⁷
- schools can monitor all their energy supplies and sub-meter major electrical loads.

27 <https://sfb.teachernet.gov.uk/Login.aspx>

Recommendation 24

DCSF and PfS engage with local government and schools to consider:

- how energy data available from smart meters and other sources can be utilised to enable comparisons of energy performance between similar schools
- how best to use performance feedback as part of a package of measures to encourage schools to reduce energy use.

Extending POE

In 2009 PfS piloted a POE to gather feedback on the general performance of some of the first schools delivered within BSF. We would like PfS' methodology for gathering post-occupancy feedback (developed for their POE pilot, see page 24) to be extended to specifically examine energy/carbon performance and associated costs (both capital and lifecycle). We would like this to be applied to all projects within BSF.

Analysing EPC and DEC reports

In our interim report we recommended exploiting the opportunities provided by the introduction of EPC and DEC energy certificates for schools (see pages 19-20). The published certificates contain minimal information but are accompanied by reports containing measures which could improve ratings, and the underlying data have potential for a range of uses. DEC's and EPC's should be analysed for all new schools to:

- identify measures commonly or uncommonly applied
- determine which measures are most effective in reducing carbon emissions
- highlight any flaws within energy modelling software used for new building design.

Sampling in depth

This analysis should be complemented by in-depth study of energy use in selected schools each year, comprising an expert walk-through, an occupant survey, an analysis of the breakdown of energy use and relevant details of how the project has developed for each school. This should determine exactly what energy is being used and for what purpose. Action can then be taken on site to address waste and lessons learnt can be disseminated more widely.

Disseminating information

There is also a need to develop a strategy for dissemination of learning from post-occupancy evaluations (for example, through case studies indicating what has and hasn't been effective), and feeding back any lessons learned as design standards are raised and BSF processes are reviewed.

Recommendation 25

PfS develops a post-occupancy evaluation process for all schools within BSF and a methodology for in-depth energy study which it applies annually to a sample of schools. Findings to be placed in the public record.

Using local authorities' data

We have now had the opportunity to consider other data that will be gathered on schools' energy performance. Local authorities will report individual schools' carbon emissions within both the CRC and national indicators in the local government performance framework (NI185 requires local authorities to measure progress in reducing CO₂ emissions through their operations).

DCSF should use this information to inform Ministers of progress as we move towards 2016/zero carbon – for instance, by reporting on the energy/carbon performance of schools completed each year from 2010. We had limited information on the energy performance of the schools that we selected for our visits, and would also like to monitor their performance using the above mechanisms.

Recommendation 26

DCSF/PfS gather and publish data on the energy/carbon performance of all schools to monitor progress as we move towards 2016/zero carbon.

Refurbish and retrofit

While we were asked to focus our work primarily on how we can achieve the goal of building zero carbon **new** schools by 2016, we have also considered, as part of our remit, the potential for reducing carbon emissions in refurbishment and retrofit.

We are grateful to AECOM for their work on this, which culminated in a very comprehensive report. This includes an assessment of all existing relevant information and case studies, along with the results of building energy modelling and consultations. The modelling was based on primary and secondary schools which were categorised as pre-1919 (solid walls) 1919-1980 (cavity walls) and post-1980 (insulated walls).

Acting on AECOM recommendations

The key conclusions, recommendations and quick wins that were reached are as follows:

- Carbon emissions from individual schools generally decrease as a result of refurbishment, even where energy efficiency is not a stated objective of the refurbishment project (typically by between 5% and 20% but occasionally much higher). This is based on energy data for 2,694 schools refurbished to some degree between 1997 and 2007.
- Building energy modelling has shown that by delivering whole-school energy efficiency refurbishments relative to current levels of energy performance, carbon savings of between 53% and 70% could be achieved. Experience suggests that the modelling results are likely to be optimistic in practice – assuming that buildings operated perfectly, which is rarely the case.
- Scaling up the potential carbon savings for all the school types modelled as proxies for the savings that could be delivered on a national scale gives an overall CO₂ saving of 66%.
- Based on modelling within this study, direct carbon emissions from the existing English schools stock could be reduced by between 50% and 65% by investing in energy efficiency measures alone. This level of emissions reduction would give a carbon saving of between 1.8 and 2.3 million tonnes per year, equivalent to between 20% and 26% of the total emissions from English schools (or around 0.28% of total UK carbon emissions). The modelling assumes optimum occupant behaviour, which will require additional measures if they are to be achieved.
- The full cost of delivering the modelled 66% saving in carbon emissions across the English schools estate has been estimated at £17 billion. However, modelling optimised to select measures based on a 'most effective use of capital' basis estimated similar savings (65%) for £12 billion.

As AECOM points out, some of these costs would be incurred anyway through routine schools maintenance and upgrading. Nevertheless, capital investment of between £12 billion and £17 billion is clearly significant and even if committed by the Government would need to be prioritised over a number of years. AECOM identifies several quick win measures that could deliver high carbon savings at relatively low cost, therefore offering best value in terms of reducing carbon emissions for least capital expenditure. Their main recommendations are to replace inefficient boilers with more efficient models and appropriate controls, and to insulate the roof or ceiling.

All these measures could be delivered at a cost per tonne of CO₂ per year saved of between £1,200 and £3,000 and may therefore represent better use of capital than investment in low or zero carbon technologies.

The single biggest win in terms of cost effective carbon saving would be to replace all oil-fired boilers with more efficient heating systems and at the same time consider fuel switching to, for example, biomass. It is recognised that many schools with oil-fired boilers tend to be in rural areas and are not able to connect to the gas grid, but are more likely to have biomass supplies nearby.

Recommendation 27

DCSF targets a programme of energy reducing refurbishment work (linked to behaviour change) to cut emissions in existing schools.

Measures will build an understanding of the level of carbon savings that are achievable in practice and how DCSF capital programmes can best deliver reductions in line with carbon budgets.

Recommendation 28

DCSF encourages CLG to incorporate specific energy efficiency recommendations for schools into the DEC assessor software tools that are owned by CLG.

PART 2 – Beyond the Zero Carbon Task Force

We have developed alongside this final report a proposed plan for implementing our recommendations. Ultimate responsibility for driving forward the recommendations needs to sit with DCSF as part of its wider strategy for sustainable development and its carbon management plan. However, other stakeholders – particularly PfS – have a key role to play.

Recommendation 29

A named, senior champion is identified in DCSF at Director level and a champion in PfS at a similar level; and that consideration is given to the need for the Sustainable Development Commission to have an overseeing/ monitoring role.

Recommendation 30

DCSF reconvenes the Zero Carbon Task Force every year for five years to receive a report on progress.

Implementation plan

	Action	Owner	Description	Timing
1	Work with PfS to determine how best to maximise the reduction in carbon emissions across each local authority area during the planning of capital developments.	DCSF	<p>Develop the planning processes within BSF and the Primary Capital Programme to consider how capital investment will reduce energy and carbon use.</p> <p>Explore the following options:</p> <ul style="list-style-type: none"> – Delivering an overall carbon reduction through a mix of new build and refurbishment – Considering as allowable solutions carbon measures that are not limited to new-build – Hypothecating funding for carbon reductions through refurbishment and retrofit – Linking funding agreements with local authorities to carbon reductions 	2010

	Action	Owner	Description	Timing
2	<p>Work with CABE to help build knowledge within local authority clients on the issues of low carbon design, both for BSF and the PCP.</p> <p>Develop the role of the client design adviser to ensure that this is satisfactorily addressed at the earliest stages of school (and other) building projects and is safeguarded throughout the design and construction and into the operation of buildings.</p>	PfS	<p>Explore options to introduce specific requirements for carbon reduction for new build and refurbishment projects through the minimum design standards (MDS) that applied within Building Schools for the Future, and consider how these principles might be applied to the Primary Capital Programme.</p> <p>Promote best practice examples of school projects which meet these requirements (such as through case studies).</p>	2010
3	<p>Maximise the potential to engage all schools in energy/carbon management as the carbon reduction commitment is rolled out and carbon budgets are introduced.</p>	DCSF	<p>Encourage schools to take up DCSF's display meter offer and, through the Sustainable Schools initiative, provide signposting to energy efficient guidance and products.</p> <p>Increase schools' awareness of low carbon measures and engage with them through an active behaviour change programme which increases the skills and confidence of teaching teams to make their school sustainable.</p> <p>Consider how energy saving by schools can be incentivised – for example, by linking to funding for low carbon measures during retrofit or refurbishment.</p>	2010-2012

	Action	Owner	Description	Timing
4	Explore how energy awareness and management can best be built into school staff training and continuing professional development (CPD); and work with responsible bodies to agree programmes of training and CPD for school leaders, teachers and facilities management staff.	DCSF	Build course elements on energy into teacher training and continuing professional development. Work with the National College for Leadership in Schools and Children's Services (NC) and other bodies to determine how best to support heads, governors, school managers and others with a role in facilities management.	2010
5	Require designers of schools to consider the curriculum opportunities in their designs and develop guidance (or draw on an existing resources such as that being developed by CABE and partners) that makes the curriculum and cross-curricular connections for them.	PfS	Introduce a mechanism to ensure designers have considered curriculum opportunities in their designs. Develop and share examples of schools where this has been achieved.	from 2010
6	Work with BIS and its stakeholders identified within its strategy for sustainable construction to ensure that consultants and contractors working on new school projects have the necessary skills to deliver low carbon schools.	PfS	Ensure that any particular requirements for schools are identified and addressed within the strategy and use the capital programme to pilot or test elements of the strategy. Consider further opportunities to include training on low carbon design/ construction within relevant university courses, mid-career courses, professional institutions and professional design groups/forums which consider school design.	2010

	Action	Owner	Description	Timing
7	Engage with the ICT industry to agree specific radically reduced requirements for the energy/carbon performance of ICT services in schools.	Becta	<p>Engage with suppliers to agree energy/carbon performance requirements for ICT in schools.</p> <p>Develop agreed metrics around ICT energy conservation and support capacity, agree specific requirements for schools' ICT and how performance against any requirements can be measured/assessed, and highlight any needs for legislation and regulation in this area.</p> <p>Build on standards that have already been developed or promoted through Defra's Framework Directive for the Eco-design of Energy Using Products (EuP) and the European Commission's Green Public Procurement initiative.</p>	2010
8	Work with the ICT industry to develop a methodology to measure the actual operational energy performance of ICT service providers.	Becta	<p>Explore options for introducing energy ratings or other standards for ICT infrastructure systems and services, and improve models of energy use – small scale investigations to develop theoretical models of energy use/energy grading within various school ICT infrastructure systems – and compare with measured operational performance.</p> <p>Feed findings back into calculation tools to enable targets to be set.</p>	
9	Engage with local authorities and schools in changing behaviour through an active social marketing/behaviour change programme, linked to capital retrofit or refurbishment funding wherever possible.	DCSF	Oxford Strategic Marketing have been commissioned to develop and deliver a two-year programme. Launch overarching awareness raising programme linked to meter offer, followed by targeted social marketing within the secondary schools sector.	2010- 2011

	Action	Owner	Description	Timing
10	Continue to develop and disseminate tools and guidance on energy efficient ICT.	Becta	<p>Explore options and develop a means for comparing energy use (for example, by pre-populating the existing ICT energy comparison tool with sample ICT solutions) and estimating savings available. Disseminate advice/guidance to schools.</p> <p>Promote the use of power management for ICT in schools.</p> <p>Explore options and develop and consolidate existing ICT energy comparison tool, guidance and feedback routes for schools.</p>	2010
11	Develop professional qualifications for ICT technicians which supports energy conservation and power management.	Becta	Adopt a new energy conservation process within Becta's framework for ICT Technical Support (FITS) and introduce accreditation for FITS technicians.	2011
12	<p>Review BSF processes, procurement methods, standards and requirements which impact on energy/ carbon to ensure they reflect the highest and most cost effective standards that can be achieved, and are addressed at every opportunity.</p> <p>Consider how these requirements might be applied to the Primary Capital Programme and other school building projects.</p>	PfS	<p>Immediately review BSF processes, procurement methods, standards and requirements which impact on energy/ carbon to ensure they reflect the highest and most cost effective standards that can be achieved, and are addressed as soon as possible within the process and at every subsequent opportunity.</p> <p>Review, taking account of the outcomes of research into reducing carbon emissions from buildings and their energy supplies.</p> <p>Consider how these requirements might be applied to the Primary Capital Programme and other school building projects outside BSF.</p>	2010

	Action	Owner	Description	Timing
13	Implement a regular cycle of BSF/PCP reviews, no less than every three years, so that processes and requirements reflect learning, technological and other advances that will support the step changes to zero carbon.	PfS	<p>Consider energy performance of recently constructed schools, proposed changes to building regulations, technical developments and market changes to update models for zero carbon schools in five separate scenarios and revise carbon targets for new schools.</p> <p>Take account of other drivers for low carbon (such as the introduction of feed-in tariffs during 2010 and the renewable heat incentive from 2011).</p>	2012-2015
14	Be certain that PfS ensures that consideration of carbon is part of CABE's assessments of BSF projects.	PfS	Ensure that carbon is considered during CABE reviews and determine how its requirements are satisfied within CABE's minimum design standards (MDS) – section 7 of which covers 'Resources: deploying convincing environmental strategies'.	2010
15	Refresh functional requirements, technical specifications and standards to reduce the energy requirements of ICT services, and develop accreditation processes and procurement of ICT based on these criteria.	Becta	Review functional requirements and technical principles for ICT, taking account of anticipated energy use/ carbon emissions. (Requirements to be introduced through Becta's framework for ICT Technical Support (FITS).)	2010
16	Develop energy performance requirements within ICT support frameworks and identify any barriers (within new build, refurbishment and retrofit projects) and implement incentives to overcome these.	Becta	<p>Develop models for low carbon ICT in schools and promote low carbon models and solutions.</p> <p>Introduce an energy grading metric of actual measured operational performance of service providers, and report on performance.</p> <p>Identify barriers to take-up and implement incentives for low carbon ICT services.</p>	2011-2012

	Action	Owner	Description	Timing
17	Develop a methodology and a supporting compliance tool (decision tree or similar) to ensure that factors which are most likely to contribute to the delivery of low or zero carbon schools are addressed.	PfS	Develop a methodology to help ensure that carbon has been given sufficient and appropriate consideration. Its purpose is to secure compliance with requirements rather than to aid design, but it may be required to determine which low or zero carbon energy supplies are best suited to individual school projects, and to identify factors that are crucial to their inclusion or exclusion (such as costs, local weather data and other environmental conditions, and space and other characteristics of the school).	2010
18	Develop guidance on the options for low and zero carbon energy supplies that can be applied to schools of different sizes in various locations.	PfS	Develop priorities or a process map to help determine which low or zero carbon energy supplies are best suited to individual school projects.	2010
19	Classify renewable energy systems and other low and zero carbon energy sources as 'permitted development' for planning purposes for schools, allowing them to be installed without the need for planning permission.	CLG	Ensure that renewable energy systems and other low and zero carbon energy sources are classified as 'permitted development' for planning purposes, allowing them to be installed without the need for planning permission. Identify priority energy saving measures that apply during school refurbishment and include as additional default recommendations within software that is used to develop DEC's.	2010

	Action	Owner	Description	Timing
20	Identify and monitor the outcomes of research into new low carbon energy sources that can be adopted for buildings, and work with suppliers to keep abreast of developments in the market for low carbon products.	PfS	Work with research organisations and manufacturers/suppliers to explore options for improving efficiency/ reducing costs such as for low carbon products, for carbon benefits of off-site construction, and for simplifying operation by school occupants.	2010
21	<p>Consider the potential for further allowable solutions that permit credits for:</p> <ul style="list-style-type: none"> • retrofit and refurbishment improvements for existing school buildings • carbon savings that are realised through the provision of coordinated, off-site ICT services • nominated renewable energy systems that are installed on sites other than the school but which are owned by the local authority. <p>Ensure that CLG continues to explore the use of a Community/Green Fund to help develop renewable energy infrastructure and allowable solutions.</p>	DCSF	<p>Respond to CLG's consultation on zero carbon non-domestic buildings to encourage the adoption of further allowable solutions for schools to include:</p> <ul style="list-style-type: none"> • retrofit and refurbishment improvements for existing school buildings • carbon savings that are realised through the provision of coordinated, off-site ICT services • nominated renewable energy systems that are installed on sites other than the school but which are owned by the local authority. 	2010

	Action	Owner	Description	Timing
22	<p>Commission at least four zero carbon pilots in each of the nine government office regions, to be constructed by 2015 so that information on their first year of operation is publicly available by 2016.</p> <p>DCSF to identify a funding stream in its capital programme from April 2011.</p>	PfS	<p>Identify funding and target school projects so that by 2016 there are at least two new schools (one primary and one secondary) and two refurbished schools (one primary and one secondary) in operation in each of the nine government office regions.</p> <p>Identify sites within proposed Ecotowns, BSF or the PCP so that there are two zero carbon schools (one primary and one secondary) in operation in each government office region by 2016.</p>	2016
23	<p>Continue to provide additional funding to enable schools in BSF and the Academies programme to meet a 60% reduction in carbon emissions, and that actual performance against this target is monitored. Identify funding to support a step change from 2013, with revised processes and the ambition of achieving a new target provisionally set at 10kgCO₂/m².</p>	DCSF	<p>Introduce a revised target for newly built schools from 2013 (provisionally to be set at 10kgCO₂/m² p.a. as suggested in DCSF's consultation on a carbon management strategy for schools). This corresponds to a reduction of ~80% on 2002 building standards.</p>	2013

	Action	Owner	Description	Timing
24	<p>Engage with local government and schools to consider:</p> <ul style="list-style-type: none"> • how energy data available from smart meters and other sources can be utilised to enable comparisons of energy performance between similar schools • how best to use performance feedback as part of a package of measures to encourage schools to reduce energy use. 	DCSF/ PFS	<p>Develop smart metering in schools so that:</p> <ul style="list-style-type: none"> • the data available from these meters is collated to allow schools to compare their performance with similar schools – similar to the cost comparisons that can be made within the financial benchmarking website for schools • schools can monitor all their energy supplies and sub-meter major electrical loads. 	2010
25	<p>Develop a post-occupancy evaluation (POE) process for all schools within BSF and a methodology for in-depth energy study to apply annually to a sample of schools. Findings to be placed in the public record.</p>	PfS	<p>Develop a POE process for all schools within BSF and an in-depth energy study of small sample of schools. Disseminate findings and feed any lessons learnt into the BSF process.</p> <p>Consider the use of a template so that data cost information can be accurately gathered in a consistent format across selected projects.</p> <p>Introduce a requirement for contractors to maintain records of energy use in schools they have constructed, for at least the first three years of the schools' operation.</p>	2010

	Action	Owner	Description	Timing
26	Gather and publish data on the energy/carbon performance of all schools to monitor progress as we move towards 2016/zero carbon.	DCSF/ PFS	Gather data on performance of all schools to monitor progress towards 2016/zero carbon. Consider how data could be centrally gathered – to allow, for example, comparisons of energy performance between similar schools – and who is best placed to provide this information/service.	from 2010
27	Target a programme of energy reducing refurbishment work (linked to behaviour change) to cut emissions in existing schools. Measures will build an understanding of the level of carbon savings that are achievable in practice and how DCSF capital programmes can best deliver reductions in line with carbon budgets.	DCSF	Target representative refurbishment projects to determine the levels of achievable carbon savings. (Current evidence is based on modelling.) Link capital investment to behavioural change and investigate outcomes to inform future refinements/developments of DCSF's carbon management strategy/carbon budgets.	2010
28	Encourage CLG to incorporate specific energy efficiency recommendations for schools into the DEC assessor software tools that are owned by CLG.	DCSF	Encourage CLG to adapt the templates for recommendation reports that are provided alongside display energy certificates (DECs), to list as default those measures that we have found are most likely to achieve significant carbon reduction during refurbishment of school buildings or which could be retrofitted. Recommendations to be based on the findings of the report submitted by AECOM.	2010

	Action	Owner	Description	Timing
29	<p>Identify a named, senior champion in DCSF at Director level; and a champion in PfS at a similar level.</p> <p>Consider the need for the Sustainable Development Commission to have an overseeing/monitoring role.</p>	DCSF/ PfS	<p>Identify champions at Director level within each organisation to ensure that the recommendations of the Task Force are addressed and that carbon emissions from school buildings (new, refurbished and existing) remains high on the Department's agenda.</p> <p>Consider the need for independent periodic review by an external body such as the Sustainable Development Commission.</p>	2010
30	Reconvene the Zero Carbon Task Force every year for five years to receive a report on progress.	DCSF	Reconvene the Task Force (or agreed representation of the Task Force) to report on progress and review future actions within the implementation plan.	2010

Annex A – Zero Carbon Task Force terms of reference

The aims of the Zero Carbon Task Force are to:

- develop a roadmap to zero carbon for all new schools by 2016; supported by research, including setting out clear targets and milestones along the way
- make recommendations for the best way of implementing the roadmap in projects delivered through BSF (including Academies) and non- BSF projects
- identify any limits for energy efficiency for agreed school types and locations, where it is agreed that zero carbon cannot be achieved
- identify exemplary developments, either existing (such as where low carbon energy infrastructures are in place) or planned (such as Ecotowns) and explore their potential for roll out
- scope the potential for reducing carbon emissions in refurbishment projects.

This will require consideration of:

- the cost, benefits and affordability of proposals, and potential impact on capital programmes
- a working definition of a zero carbon school, which will include energy used to heat, cool and light the building, together with energy used to power equipment used within the school
- a mechanism to calculate the performance of a zero carbon school
- available technologies and future potential for developing technologies to enable the target of 2016 to be met
- the opportunities provided by a zero carbon new building for teaching and learning.

The Task Force will NOT:

- consider carbon emissions beyond those attributable to the energy used within the building
- address broader educational and sustainable schools issues which are not related to reducing carbon emissions from new building or refurbishment
- consider carbon savings through offset or other measures to link with schools overseas.

The Task Force will aim to ensure that carbon reductions are met in an efficient and socially responsible way – to discourage measures to achieve zero carbon school buildings which pass the burden elsewhere.

Annex B – Membership and key contributors

Robin Nicholson (Chairman) Senior Practice Director, Edward Cullinan Architects

Irena Bauman Bauman Lyons Architects

Bill Bordass William Bordass Associates and the Usable Buildings Trust

Sally Brooks Deputy Director, Schools Capital, Department for Children Schools and Families

Simon Burton Regional Director, AECOM (Faber Maunsel) Sustainable Development Group London

Lizzie Chatterjee Senior Policy Adviser, Sustainable Buildings, Sustainable Development Commission

Peter Clegg Senior Partner, Feilden Clegg Bradley Studios

Andrew Cripps Regional Director, AECOM Limited

Vic Ebdon Head of Strategic Planning, Children & Young People's Services Directorate, Devon County Council

Mike Entwisle Associate Director, Buro Happold Limited

Andy Ford Director, Fulcrum Consulting

Professor Brian Ford Professor of Bioclimatic Architecture and Head of the School of the Built Environment, University of Nottingham

Mairi Johnson Policy & Programme Director, Partnerships for Schools

Anthony Karabinas Policy Officer, Department for Communities and Local Government

Stephen Lucey Executive Director, Becta

Dame Ellen MacArthur

George Martin Head of Sustainable Development, Willmott Dixon Ltd

Peter Maxwell Head of Enabling – Public Buildings, Commission for Architecture and the Built Environment

Jon Mussett Head of Building Design Consultancy, Building Research Establishment

Deb Thoma Director, Arup Building Engineering

Liz Warren Policy Analyst, Sustainable Development Commission

Key contributors

With particular thanks for contributions from:

Justin Slater former Policy & Programme Director, Partnerships for Schools

Adrian Leaman The Usable Buildings Trust

Helen Everleigh Senior Policy Adviser on Sustainable Buildings, Sustainable Development Commission

Richard Green Becta

Jane Briginshaw Head of Design Unit, Partnerships for Schools

Russell Symes Commercial Manager, Partnerships for Schools

DCSF Children and Young People's Panel
Sorrell Foundation Pupils Board

AECOM

The Chartered Institution of Building Services Engineers

e.on

The Further Education Task Force

Logica

The Zero Carbon Hub

Members of the design, construction and ICT sectors that contributed to our workshops.

A full list of respondents to our call for evidence can be viewed online at within the Consultations area of the DCSF's web-site <http://www.dcsf.gov.uk/consultations/index.cfm?action=conResults&external=no&consultationId=1565&menu=1>

Annex C – Schools visited

Between March and October 2009, Task Force members and members of DCSF Secretariat visited 15 schools. We are very grateful to the staff and students who gave their valuable time and shared their views with us:

Ashley CofE Aided Primary School, Walton on Thames, Surrey

Aufkirchen Montessori School (built to passivhaus standards), Erding, Germany

Bowbridge Primary School, Newark, Nottinghamshire

Bristol Brunel Academy and Bristol Merchants Academy, Bristol

Cardinal Wiseman Catholic Technology College, Birmingham

Christ the King School, Huyton, Liverpool

Everest College, Basingstoke, Hampshire

Herbert Strutt Primary School, Derby

Howe Dell Primary School, Hertfordshire

Oakgrove Secondary School, Milton Keynes

St Francis of Assisi Academy, Liverpool

St Luke's Primary School, Wolverhampton

St Mary Magdalene Academy, Islington

The King's School, Peterborough

Whitecross High School and Specialist Sports College, Hereford

Please see <http://www.teachernet.gov.uk/docbank/index.cfm?id=14659> for more detailed information about these visits – including some top tips which are based on the feedback received from those we visited.

Annex D – Modelling zero carbon schools

To support the work of the Zero carbon task force, DCSF commissioned a study to investigate the potential for reducing carbon emissions for a new build school in five scenarios. This investigated secondary and primary schools in urban and suburban locations and considered how the energy needs of a new school within an Ecotown might be served. The reference points for this study were schools constructed to the current (2006) building regulations.

The project aims were to

- establish how the potential reduction in carbon varies between these scenarios, and the factors which contribute to these variations
- provide indicative capital costs and estimates of the associated carbon reductions for each measure.

The main findings were as follows:

- It was not possible to achieve zero carbon through on-site low carbon measures for each school type in either urban or suburban locations.
- Achieving zero carbon in Ecotowns is dependant on the energy source and infrastructure available to the school.
- Energy efficiency measures alone could achieve an annual reduction of 12-14kgCO₂/m², which represents a reduction of ~33% relative to anticipated total energy used by buildings constructed to the standards required by 2006 building regulations. Most, but not all, energy efficient features were cost effective – they had a positive net present value over a 25-year evaluation period. The modelling indicated that although it is technically feasible to glaze and to insulate floors and roofs to very high levels of performance, these levels do not show a benefit in terms of lifecycle costs.
- Most LZC energy sources were not economically feasible, even taking into account the financial benefit of feed-in tariffs, which will be introduced in April 2010. Solar thermal systems were shown to have a slightly positive net present value for both types of school, regardless of their location. Gas fired CHP had a strong positive net present value for secondary schools regardless of location, and photovoltaics could be shown to be marginally cost effective when the benefit of feed-in tariffs was considered.

- Secondary schools had proportionally higher energy demand than primary schools (for both electricity and heating fuels), and more LZC technologies were viable for secondary schools. Overall higher percentage carbon reductions are available to secondary schools than primary schools.
- It may be possible for schools in other locations to achieve zero carbon, but this will require low and zero carbon technologies which provide both heat and power.
- The location had little impact on the types of LZC energy sources that could be implemented.

The findings of the report are summarised in the tables and chart below.

Table 1.0 Energy efficiency summary table

No.	Energy Efficiency Measure	Potential Annual Reduction (kgCO ₂ /m ²)	Capital Costs £/m ² (@ 2009 prices)	£ (Capital Cost) per kgCO ₂ Saved
0	Base building	0	0	–
1	Basic smart metering	0.14	3.51	25.07
2	Additional zone heating controls	0.04	2.24	59.38
3	Heat recovery for mechanically ventilated rooms	0.11	0.70	6.11
4	High efficiency condensing boilers @ 100% η	1.97	4.69	2.38
5	Advanced smart metering	1.29	19.56	15.11
6	Walls, U-value – 0.3	0.18	2.85	15.49
7	Walls, U-value – 0.27	0.29	2.85	9.87
8	Roof, U-value – 0.13	0.71	13.08	18.42
9	Floor, U-value – 0.22	0.11	3.07	26.72
10	Advanced lighting controls	2.66	4.42	1.66
11	High efficiency lighting (2.0 w/m ² /100lux)	2.07	1.73	0.83
12	Floor, U-value – 0.20	0.18	12.54	68.12

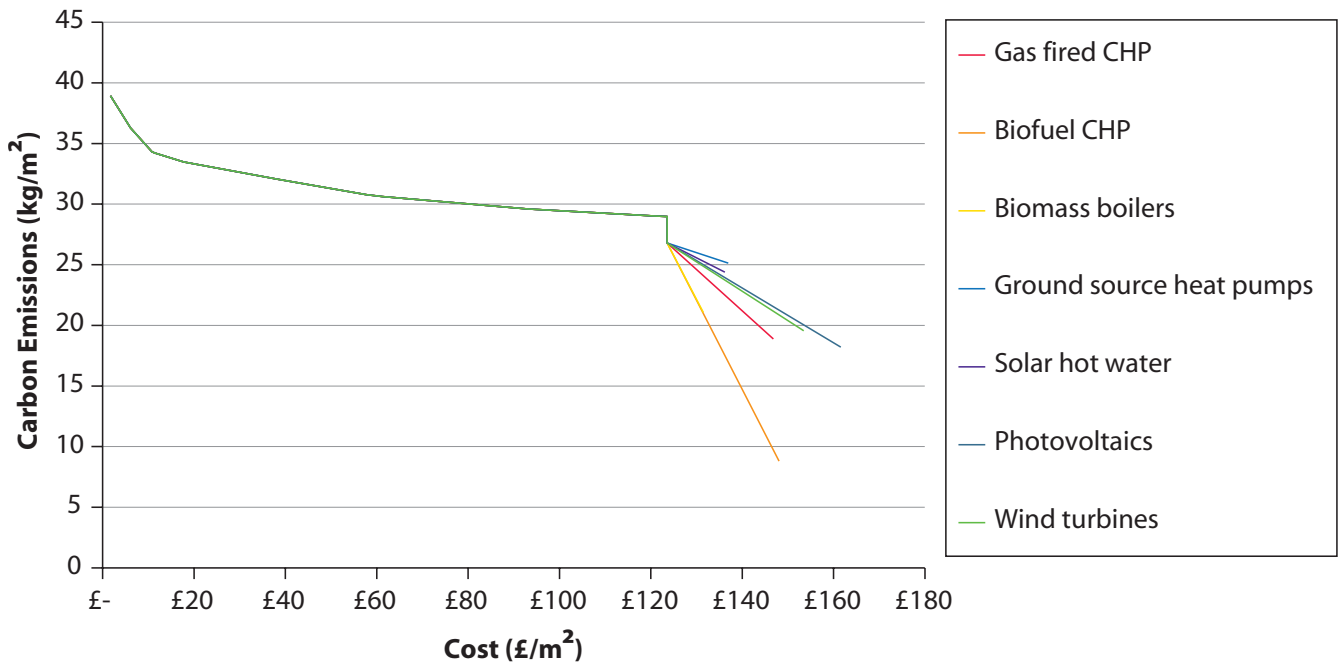
Table 1.0 Energy efficiency summary table (cont'd...)

No.	Energy Efficiency Measure	Potential Annual Reduction (kgCO ₂ /m ²)	Capital Costs £/m ² (@ 2009 prices)	£ (Capital Cost) per kgCO ₂ Saved
13	Window, U-value – 1.6	0.84	17.88	21.21
14	Walls, U-value – 0.25	0.37	2.85	7.73
15	Walls, U-value – 0.15	0.73	6.23	8.55
16	Floor, U-value – 0.10	0.58	28.23	49.09
17	Roof, U-value – 0.08	1.03	31.77	30.70
18	Window, U-value – 1.8	0.76	15.02	19.73
19	Window, U-value – 1.4	1.41	20.50	14.58
20	Building orientation	0.16	0.00	0.00
21	Solar control glazing	-1.02	10.97	–
22	Glazing ratio – 30%	-0.11	-14.33	–
23	Enhanced air permeability (5m ³ /(h.m ²)@50pa)	1.18	0.00	0.00
24	Enhanced air permeability (2m ³ /(h.m ²)@50pa)	2.19	0.00	0.00
25	Mechanical ventilation with heat recovery	3.31	75.93	22.91
26	Enhanced design	12.58	195.01	15.50

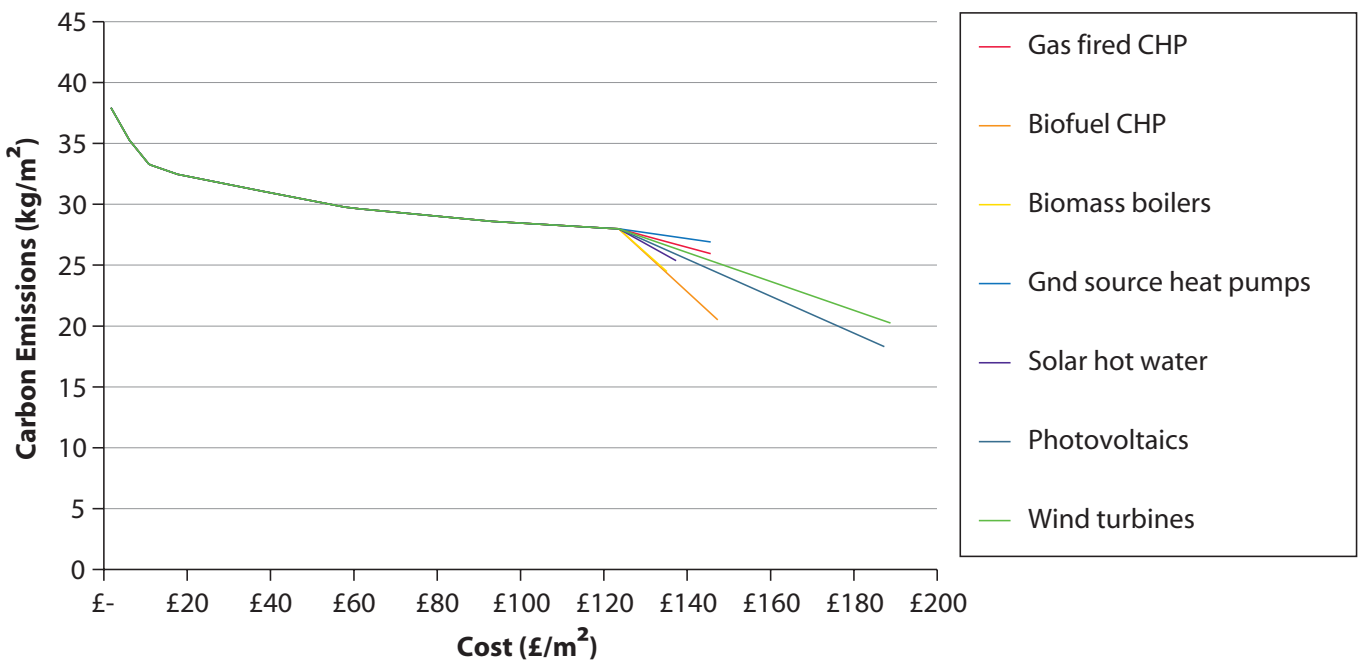
Table 2.0 Low to zero carbon technologies summary table

No.	LZC Measure	Potential Annual Reduction (kgCO ₂ /m ²) – Primary	Potential Annual Reduction (kgCO ₂ /m ²) – Secondary	Capital Costs £/m ² (@ 2009 prices) – Primary	Capital Costs £/m ² (@ 2009 prices) – Secondary	£ (Capital Cost) per kgCO ₂ Saved
0	Enhanced design	0.00	0.00	0.00	0.00	–
1	Photovoltaics	9.67	8.58	63.80	38.04	5.58
2	Wind turbines	7.73	7.23	65.25	29.91	6.36
3	Ground source heat pumps	1.07	1.66	22.09	13.42	13.01
4	Biomass boilers	3.50	5.72	11.60	7.98	2.12
5	Gas fired combined heat and power units	2.04	7.91	21.02	23.26	4.45
6	Bio fired combined heat and power units	7.47	17.98	23.79	24.53	1.90
7	Solar hot water heating	2.61	2.40	13.81	12.66	5.28
8	Option 1: photovoltaics and ground source heat	10.74	10.23	85.89	51.46	6.55
9	Option 2: photovoltaics and biomass boilers	13.18	14.29	75.39	46.02	4.42

Capital cost v carbon reduction (secondary school)



Capital cost v carbon reduction (primary school)





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