

A Low Carbon Building Standards Strategy For Scotland

**Report of a panel appointed by Scottish Ministers
Chaired by Lynne Sullivan
2007**



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Housing at Silverhills, Roseneath.
Architect: Anderson Bell Christie Architects.



Ministerial Endorsement

IN AUGUST 2007, I appointed an expert panel to recommend measures to improve the energy performance of houses and buildings in Scotland and thereby reduce carbon dioxide emissions.

The panel met in September and brought together distinguished representatives from the construction industry comprising designers, developers, contractors, verifiers, researchers and energy experts. I appreciate all their input, but in particular the advice of those experts who attended from Norway, Denmark and Austria, and the hard work of Lynne Sullivan in chairing the panel.

I am pleased to have participated in the panel's deliberations and was particularly impressed with the efficient manner in which a wide range of issues was investigated. I am grateful to all the members of the panel for their unstinting work in finalising this report.

The panel's report sets out demanding standards to progressively deliver carbon dioxide emission savings from buildings, with an ultimate aspiration of 'total life' zero carbon buildings by 2030. It also recommends that future energy standards be signalled to industry, well in advance of their implementation date, which would offer a degree of certainty which can support effective business and investment planning. Other key issues identified include improvements to existing buildings and ensuring that buildings are constructed as designed, thereby achieving real carbon savings. I am pleased to note that 'Costings' has been identified as one of the work streams and that cost benefit analyses are to be developed in partnership with the development and construction industry. It is essential that the Scottish Government is fully aware of the cost implications for the strategic infrastructure investment and affordable housing programmes and can therefore identify the provisions it may require to make in future budgets.

I thank the panel for having identified the work necessary to understand the implications of the strategy. The recommended standards are tough, but if they can be implemented, they would make a worthwhile contribution to our proposed 80% reduction in emissions by 2050. The first task ahead is to assess whether the standards and the recommendations on new and existing buildings can be implemented in a way that is consistent with the full range of strategic objectives that we have set out for Scotland's future.



A handwritten signature in black ink, appearing to read 'Stewart Stevenson'.

Stewart Stevenson MSP
Minister for Transport,
Infrastructure and
Climate Change

Kirk Park, Dalguise, Perthshire.
Architect: Arc Architects.



Chair's Foreword

CLIMATE CHANGE is a global problem exacerbated by human activity. Buildings, as the modern locus of much human activity, are the source of nearly half of emissions of carbon dioxide. Changes in behaviour will do most to reduce emissions, but the design, construction, maintenance and re-use of buildings can play their part. The strategy for low carbon building standards that is proposed in this report is what the members of the panel appointed by Stewart Stevenson MSP believe is most appropriate for Scotland, in the light of our understanding of the context and against the background of climate destabilisation.

This is not a technical document, but we have used our collective experience to produce a challenge that is both demanding and realistic, within a time frame which we consider to be both essential and achievable. We have taken a pragmatic approach to permit effective implementation, whilst detailed definitions, targets and specific measures will have to be developed as part of the proposed workstreams for the strategy to be meaningful and have impact.

Climate change mitigation cannot be delivered simply by a buildings strategy. During our debates we agreed that positive benefits from delivering low carbon buildings will be reduced if the occupiers have an average travel to work time of over an hour or if the energy supply to the building is not sustainable. It will need a comprehensive approach to be taken by the Scottish Government on matters relating to transport, planning, energy policy, business rates and finance. The planned Scottish Climate Change Bill should set overarching targets for Scottish emissions and create a framework for policy developments.

Wider and related measures would include reduced carbon emissions in electricity generation, use of waste heat from electricity generation, legislation to control the performance of electrical appliances, development of community plans to allow heat capture from power generation and, where practicable, community power centres and district renewable systems. Also, the implications of adaptation to climate change will need to be understood and acted upon.

The measures recommended in our report will have cost implications of a magnitude that will impact not only on the owners involved but also the end users. Whilst we touched on such issues, there also needs to be a debate on wider considerations, such as the role of public procurement and the impact of new designs on the willingness of lenders to lend and investors to invest.

We are clear that the adoption of this strategy cannot simply be a technical decision. It will impact materially on affordable housing for social rent, first time buyers and key workers as well as many small and medium sized



A handwritten signature in black ink, appearing to read 'Lynne Sullivan'.

Lynne Sullivan
Chair

businesses. All of these sectors are extremely price/cost sensitive but need to be clear that there will be material capital cost increases whose value will be realised in the long term. We recognise there must be consideration of how these cost increases can be funded but overall we agreed by consensus a low carbon building standards strategy that is both challenging and practicable.

We are therefore recommending a strategy that will move Scotland up the European league to one whereby we will have the best standards within the European Union. It is a proposal for rapid change and sets a very ambitious target for implementation.

Burnett House, Banchory, Royal Deeside.
Architect: Gokay Deveci.



Summary of Recommendations

WE, AS MEMBERS of the panel appointed by Scottish Ministers to advise on a low carbon building standards strategy, make the following recommendations. These will contribute to the overall goal of sustainable buildings which meet the current and future needs of the Scottish people and contribute positively to their well being, health and productivity, while minimising impact on the environment.



Minister with panel members from Austria, Denmark and Norway.

Eventual and Staged Standards

We recommend for new buildings:

- ✓ Net zero carbon buildings (i.e. space and water heating, lighting and ventilation) by 2016/2017, if practical.
- ✓ Two intermediate stages on the way to net zero carbon buildings, one change in energy standards in 2010 (low carbon buildings) and another in 2013 (very low carbon buildings).
- ✓ The 2010 change in energy standards for non-domestic buildings should deliver carbon dioxide savings of 50% more than 2007 standards.
- ✓ The 2010 change in energy standards for domestic buildings should deliver carbon dioxide savings of 30% more than 2007 standards.
- ✓ The 2013 change in energy standards for non-domestic buildings should deliver carbon dioxide savings of 75% more than 2007 standards.
- ✓ The 2013 change in energy standards for domestic buildings should deliver carbon dioxide savings of 60% more than 2007 standards.
- ✓ Backstop levels of U-values and airtightness for building fabric should be improved in 2010 to match those of Nordic countries, but consideration must be given to the social and financial impact of measures that would necessitate mechanical ventilation with heat recovery in domestic buildings.
- ✓ The ambition of total-life zero carbon buildings by 2030.

We recommend for existing buildings:

- ✓ Consideration of developing practical performance standards for existing buildings (aligned with the energy performance certificates).

Workstreams

We recommend:

- ✓ That the nine workstreams identified are followed and funded by the Scottish Government.

1 Performance in Practice

We recommend:

- ✓ Research to review the performance achieved in use and any issues found for buildings designed to be low energy, low carbon, zero energy or zero carbon.
- ✓ Monitoring of recent private and public sector low carbon domestic and non-domestic buildings in Scotland including behavioural and occupier lifestyle monitoring as well as energy efficiency, carbon footprint, temperature, ventilation etc. built both with public funding and by the private sector.
- ✓ Research to establish efficiency of existing installations of low carbon equipment.
- ✓ Consideration of 'PassivHaus' performance and its effect on occupant behaviour and comfort.

2 Raising Standards

We recommend:

- ✓ That both the carbon dioxide emissions standard and the backstop measures should be raised as set out in the eventual and staged standards.
- ✓ That the carbon dioxide emissions standard be modified to take account of energy consumption.
- ✓ Consideration of inclusion within building regulations of the energy efficiency of appliances that are built-in white goods in newly-created dwellings and IT equipment in non-domestic buildings.
- ✓ Consideration of the possibility of taking account of the energy performance of transportation systems, such as escalators.
- ✓ Consideration of the role that building regulations can play in terms of smart meters.
- ✓ Consideration of a requirement for consequential improvements and research carried out on inequity and compliance issues.
- ✓ That new public buildings should be built to future energy standards, rather than just the current standards.
- ✓ Training in new technologies, new products and new standards should be a priority for all parts of the construction industry and this should be supported by the Scottish Government.
- ✓ Consideration of the embodied energy within construction products in preparation for any possible change in the Construction Products Directive.

3 Existing Non-domestic Buildings

We recommend:

- ✓ The introduction of legislation to require all owners of non-domestic buildings to conduct a carbon and energy assessment and produce a programme for upgrading.
- ✓ The empowerment of local authorities, or similar public bodies, to check such assessments.
- ✓ The publication of guidance for different types of non-domestic buildings to assist in this process.
- ✓ Consideration of ways to encourage owners to implement recommendations arising from the carbon and energy assessment.
- ✓ That in the procurement of buildings by the Scottish Government the rating on the Energy Performance Certificate should be a significant factor.

4 Existing Domestic Buildings

We recommend:

- ✓ Consideration of measures and targets for reducing carbon emissions from the existing stock and incentives to encourage home owners to undertake improvements.
- ✓ As part of this strategy existing carbon and energy efficiency programmes and measures are continued, making them more carbon focussed where appropriate.
- ✓ That the building regulations continue to set the minimum standards that apply when building owners elect to do work on existing domestic buildings.
- ✓ That the Scottish Building Standards Agency continue to provide guidance on how to meet the minimum standards that apply to new work on the existing housing stock and should give consideration to joint ‘badging’ with industry bodies of such material.
- ✓ That, only where there is insufficient material currently provided in the public domain, the Scottish Building Standards Agency should provide additional guidance on energy performance, sustainability and carbon dioxide saving measures to bridge the gap.

5 Low Carbon Equipment

We recommend:

- ✓ That the requirement for on-site low and zero carbon equipment should be reviewed and probably removed from Scottish Planning Policy 6 (Renewable Energy) as the 'very low carbon' standards are introduced in 2013.
- ✓ That the energy standards for buildings should only be set at national level under the building regulations.
- ✓ Consideration of the appropriate split of responsibilities for local energy generation between planning and building standards.
- ✓ Research to find ways to encourage low carbon local energy centres for large developments and, where potential exists, in existing stock.
- ✓ Development of guidance on safe and productive installation that is appropriate to designers, installers and the general public.
- ✓ Examination of the building regulations and associated guidance with respect to low carbon equipment, including consideration of the design of buildings for the future installation of certain technologies.
- ✓ Schemes for Approved Certifiers of Construction should be encouraged, so that suitably qualified and experienced tradesmen can certify that installations comply with the building regulations.

6 Process

We recommend:

- ✓ That the future standards should be set in advance (i.e. publish the 2010 standards in 2008 and the 2013 standards at the same time as the 2010 standards become mandatory).
- ✓ Consideration of the introduction of a reduced or zero warrant fee for those designing to the future energy standards in advance of their implementation.
- ✓ Consideration of the duration of warrants and examination of the possibility of requiring a substantial start to be made on site within a fixed period of the date of granting of the warrant.

7 Compliance

We recommend:

- ✓ Consideration of the guidance to verifiers on what constitutes ‘reasonable enquiry’.
- ✓ Consideration of the role and effectiveness of airtightness testing and the use of thermal imaging.
- ✓ Research to understand better why there is a gap between ‘as designed’, ‘as built’ and ‘as managed’ energy performance.
- ✓ Consideration of the funding of verification work at the completion certificate stage.
- ✓ Encouragement of the development of more schemes for certifiers of construction.

8 Energy Performance of Buildings Directive

We recommend:

- ✓ That primary legislation is sought to allow Scottish Ministers the opportunity to extend the provision and type of Energy Performance Certificates.
- ✓ That a national electronic database is set up for collecting the information that underpins the Energy Performance Certificate calculation for non-domestic buildings.

9 Costings

We recommend:

- ✓ Research to analyse the cost impacts on new buildings of energy standards and other sustainability measures proposed for the building regulations in 2010, including life cycle analysis techniques.
- ✓ Cost benefit analyses are also undertaken of incentives through the building warrant system for building to higher levels of energy performance and of the use of tests for compliance with energy standards.
- ✓ Cost benefit analyses are undertaken of measures to promote the improved energy performance of existing buildings (a duty on owners to assess and improve the condition of their buildings, a requirement for consequential improvements and extended energy certification using operational ratings for non-domestic buildings).
- ✓ Research to analyse cost projections for new technologies and techniques.
- ✓ That all costing research is conducted in partnership with industry, with particular attention paid to the full cost of development projects and the potential impact on construction practice.
- ✓ Opportunities are taken to learn from international partners.

Scottish Seabird Centre, North Berwick.
Architect: Simpson & Brown Architects.



Context and Background

THE STERN REVIEW highlighted that there is now an overwhelming body of scientific evidence showing that climate change is a serious and urgent issue. More than 40% of Scotland's carbon dioxide emissions, a major cause of climate change, come from the energy we use to heat, light and run our buildings. So it is vital to ensure that new buildings are built in a way that minimises these harmful emissions and that existing buildings are improved and refurbished so that their use results in lower carbon emissions.

Scotland has a long and successful history of requiring building work to achieve good national standards. The building standards system was introduced to ensure that the health, safety and welfare of people in and around buildings is protected. Over the last fifty years new buildings have had to reach increasingly higher standards and existing buildings which have become dangerous or defective have been required to be improved. The conservation of fuel and power has also been a growing concern, initially to promote warm, damp-free houses, then to conserve fuel stocks and reduce fuel poverty. However there is now an overarching need to ensure that not only individuals in and around buildings are protected, but that the environment is also protected. So more recently, the focus of energy standards has been on reducing carbon emissions.

In order to determine what the standards for buildings in terms of carbon emissions should eventually be, and how soon these can be achieved, Scottish Ministers appointed us as a panel of experts in construction and energy matters. This is our report setting out a strategy for low carbon building standards. Information on how we worked together to produce this strategy are described in Appendix A.

This Low Carbon Building Standards Strategy is intended to drive a step change in building practice. It sets out a vision for the way the building standard system and policies in Scotland should develop over the next ten years and beyond. It provides a route map that will lead to low

and eventually total-life zero carbon buildings and recommends future developments in building standards in relation to carbon emissions from, and energy use in, buildings. This offers greater certainty about future regulations to developers and other key players in the industry who wish to gain market advantage by exceeding the current minimum standards.

The strategy addresses the different issues and needs facing domestic and non-domestic buildings. It also recognises that much of the building stock which will be in use for the next fifty years has already been built and that there needs to be consideration of how these buildings are treated. The refurbishment and improvement of the current stock is essential if we are to make any significant inroads into the reduction of carbon emissions from buildings.

In terms of new housing it is probable that by 2050 a significant percentage of the total stock will have been built between now and then. Current house build rates of around 24,500 per year offer an important opportunity to build high standards of energy performance and efficiency into the homes that will remain in use for future decades.

Arbroath Abbey Visitor Centre.
Architect: Simpson & Brown Architects.



The Role of Scottish Building Standards

THE VISION behind the Scottish building standards system is of a construction industry which consistently produces buildings which are safe, accessible to everyone, durable and sustainable, resulting in as few carbon emissions over their lifecycle as possible. To achieve this vision, architectural creativity and technical innovation must be encouraged and not restricted. Opportunities to improve existing buildings must be found, while treating them with respect as an important component of sustainable communities and the Scottish built heritage. Where mandatory standards must be set, they need to be as simple as possible and based on sound thinking and clear evidence. The skills of professionals and craftsmen need to be recognised and respected when considering the acceptability of designs. The Scottish performance based building standards should continue to be recognised as amongst the best in the world. It is in the context of this vision that we, the panel, believe this strategy must be implemented.

The principles of national standards enforceable by law, the verification of design before work starts on site and setting of standards in functional terms so as not to limit creativity and innovative design are the fundamentals of the Scottish building standards system. It is through using these that the strategy can be effective. Appendix B sets out more details on how the system works and how the standards and guidance are written.

Alongside other legislative or policy approaches prioritising low and zero carbon emissions for settlements and transport, business activity etc., it is the Scottish building standards system which will have the key role to play in promoting low and zero carbon buildings. For new buildings this can be through successively higher standards for thermal efficiency, the introduction of low carbon equipment and better building practice. This must apply equally to domestic and non-domestic buildings. For existing buildings, even where no building work is already planned, owners need to be encouraged and enabled to assess their buildings and develop cost-effective programmes of improvement.

The Scottish standards have always been based on sound research and have always helped the smaller builders, by stating not only what targets must be achieved, but by giving clear and simple advice on how these standards can be achieved. That must remain the intention behind the regulations and guidance - sound research translated into practical solutions. Appendix C consists of the summaries of two research reports prepared for the panel which were significant in developing this strategy.

While the small builders need assistance and support it is also essential that the more experienced designers are also encouraged to create innovative solutions and test out new technologies which can be verified through performance. There must be a route map showing where the standards will successively progress to, so as to foster innovation. Some designers and manufacturers will wish to move ahead faster and gain financial and technical advantage by building to future standards. They will have the assurance of knowing where these will be by virtue of this strategy.

Not only is it important that buildings are designed properly, it is also essential that they are constructed in accordance with those designs and that workmanship on site is of a high quality. These objectives must be underpinned by research to establish the extent of carbon savings which can be achieved by different methods as well as the additional costs of implementing new and higher standards. It is for this reason that the strategy concerns itself not only with assessments of designs and proposals at the building warrant stage, but also with verification of the final completed building.

In addition, the importance of training should not be underestimated as one of our European members advised, in relation to site quality and workmanship with respect to 'PassivHaus'. The skills gap is a key barrier and training throughout the construction industry is essential to enable the transition to a low carbon economy to take place.

Eventual and Staged Standards

WE HAVE used the descriptors ‘low carbon’, ‘very low carbon’ and ‘net zero carbon’, as the language of the route map towards ‘total-life zero carbon’ buildings. The term ‘net zero carbon buildings’ is used to describe buildings where space and water heating, lighting and ventilation are included. We propose that net zero carbon new buildings should be required by 2016/2017, if practical.

With this aspiration set, we agreed that a staged approach is necessary. We understand that due to the legislative process it is not practicable to make changes to the standards and guidance in anything less than two-yearly intervals. In view of this we propose that two stages are necessary, one in 2010 (low carbon buildings) and another in 2013 (very low carbon buildings).

Beyond 2016/2017 our long term ambition is for ‘total-life zero carbon buildings’ and we think this may be achieved by 2030. By this term we mean that the building should be responsible for net zero carbon emissions over its entire life, including construction (the embodied energy of building materials), use, maintenance and finally, demolition. We recognise it is too early to be certain if this can be achieved by 2030, but we think it should be the aspiration for the construction industry.

We feel strongly that information on the future energy standards should be given to industry as soon as possible, to enable them to prepare for changes. Taking research into account, we advise that the first set of improvement percentages (i.e. reduction in CO₂ emissions) on top of the 2007 energy standards should be 30% for domestic buildings and 50% for non-domestic buildings in 2010. From a baseline in 2005 at the start of the new building standard system this equates to around 45% and 65% respectively. We acknowledge that the costings in the research (see Appendix C) only indicate capital construction costs and do not reflect any costs that may occur through a reduction in build-density, as a direct result of meeting tougher standards. These changes will translate into energy standards that exceed those of the Nordic countries.

Whilst agreeing to these improvement levels, there is concern amongst panel members about the knock-on effect to the affordability of housing. In particular, these proposals could have a significant impact on small flats that will be purchased by first-time buyers and key-workers. We acknowledge that unlike the social rented sector, there is currently no government funding available for such units.

For the second set of improvement percentages on top of the 2007 energy standards, we suggest 60% for domestic buildings and 75% for non-domestic buildings in 2013. From the 2005 baseline, this equates to around 70% and 80%, respectively.

We also agree that the Scottish backstop levels of air permeability and U-values for building fabric should equate to those constructions that are usually adopted in practice for Nordic countries. The issue of ‘PassivHaus’ standards for housing was raised on several occasions during our discussions. Although having many examples of ‘PassivHaus’ (2,500 in total) in his own country, one of our European members was most insistent that you could not impose ‘PassivHaus’ living habits on home owners and occupiers. The main issue associated with ‘PassivHaus’ is that to realise the enhanced energy performance and to avoid mould growth arising from condensation, the occupants must be prepared to adjust

their lifestyle to rely solely on mechanical ventilation with heat recovery (MVHR), including frequent changes of filters and the associated running costs. In his country there was significant subsidy for those who elected to build and occupy such houses, but most importantly these people had made the decision themselves and had not been forced to live this way through regulation. Recent research also demonstrates that the heat recovery element would only contribute to savings in CO₂ emissions if the system is very efficient and uses low power fans. We advise a measured approach to improving the air permeability of housing, which considers the impact on householders of MVHR.

All the foregoing discussion has been about new buildings and building work where standards are required through the Building (Scotland) Act 2003. However the bigger problem is the existing building stock. Here we, as a panel, cannot set any eventual, or staged standards, but we do think minimum performance standards for existing buildings should be developed. These need to build upon the Energy Performance Certificates (EPCs) developed under the Energy Performance of Buildings Directive (EPBD). This will require a lot of work, but it is important that this begins now and is regarded as very important.

We recommend for new buildings:

- ✓ Net zero carbon buildings (i.e. space and water heating, lighting and ventilation) by 2016/2017, if practical.
- ✓ Two intermediate stages on the way to net zero carbon buildings, one change in energy standards in 2010 (low carbon buildings) and another in 2013 (very low carbon buildings).
- ✓ The 2010 change in energy standards for non-domestic buildings should deliver carbon dioxide savings of 50% more than 2007 standards.
- ✓ The 2010 change in energy standards for domestic buildings should deliver carbon dioxide savings of 30% more than 2007 standards.
- ✓ The 2013 change in energy standards for non-domestic buildings should deliver carbon dioxide savings of 75% more than 2007 standards.
- ✓ The 2013 change in energy standards for domestic buildings should deliver carbon dioxide savings of 60% more than 2007 standards.
- ✓ Backstop levels of U-values and airtightness for building fabric should be improved in 2010 to match those of Nordic countries, but consideration must be given to the social and financial impact of measures that would necessitate mechanical ventilation with heat recovery in domestic buildings.
- ✓ The ambition of total-life zero carbon buildings by 2030.

We recommend for existing buildings:

- ✓ Consideration of developing practical performance standards for existing buildings (aligned with the Energy Performance Certificates).

St Thomas of Aquin's High School, Edinburgh.
Architect: City of Edinburgh Council.



Workstreams

OUR AMBITION is to reach a position where all new buildings in Scotland are total-life zero carbon and that along the route we achieve net zero carbon buildings in ten years. This will require a transformation of the construction industry so it can deliver low, very low and zero carbon, climate change adaptable buildings at minimum social and economic cost and risk.

This has to be made an integral part of the building standards system and enforced with the same rigour as the standards on safety (structural, fire etc.) and health (drainage, noise etc.) For existing buildings it is clear that we cannot make them completely net zero carbon, but the target is to reduce their carbon emissions steadily and consistently over the next ten years with owners taking responsibility for improving their own buildings.

To achieve these milestones we propose a series of workstreams. These are:

- 1 Performance in Practice
- 2 Raising Standards
- 3 Existing Non-domestic Buildings
- 4 Existing Domestic Buildings
- 5 Low Carbon Equipment
- 6 Process
- 7 Compliance
- 8 Energy Performance of Buildings Directive
- 9 Costings

The workstreams we advocate are not sequential and need to be developed in parallel. Although it is difficult to put them into an order of priority we concur that the first two listed, analysis of buildings being constructed and raising standards are probably first and second in importance. These are closely followed by work on the existing building stock (both non-domestic and domestic).

We are aware that the last work stream, 'Costings', will not in itself reduce carbon emissions, but we feel it is essential that there is a dedicated study to evaluate the impact of the other workstreams in order to ensure that the measures being implemented show a cost and a benefit. We acknowledge that building to higher energy standards and thereby reducing carbon emissions will be more expensive, and we also recognise that not all of these costs can be met by lower fuel bills. It is the building users, whether residents or clientele and the public who will eventually have to pay these extra costs of reducing emissions.

The building industry is extremely price sensitive and it is imperative that consideration is given to costs from the start. This is not only to the specific costs of more energy efficient construction, but also to the impact of extra regulations and requirements on the whole building procurement and management process.

There is a value associated with reducing carbon emissions. It is a societal value which is realised in the future, whereas the costs of mitigation are borne by individuals or entities today. This report is not the place to go into detail, but there is a potential economic impact on society which climate change adaptation represents. It should be recognised that the scope of the panel's discussion did not permit us to discuss this in detail or to involve individuals with the appropriate expertise.

Most of these workstreams will be the responsibility of the Scottish Building Standards Agency (SBSA), with the assistance of the Building Standards Advisory Committee (BSAC). However some cross-over into other parts of government needs to be addressed by the appropriate directorates (e.g. planning, housing, energy, etc.)

We recommend:

- ✓ That the nine workstreams identified are followed and funded by Scottish Government.

City of Edinburgh Council Headquarters.
Architect: Building Design Partnership.





Performance in Practice

WE RECOGNISE that designing to high standards of performance is only the first stage in reducing CO₂ emissions from buildings. The quality of construction, the performance of the services equipment and the way that buildings are used all govern energy demand in practice, whilst the carbon intensity of the energy supply also influences the rate of CO₂ emissions.

Before requiring more demanding levels of performance, we believe it is necessary that research is undertaken. This should attempt to establish the range of performance that is achieved by the 'best in class' buildings that are already designed to demanding levels and identify any measures that have proved useful in ensuring high performance in practice.

We advocate the study should cover both domestic and non-domestic buildings and should aim, wherever possible, to establish performance in terms of energy demand for each fuel (annual kWh/m²), any energy generated on-site (kWh), and total emissions of carbon dioxide (kgCO₂/m²). It should report, wherever possible, on the following issues:

- Levels of design performance and assumptions of occupant behaviour.
- Types of construction and principles of services installation.
- Area and volume of building, design occupancy.
- Performance in practice, including any on-site low carbon equipment.
- Changes in the carbon intensity of the energy supply since design.
- Patterns of occupant behaviour.
- Perception of the comfort, controllability and maintenance of the building by occupants and/or managers.
- Any known problems in the performance of the buildings.

The panel learned a great deal from the experience of its European members. This study should make use of similar experience by collating reports on buildings in similar climates that are designed to be low energy, low carbon, zero energy, or zero carbon.

We know very little about the performance of similar projects in Scotland and the Scottish Government should fund a monitoring programme of recent low carbon

buildings in Scotland. The study should include projects that have been funded by the Scottish Government, by housing associations and by local authorities. We are also concerned that the study should also cover private sector buildings. As members of the panel, we are keen to offer the Scottish Government our support in facilitating studies of private sector buildings.

The importance of such monitoring will increase as each of the stages in our strategy is met. It will be hard to defend a continual raising of standards if we are not confident that the standards already set are achievable in practice and are being achieved.

We recommend:

- ✓ Research to review the performance achieved in use and any issues found for buildings designed to be low energy, low carbon, zero energy or zero carbon.
- ✓ Monitoring of recent private and public sector low carbon domestic and non-domestic buildings in Scotland including behavioural and occupier lifestyle monitoring as well as energy efficiency, carbon footprint, temperature, ventilation etc. built both with public funding and by the private sector.
- ✓ Research to establish efficiency of existing installations of low carbon equipment.
- ✓ Consideration of 'PassivHaus' performance and its effect on occupant behaviour and comfort.



Raising Standards

IN ADDITION to improving the energy standards in a series of logical stages we have identified three distinct areas where the requirements could be increased, namely: the scope of the energy standards, the use of continuing requirements and the possibility of consequential improvements.

With regard to the scope of the energy standards, we believe that not only should a carbon dioxide emissions standard be set but that it should be extended to take into account energy consumption. The European countries represented on the panel all use energy as an indicator.

Certain appliances could become a subject for building regulations, but urge caution on what is classed as a fixture or fitting and what is considered to be freestanding equipment. In newly created dwellings it could be important to consider built-in white goods, while IT equipment might be more significant in non-domestic buildings. We would have concerns if building regulations covered all appliances not only in setting standards but also, because of pressures

in enforcement and what would subsequently happen if occupiers choose to bring in their own appliances. On the subject of transportation systems, such as lifts and escalators, we have reservations about a standard that might adversely impact on access for disabled persons. Therefore this topic should be explored in more detail as it may be possible to set measures for some equipment such as escalators. With regard to setting standards for industrial processes and commercial uses, we also urge caution. However it may be possible to set some backstop measures, for example, the efficiency of boiler plant dedicated to serving swimming pools.

'Wester Tombain' nr Grantown-on-Spey.
Architect: MAKE Architects.



We note the continuing requirement powers within the Building (Scotland) Act 2003 and the part that they could possibly play in terms of maintaining the energy performance of a building. Although there is a possibility that these powers could be used for non-domestic buildings, we suggest that the energy performance certificate required by the EPBD is likely to be a stronger lever as discussed in workstream 8.

The panel has mixed views on the feasibility of consequential improvements applied to existing buildings. Observations include the following:

- Consequential improvements should focus energy efficiency measures related to the work that was being done at the choice of the building owner.
- Nothing should cause the building occupier to have to vacate the building.
- Consequential improvements may well drive some building owners to work outwith the law thereby jeopardising compliance with safety issues such as structure and fire.

Overall, the panel consider that such a measure would apply in an inequitable way. However, if this inequity could be overcome, for example, by way of grants, we concur that it would be an approach worth considering.

We raised the possibility of covering embodied energy in building products, but are concerned that at this stage, such a step would fall foul of the EU Construction Products Directive (CPD). We conclude that the best time to examine embodied energy within the context of the Scottish building standards system would be after the European Commission have re-examined the CPD. We welcome the other sustainability measures that are currently being progressed by the SBSA through Scottish building regulations. We agree that carbon dioxide savings will accrue as a result of this work, but consider that trying to quantify the amount saved will be of little benefit.

We discussed the value of smart meters and are keen to see their wider application.

Public procurement, in our view, is a hugely underplayed policy instrument. In deciding on the criteria for the design of new public buildings the Scottish Government should ensure they are building not just to the current building standards, but to those which we have recommended for 2010 or 2013.

We recommend:

- ✓ That both the carbon dioxide emissions standard and the backstop measures should be raised as set out in the eventual and staged standards.
- ✓ That the carbon dioxide emissions standard be modified to take account of energy consumption.
- ✓ Consideration of inclusion within building regulations of the energy efficiency of appliances that are built-in white goods in newly-created dwellings and IT equipment in non-domestic buildings.
- ✓ Consideration of the possibility of taking account of the energy performance of transportation systems, such as escalators.
- ✓ Consideration of the role that building regulations can play in terms of smart meters.
- ✓ Consideration of a requirement for consequential improvements and research carried out on inequity and compliance issues.
- ✓ That new public buildings should be built to future energy standards, rather than just the current standards.
- ✓ Training in new technologies, new products and new standards should be a priority for all parts of the construction industry and this should be supported by the Scottish Government.
- ✓ Consideration of the embodied energy within construction products in preparation for any possible change in the Construction Products Directive.

3

Existing Non-domestic Buildings

WE ARE AWARE that the certification of the energy performance of a building, with a statement of the estimated carbon dioxide emissions and guidance on cost effective improvements, is being introduced under the EPBD. Useful as this is, we note that the EPBD does not require that action is taken to improve energy performance, but relies solely on market forces to promote improvements.

We therefore considered the possibility of new legislation which could require building owners to obtain energy performance certification of their building, even if not required to do so under the EPBD. Following such an energy assessment, they could be required to develop a programme of improvements to reduce carbon dioxide emissions and thereafter carry out any necessary improvements. We discussed the possibility of enabling legislation being part of the Scottish Climate Change Bill which has been proposed for 2008.

Most other legislation applying to existing buildings is restricted to non-domestic buildings and we wondered if the same approach could be taken with energy assessments. Restricting the duties of assessment and improvement to the owners of non-domestic buildings might make implementation more manageable. There was also discussion of the possibility of such legislation being phased with a size threshold coming down in a series of well publicised stages until all non-domestic buildings were covered. We are aware that there is already public pressure to consider the carbon footprint of buildings. Many large companies already have begun the process of sustainability assessments and are likely to present themselves as leaders in this field (e.g. the supermarkets and leading retailers, the banks and major financial institutions).

We are aware of how a risk based mechanism of owner assessment has been adopted in the Fire (Scotland) Act 2005 to improve the fire safety of existing buildings. This could provide a model for the administration of a system to improve energy efficiency and reduce carbon emissions.

As with new buildings we believe that the role of public procurement is not sufficiently exploited. The value of EPCs would be greatly enhanced if the Scottish Government made them a criteria in public procurement decisions on building selection.

Clearly, if duties of assessment and improvement were placed on building owners then there would be a need for good practice guidance on risk assessment and action plans.

We recommend:

- ✓ The introduction of legislation to require all owners of non-domestic buildings to conduct a carbon and energy assessment and produce a programme for upgrading.
- ✓ The empowerment of local authorities, or similar public bodies, to check such assessments.
- ✓ The publication of guidance for different types of non-domestic buildings to assist in this process.
- ✓ Consideration of ways to encourage owners to implement recommendations arising from the carbon and energy assessment.
- ✓ That in the procurement of buildings by the Scottish Government the rating on the Energy Performance Certificate should be a significant factor.

Business Incubation Centre, Alba Campus, Livingston.
Architect: 3DReid.



4

Existing Domestic Buildings

WE NOTE the work already being carried out by various parts of the Scottish Government and the role of the SBSA with regard to the existing housing stock. There are however differing views within the panel as to the next steps.

Recognising the very large contribution of existing domestic buildings to carbon emissions and the need to increase effective action in this sector, the Scottish Government should continue to develop measures and targets for reducing carbon emissions from the existing domestic stock.

Improved communication of energy efficiency measures to the wider public could be considered, but the majority of us think that this should be left to other organisations. There are however exceptions to this and the SBSA sustainability guide for home improvements received specific mention as an example of good guidance which bridged a gap in publicly available information.

There is an overall consensus that financial subsidy is necessary to promote energy efficiency, but also a recognition that in the long run this is a cost burden on everybody. On the whole we consider that the SBSA is in the best position to set the minimum standards when work is done to existing housing and give guidance on how such standards are met. It would be particularly useful if such guidance could also be included in publications intended for those undertaking minor alterations or extensions to their own homes, for example kitchen extensions and loft conversions. In this way it may be possible to encourage those undertaking such work to consider the wider improvement of their homes.

We recommend:

- ✓ Consideration of measures and targets for reducing carbon emissions from the existing stock and incentives to encourage home owners to undertake improvements.
- ✓ As part of this strategy existing carbon and energy efficiency programmes and measures are continued, making them more carbon focussed where appropriate.
- ✓ That the building regulations continue to set the minimum standards that apply when building owners elect to do work on existing domestic buildings.
- ✓ That the Scottish Building Standards Agency continue to provide guidance on how to meet the minimum standards that apply to new work on the existing housing stock and should give consideration to joint 'badging' with industry bodies of such material.
- ✓ That, only where there is insufficient material currently provided in the public domain, the Scottish Building Standards Agency should provide additional guidance on energy performance, sustainability and carbon dioxide saving measures to bridge the gap.

Housing: Newton Mearns.



5

Low Carbon Equipment

WE DISCUSSED the various terms used to describe low carbon equipment and agreed that we should consider all the equipment listed as 'low and zero carbon technologies' in Appendix D.

It is clear that, alongside energy efficiency measures, certain types of installations of low carbon equipment should have a part to play in achieving the Scottish Government's targets for reducing carbon dioxide emissions. However having considered evidence from research and from recent experience, we do not consider that the industry is yet sufficiently well developed to justify mandatory requirements in building regulations for low carbon equipment or to require all buildings to become generators of electricity. We also have concerns about the issues identified below.

The cost of energy generation when viewed at the level of individual buildings could be such that it will

tend to discourage development. This is particularly applicable to the provision of affordable housing, where the investment could be significant and the returns are of relatively limited benefit. Some low carbon equipment in housing can make services substantially more complex, more difficult for occupants to understand and more expensive to maintain. Alternatively, investment in reducing the carbon dioxide intensity of the UK energy supply alongside energy efficiency measures in buildings would produce better value, more substantial and reliable production than numerous small-scale, building-integrated technologies.

We are aware that several building-integrated technologies are well established. However, others are relatively immature and are not ready for mainstream use. Indeed, certain of the technologies available are failing to achieve their intended

[Berwickshire Housing Association's solar energised experimental property.](#)



performance when integrated into buildings. We also note the construction industry needs to develop its knowledge and skills base to ensure that installations of low carbon equipment are both safe and productive. This applies particularly when such equipment is added to existing buildings and includes the development of training opportunities for both designers and tradesmen. There is a need for the industry to develop appropriate guidance to developers, clients and designers on the optimal conditions and contra-indications for the use of each technology, both singly and in combination. There should also be guidance for the occupants and managers of buildings on how to use a building in an energy efficient manner, including understanding the relationship of low carbon equipment with other aspects of the building.

The panel appreciates the intention of the last administration in introducing the requirements in Scottish Planning Policy 'Renewable Energy' (SPP6) for on-site low and zero carbon equipment. While this measure aims to reduce carbon dioxide emissions and promote the development of the renewables industry, the installation of low carbon equipment is unlikely to produce cost-effective reductions in carbon dioxide emissions without energy efficiency measures. We therefore consider that as energy standards in building regulations become more demanding it will be necessary to reconsider the role of planning. There is also a need to consider more generally what the respective roles of planning and building standards should be in promoting the development of local energy centres.

It is important to ensure that local energy generation and renewable heat technologies can make a worthwhile and economic contribution to reductions of both energy demand and CO₂ emissions and we have identified work that needs to be done. Such energy generation and local heat technology will be more efficient and effective if it is provided centrally to serve a large development, whether domestic or non-domestic, than if each individual building is required to do this on site. Europe offers many examples of district heat systems and increasing use of combined heat and power (CHP). An important point is that community/district heating works best when the locality has been zoned for district heating only (e.g. as is the case in Copenhagen and other cities where they have made it impossible to 'by-pass' the district heating which assures the firm, long term heating load which is essential for district heating economics.) In particular, we would wish to promote local energy centres in large developments, managed by Energy Service Companies that will use CHP equipment to deliver energy to a local network, avoiding the additional CO₂ and transmission losses of national grid electricity.

We recommend:

- ✓ That the requirement for on-site low and zero carbon equipment should be reviewed and probably removed from Scottish Planning Policy 6 (Renewable Energy) as the very low carbon standards are introduced in 2013.
- ✓ That the energy standards for buildings should only be set at national level under the building regulations.
- ✓ Consideration of the appropriate split of responsibilities for local energy generation between planning and building standards.
- ✓ Research to find ways to encourage low carbon local energy centres for large developments and, where potential exists, in existing stock.
- ✓ Development of guidance on safe and productive installation that is appropriate to designers, installers and the general public.
- ✓ Examination of the building regulations and associated guidance with respect to low carbon equipment, including consideration of the design of buildings for the future installation of certain technologies.
- ✓ Schemes for Approved Certifiers of Construction should be encouraged, so that suitably qualified and experienced tradesmen can certify that installations comply with the building regulations.

6 Process

WE WERE TOLD how the significant changes which came into force on 1st May this year led to a dramatic increase in the number of warrants applied for in March and April as developers ensured that their designs were considered under the outgoing standards. This is unfortunate, especially as some of these applications were not always sufficiently prepared and did not have the necessary details. As warrants for building work are valid for three years from being granted and as the verification process for complex buildings may take some months, we understand that this will mean that some projects applied for in March 2007 could still be under construction to the old (pre 2007) standards in the summer of 2010.

We are concerned that as the standards become even more stringent there will be even greater incentive to developers to apply earlier than usual so as to be able to build to the old standards. This is clearly undesirable and precisely the reverse of what should be encouraged. We are of the opinion that there needs to be incentives for designers to actively adopt the new standards even before they become the legal minimum.

For this to be possible it is important that future standards are published well in advance of them coming into force. It is imperative that if developers are to be encouraged to design to future standards then those are the standards which come into force.

To make it attractive to design to a higher standard, we think consideration should be given to differentiation between the warrant fee scales for work done to the current standards and work done to meet the future standards which are more demanding.

We also considered if a change to the warrant process could be made to prevent buildings being built a long time after the introduction of higher standards. It might be possible to either reduce the length of the warrant or perhaps insist that if work does not begin on site within a short period of the granting of the warrant then it must be built to the newer and more demanding standards.

We recommend:

- ✓ That the future standards should be set in advance (i.e. publish the 2010 standards in 2008 and the 2013 standard at the same time as the 2010 standards become mandatory).
- ✓ Consideration of the introduction of a reduced or zero warrant fee for those designing to the future energy standards in advance of their implementation.
- ✓ Consideration of the duration of warrants and examination of the possibility of requiring a substantial start to be made on site within a fixed period of the date of granting of the warrant.

Scottish Seabird Centre, North Berwick.
Architect: Simpson & Brown Architects.





Compliance

WE FELT that, although setting standards is important, it only achieves benefits if there are robust mechanisms to ensure these standards are being met in the completed buildings.

We are aware that the Scottish building standards system has always been pre-emptive, based on the verification that designs comply with the standards before a warrant is granted and work permitted to start on site. This has worked well where the standards are primarily concerned with health and safety. However, we are concerned that, for issues such as energy and noise, incorrect detailing or poor assembly of components can have a significant impact on overall performance. We believe there is a need for greater certainty during the construction stage. We are of the opinion that it is essential to examine ways of increasing the ability of verifiers to check that the completion certificates presented at the end of the construction process are correct and consistent with the approved design.

We agreed that it is right that the duty to ensure that their building is compliant is placed on the building owner. However, the verifier should play a more investigative role during construction and completion so as to be able to more correctly accept or reject the completion certificate. Although the legislation requires the verifiers to make reasonable enquiry in deciding whether or not to accept this completion certificate, we note that there is no guidance on what constitutes 'reasonable enquiry'. There are also no requirements or guidance for inspection or testing, except for certain levels of airtightness and for sound performance in some circumstances.

We are aware that under the current funding regime only about 25% of the warrant fee is expected to be expended on verifying the completion certificate. It is important to establish if this yields enough income for verifiers to undertake an enhanced role during construction. If not, further resources need to be identified, either by increasing the warrant fee, or shifting the balance from warrant checking to completion certificate verifying.

All the stakeholders have to have ownership of the challenge and there has to be a partnership approach. Research needs to be carried out to understand better why there is a gap between 'as designed', 'as built' and 'as managed', to ensure that not only are buildings designed to the required standard but are also built and operated to those standards paying sufficient attention to detail and quality. In a very low/zero carbon building world, detail and quality will be the make or break factors for actually achieving very low/zero carbon targets.

We recommend:

- ✓ Consideration of the guidance to verifiers on what constitutes 'reasonable enquiry'.
- ✓ Consideration of the role and effectiveness of airtightness testing and the use of thermal imaging.
- ✓ Research to understand better why there is a gap between 'as designed', 'as built' and 'as managed' energy performance.
- ✓ Consideration of the funding of verification work at the completion certificate stage.
- ✓ Encouragement of the development of more schemes for certifiers of construction.

8

Energy Performance of Buildings Directive

ENERGY PERFORMANCE CERTIFICATES (EPCs) will be required by the Energy Performance of Buildings Directive (EPBD) for all buildings when they are constructed, sold or rented out and also for all large public buildings. The panel are divided in their views on the value of EPCs, with some panel members pointing to the extra cost involved and questioning whether the public would actually take notice. On the other hand, some panel members felt that labels do affect the market and cited the labelling of domestic appliances as proof of market transformation. As implementing this EPBD requirement is still at an early stage throughout Europe, it is understandable that this 'value of EPCs' debate took place amongst panel members.

The merits of having a national electronic database for collecting the information that underpins the EPC calculation was discussed. We were advised that such a database, the Home Energy Efficiency Database (HEED) is being extended to accept EPC information on existing dwellings. This is maintained by the Energy Saving Trust and used to promote energy efficiency improvements. However we are aware that there is currently no equivalent database arrangement being made for non-domestic buildings which could be readily accessed by a body such as the Carbon Trust. We suggest that there would be benefit in adopting a parallel approach.

We note that it is possible to go beyond the requirements of the EPBD using the powers currently available however we are aware that there may be an opportunity to include enabling powers within proposed primary legislation, such as the recently announced Scottish Climate Change Bill.

Although we were divided on the ultimate benefits of EPCs, we are agreed that primary legislation should be sought at this stage to allow Scottish Ministers a future opportunity to extend the scope of EPCs. This will be useful when the benefits of certification are proven. We suggest that the powers sought should include: varying the lifespan of EPCs, extending display of EPCs to other classes of building and requiring operational rating EPCs.

We recommend:

- ✓ That primary legislation is sought to allow Scottish Ministers the opportunity to extend the provision and type of Energy Performance Certificates.
- ✓ That a national electronic database is set up for collecting the information that underpins the Energy Performance Certificate calculation for non-domestic buildings.

SNH Headquarters, Inverness.
Architect: Keppie Architects.



9 Costings

THE MEASURES we have discussed could impose considerable constraints on development and we urge that sufficient resources should be made available to assess the potential impact of any of the measures investigated. Members of the panel are pleased to offer the Scottish Government their support in facilitating studies of private sector buildings.

For new buildings, the immediate need is for further analysis of the impact on costs of the requirements proposed for 2010. In particular, there should be an investigation of the impact on affordable housing provided by both registered social landlords and the private sector and on certain types of non-domestic buildings that are important to Scotland's economic and social development (hotels, retail, leisure, light industrial, offices, schools, hospitals etc.) For non-domestic buildings, the modelling should consider the costs of local energy centres. The costings should also cover other sustainability measures that are being considered by current BSAC working parties.

Government and industry need to work in partnership to ensure that costings are realistic. We commend the methodology used in ongoing research for SBSA that uses realistic benchmark buildings and takes advice both from architects on the buildability of measures and from developers on their decision-making processes. Costings should fully reflect the costs of development projects. In addition to modelling exercises, it may also be possible to collate cost information from existing low carbon buildings in Scotland.

Given that energy efficient, low carbon buildings are not mainstream practice anywhere, costings tend to reflect the costs of a relatively small sample of demonstration projects and social housing. We advise that attention should be paid to the methods used in modelling projections for technologies and techniques that are not in mainstream use. There is an assumption that economies of scale will inevitably lower the initial costs of innovative products and demonstration projects, as for electronic products. However we suggest this assumption may not be valid for construction products, building systems or construction techniques.

Different types of business relationships have been developed in response to the challenges to the construction industry set by the Latham and Egan reports in the 1990s, with 'partnering' being an arrangement in which the parties to a contract work towards agreed goals in an atmosphere of trust and openness which will benefit all concerned. Information should also be collated on the impact of procurement practices, including partnering, in the delivery of innovative construction practice.

Our proposed strategy includes other recommendations for both new buildings and existing buildings, which will also require cost benefit analyses.

We recommend:

- ✓ Research to analyse the cost impacts on new buildings of energy standards and other sustainability measures proposed for the building regulations in 2010, including life cycle analysis techniques.
- ✓ Cost benefit analyses are also undertaken of incentives through the building warrant system for building to higher levels of energy performance and of the use of tests for compliance with energy standards.
- ✓ Cost benefit analyses are undertaken of measures to promote the improved energy performance of existing buildings (a duty on owners to assess and improve the condition of their buildings, a requirement for consequential improvements and extended energy certification using operational ratings for non-domestic buildings).
- ✓ Research to analyse cost projections for new technologies and techniques.
- ✓ That all costing research is conducted in partnership with industry, with particular attention paid to the full cost of development projects and the potential impact on construction practice.
- ✓ Opportunities are taken to learn from international partners.

A

Appendix A How the Panel Worked

THE MINISTER for Transport, Infrastructure and Climate Change, Stewart Stevenson MSP, tasked the SBSA with convening a panel to advise on the development of a low carbon buildings strategy to increase energy efficiency and reduce carbon emissions in Scotland. The SBSA met with Scottish Government stakeholders and various organisations, including Friends of the Earth, Energy Action Scotland, WWF and the Sustainable Development Commission Scotland, to identify any issues that should be fed into the panel meeting.

The membership includes the heads of the building regulatory systems from Norway, Austria and Denmark, together with designers, developers, contractors, regulators, researchers and energy specialists, some of whom are members of BSAC. The members are shown in the table opposite.

The panel was supported by officials from the Scottish Government, including the Chief Executive of the Scottish Building Standards Agency and the Head of the Energy and Telecommunications Division.

The panel met in Edinburgh in September 2007. The first session started with a number of presentations by panel members that fed into a series of themed discussions, including presentations by the international members on their systems of energy standards, incentive schemes, and common practice in energy performance. There was also a presentation on the outcome of research commissioned by the SBSA (see Appendix C).

The Minister joined the panel to hear presentations and to lead the start of their detailed deliberations, commencing with a discussion on the long term objectives of low carbon building standards.

During the second session the focus of the discussions were structured around a series of briefing papers and associated questions provided by the SBSA in advance of the meeting. The topics covered by these papers were:

A	Low Carbon Standards
B	Staged Standards
C	Improvement of Energy Standards
D	Scope of Energy Standards
E	Low Carbon Equipment
F	Other Sustainability Standards
G	Continuing Requirements
H	Building Warrant Procedure
I	Consequential Improvements
J	Dangerous and Defective Buildings
K	Compliance
L	Housing
M	Planning
N	Existing Non-domestic Buildings
O	EPBD
P	Guidance published by the SBSA

SBSA officials summarised the panel's responses to the questions on each of the papers. Following the meeting, this report was developed under the leadership of the Chair, with the panel communicating by email.

Member	Role	Organisation
Lynne Sullivan (Chair)	Sustainability Director	Broadway Malyan Architects
Richard Amos*	Building Surveyor	Richard Amos Ltd.
Olav Berge	Director General	National Office of Technology and Administration, Norway
Sue Bush*	Building Standards Manager	Inverclyde Council
Jonathan Fair	Chief Executive	Homes for Scotland
Stephen Garvin*	Building Research Director	Building Research Establishment (BRE), Scotland
Michael Levack	Chief Executive	Scottish Building Federation
Malcolm Macleod	Director	National House Building Council (NHBC), Scotland
Rainer Mikulits	Managing Director	Austrian Institute of Construction and Engineering
Jan Kurt Rendboe	Chairman	Institute of Danish Building Control
Kenneth Ross	Vice-Chair	Scottish Property Federation
Sebastian Tombs	Chief Executive	Architecture and Design Scotland
Mike Thornton	Director, Scotland	Energy Saving Trust
Paul Tuohy	Research Fellow	Energy Systems Research Unit, University of Strathclyde
David Vincent	Director of Technology	Carbon Trust
David Wedderburn*	Solicitor Architect	Chair of BSAC
Bryan Woodley*	Chief Executive	UK Timber Frame Association
* denotes membership of BSAC		

B Appendix B

The Building Standards System in Scotland

THE BUILDING STANDARDS SYSTEM in Scotland is established by the Building (Scotland) Act 2003. The Act gives powers to Scottish Ministers to make building regulations, procedure regulations, fees regulations and other supporting legislation as necessary, to fulfil the purposes of the Act. The purposes include setting building standards and dealing with dangerous and defective buildings. The various regulations are made by Scottish Ministers, but must be approved by the Scottish Parliament before coming into force.

The system is intended to ensure that building work on both new and existing buildings results in buildings that meet reasonable standards. The standards are set out in the building regulations, which are, in the terms of the Act, intended to:

- Secure the health, safety, welfare and convenience of persons in or about buildings and of others who may be affected by buildings or matters connected with buildings.
- Further the conservation of fuel and power.
- Further the achievement of sustainable development.

The building regulations and the supporting guidance documents on how to meet the regulations are subject to scrutiny by the European Commission and the member states of the European Economic Area. This check is intended to ensure that where the regulations and guidance documents use technical specifications to describe materials or constructions, no barriers to trade in construction products are being created. This scrutiny procedure supports the European Construction Products Directive, which requires references to materials and construction methods in our regulations and guidance documents to be made in the terms used in European Standards for products and test methods. (The Directive allows for the 'harmonization' of standards before they must be used. It took ten years or so for member states to agree the first harmonized standards but these are now being regularly produced).

The purpose of the building standards system is to protect the public interest. It is not intended to provide protection to a client in a contract with a builder. The system therefore does not so much control building as set out the essential standards to be met when building work or a conversion takes place, and only to the extent necessary to meet the building regulations.

The system is pre-emptive, designed to check that the proposed building work meets the standards. Inspections during construction and on completion are limited to the minimum necessary to discourage avoidance of the legislation. The inspections do not provide a system to control work on site which is a matter for the contracts and arrangements put in place between the client and builder.

The roles established to operate the system are explained in detail below. The role of checking compliance rests with verifiers and, in prescribed ways, approved certifiers. Enforcement is by local authorities. Updating is by the SBSA, advised by the BSAC, a statutory body established under the Building (Scotland) Act 2003. The agency is an executive agency of the Scottish Government, which means it is an integral part of the government and answers directly to the responsible Scottish Minister.

The SBSA was established in June 2004 to fulfil the duties placed on Scottish Ministers by the 2003 Act. The agency prepares and updates building standards legislation and guidance documents, conducting any necessary research and consulting on changes as the Act requires. The agency, on behalf of Scottish Ministers, gives views to help verifiers make decisions in particular cases and deals with applications to relax standards for particular matters. It also approves verifiers and certifiers of design and construction and checks

how verifiers (including local authorities) and certification scheme providers are operating the system. It will be responsible for implementing Crown building verification when the relevant section of the Act is brought into force (expected to be May 2008). Finally, should it be necessary, Scottish Ministers can, through the agency, take over the verification role of a local authority.

The Building Standards Advisory Committee, established under the previous Scottish Building Act in 1959, has been continued by the 2003 Act, but given a wider remit. It is required to report to Scottish Ministers on aspects of the building standards system that may need attention. It considers developments in the industry, changes in public expectations or particular problems that arise. It must also be consulted on all proposed amendments to legislation or guidance documents. The secretariat to the committee is provided by the agency.

The intention of the committee is to provide expert advice. The members are not selected to represent particular interests, but for the experience and knowledge they can bring to the committee. The selection is made from responses to public advertisement and from nominations sought from a wide variety of bodies interested in the process of building. The expertise selected will reflect the future workload of the agency. An assessor, independent of

the Scottish Government, oversees the process at each stage.

The role of the verifier is to protect the public interest by providing an independent check of applications for building warrants to construct or demolish buildings, to provide services, fittings or equipment in buildings or to convert buildings. Verifiers are appointed by Scottish Ministers.

The Act provides for a variety of verifiers should this be required, but at present the only appointed verifiers are the 32 Scottish local authorities, each covering their own geographical area. It is probable that they will also take on the verifier role for Crown buildings when the Act is applied to them. If Scottish Ministers at some future date decide to appoint private verifiers, the regulations and procedural guidance will be amended.

Scottish Ornithologists Club, Aberlady.
Architect: Simpson & Brown Architects.



It is considered necessary to have an ongoing, independent body to enforce building legislation, with local knowledge and resources. The Act therefore provides for enforcement to be the responsibility of the local authority for the area in which the building work is taking or has taken place. This is the case no matter who has undertaken the verification role and will apply to Crown buildings when the Act is applied to them.

Any local authority choosing to contract out building standards work under the 'best value' regime must consider the technical work involved in enforcement. The local authority must be capable of dealing with the duties in part 3 of the Act relating to compliance and enforcement and in part 4 on defective and dangerous buildings.

The Act establishes a role for suitably qualified people, businesses or other bodies, when appointed by Scottish Ministers, to certify that certain design or construction work complies with the building regulations. Two roles are designated, approved certifiers of design and approved certifiers of construction, both of which certify compliance with the building regulations, as laid down in the scope of the certification scheme run by the scheme provider.

Approved certifiers of design are responsible for specified aspects of the design of buildings such as the structure. If satisfied that the proposed design meets the requirements of the building regulations, an approved certifier of design may issue a certificate for submission with the application for building warrant. Certifiers must have due regard for compliance with the full range of relevant building standards requirements, not just those of immediate relevance to the particular aspect. For instance, design of a central heating and hot water system should take into account requirements for accessibility and for fire separation and acoustic insulation of separating walls and floors as well as those for energy efficiency and hot water storage. At present there are three schemes for approved certifiers of design. The first covers structural design (both domestic and non-domestic) and is run jointly by the Institution of Structural Engineers and the Institution of Civil Engineers. The other two cover energy design, one domestic and the other non-domestic. The domestic energy scheme is offered both by BRE Certification Ltd and RIAS Services Ltd while the non-domestic scheme is only offered by BRE Certification Ltd.

Approved certifiers of construction are responsible for the construction or installation of specified parts of a building, such as the electrical installation. Again, certifiers must have due regard for compliance with the full range of building standards, not just those applicable to the part of the building covered. If satisfied that the construction has been completed in accordance with the building regulations as they applied at the time of the application for the building warrant, an approved certifier of construction may issue a certificate for submission with a completion certificate. At present there is just one scheme of certification of construction which is for electrical installations and is offered both by Scotland's Trade Association for the Electrical, Electronics and Communications Systems Industry (SELECT) and the National Inspection Council for Electrical Installation Contracting (NICEIC).

Certificates (design and construction) are taken as proof of what they purport to cover and the verifier does not check those matters. A verifier must, however, check that the person signing (the approved certifier) is suitably qualified to issue the certificate in relation to the matters certified and that the counter-signing firm (the approved body) is approved to co-ordinate the certification of those aspects. These checks are made using the on-line certification register.

Technical Handbooks give guidance on achieving the standards set in the Building (Scotland) Regulations. The standards themselves can be

found in schedule 5 to regulation 9, and are in the form of 'expanded functional standards'. That is, the standards describe the functions a building should perform, such as 'providing resistance to the spread of fire', and are an expanded and more detailed form of the previous building standards regulations.

The content of the regulations, so far as it relates to technical specifications, is also scrutinised by the European Commission (EC). The EC checks with all the other countries that have adopted the Construction Products Directive (CPD) to ensure that no barriers to trade in construction products are created, either directly or indirectly by the way products are described.

To meet the requirements of the CPD, materials and construction methods must be described by use of suitable European Standards wherever these exist. As there is a rolling programme of change to these National and European Standards the Handbooks have been designed to be readily updated.

The arrangement of the sections within Handbooks relates directly to the Essential Requirements of the CPD (as published by the EC), which construction works are expected to satisfy when they have been properly designed and built. The arrangement is as follows:

Section 1	Structure	(EC - Mechanical resistance and stability)
Section 2	Fire	(EC - Safety in case of fire)
Section 3	Environment	(EC - Hygiene, health and the environment)
Section 4	Safety	(EC - Safety in use)
Section 5	Noise	(EC - Protection against noise)
Section 6	Energy	(EC - Energy economy and heat retention).

The regulations are mandatory, but the choice of how to comply lies with the building owner. The Technical Handbooks are issued by Scottish Ministers, through the SBSA for the purpose of providing practical guidance with respect to the building regulations. If the guidance is followed in full then this should be accepted by the verifier as indicating that the building regulations have been complied with. However it is quite acceptable to use alternative methods of compliance provided they fully satisfy the regulations.

Failure to comply with the Technical Handbook does not render a person liable to civil or criminal procedures, but proof of compliance with the guidance may be relied on in any proceedings as tending to negative liability for an alleged contravention of the building regulations. Following the advice in the Technical Handbooks is therefore likely to be the normal way of complying with the building regulations. However a designer may put forward other ways of meeting the regulations in the form of alternative solutions.

The use of expanded functional standards, backed up by detailed guidance, provides a flexible system of control. Consideration of alternative solutions is assisted by the expansion of the functional standards previously used in the building standards regulations to clarify the necessary properties of each building. The need for a formal relaxation of standards is reduced as meeting the full details of given solutions is no longer mandatory. The professional judgement of the verifier, assisted by guidance on questions referred to Scottish Ministers, through the SBSA, decides whether a standard is met. In considering alternative solutions, however, it is necessary to have regard to the details of this guidance. Where performance standards or policy statements are given, every part of the solution is expected to meet them.



Appendix C

Research Summaries

The impact on costs and construction practice in Scotland of any further limitation of CO₂ emissions from new buildings

<http://www.sbsa.gov.uk/research/co2emissions.htm>

Research team:

- Turner & Townsend Management Solutions Limited
- Holmes Partnership
- Energy Systems Research Unit (ESRU), University of Strathclyde;
- Cala Homes.

THIS PROJECT sought to determine the impact on the costs of new buildings and on Scottish construction practice of any further limitation of CO₂ emissions beyond energy Standard 6.1 of the Scottish building regulations and the guidance given in the associated Technical Handbooks 2007. The project developed three benchmark buildings designed to comply with the standards and guidance, estimated their capital cost, identified potential improvement strategies, selected scenarios to reduce the target emissions rate (TER) by between 20% and 75%, and analysed the cost and construction implications of the scenarios. The designs for the benchmark buildings were developed from examples provided by Cala Homes and Holmes Partnership: a 100m² timber frame detached house, an 80m² masonry mid floor flat, and a 1000m² steel frame office building, each using gas for central heating and hot water.

The project identified strategies to improve the performance of the building fabric and to further reduce CO₂ emissions through the use of low carbon technologies. The improvement scenarios that were

chosen and costed should be seen as representative of both what is achievable and is likely to be adopted by developers. Except for the 20% improvement for the offices, each scenario included the improvement of fabric insulation and air-tightness to either an intermediate level, or to an advanced level that would require mechanical ventilation.

The improvement scenarios and additional capital construction costs are shown opposite. The project did not take account of the additional requirement in Scottish Planning Policy 6 for on-site low and zero carbon equipment. On-costs of up to less than 10% would allow reductions of 30% for the house and flat, or 50% for the office.

Insulation U-values (W/m ² K)	Intermediate level			Advanced level		
	House	Flat	Office	House	Flat	Office
walls	0.15	0.15	0.15	0.10	0.10	0.10
ground floor	0.15	0.15	0.15	0.10	0.10	0.10
roof	0.10	0.10	0.15	0.10	0.10	0.10
windows	1.4	1.0	1.4	0.80	0.80	1.0
doors	1.4	1.0	1.4	0.80	0.80	1.0
Airtightness (m ³ /m ² /h @ 50 Pa.)	5			1		

A summary table from the interim report presented to the expert panel of all strategies employed to meet the various targets for each building type.

Target Emissions Rate (TER) based on Technical Handbooks 2007 (TH07)																
Improvements	TER TH07 20%			TER TH07 30%				TER TH07 50%				TER TH07 75%				
	House	Flat	Office	House		Flat		Office	House		Flat		Office	House	Flat	Office
				i	ii	i	ii		i	ii	i	ii				
Insulation and airtightness: intermediate	●	●		●		●		●				●				
Insulation and airtightness: advanced					●		●					●		●		●
100% low energy lamps	●	●		●	●	●	●		●	●	●	●	●	●	●	●
Underfloor heat distribution				●									●			
Ground source heat pump									●		●					
Solar water heating system				●		●									●	
Mechanical ventilation with heat recovery			●		●		●	●						●	●	●
Biomass													●		●	●
Photovoltaics															●	●
On-cost %	2.8	3.6	2.7	9.8	10.4	8.0	9.3	4.5	23.7	14.5	22.9	17.5	8.8	23.0	36.0	12.4

International comparison of energy standards in building regulations: Denmark, Finland, Norway, Scotland, and Sweden

http://www.sbsa.gov.uk/research/research_projects.htm#56

Research team:

- Building Research Establishment, East Kilbride
- Statens Byggeforskningsinstitut (Danish Building Research Institute)
- VTT Building and Transport (Technical Research Centre of Finland)
- Statens Bygningstekniske Etat (Norwegian National Office of Building Technology and Administration)
- Projektengagemang on behalf of Boverket (Swedish Board of Physical Planning and Building).

Housing, Wellington Street, Stromness.
Architect: Pentarq.

A BENCHMARK HOUSE, which complies with the 2007 Scottish energy standards, was evaluated by each of the Nordic partners against their own energy standards and using their own calculation methodologies. BRE used their analyses to make a comparison of energy standards in Scotland with those in Denmark, Sweden, Norway and Finland. The panel was provided with the full report.

The house does not meet the requirements in any of the other countries considered. The main reason is concerned with differences in climate between Scotland and the other countries, all of which are appreciably colder in winter.

It is not possible to compare the energy standards of Scotland and the Nordic countries directly because of differences in what is included, particularly as regards energy use for electrical appliances and because of different inherent assumptions in the calculation methods as regards occupancy, hot water use and other factors. Despite these differences, it is clear that all the Nordic countries



have energy standards which would usually necessitate U-values that are substantially lower (more demanding) than those used in the benchmark dwelling and provide for appreciably higher internal temperatures to be maintained whilst the external temperatures are much lower.

The calculation methods are broadly similar in all the countries including Scotland. There are many differences of detail, such as assumptions for occupancy, internal heat gains, treatment of thermal bridging, treatment of solar gain, etc. but all follow the principles set out in the applicable European standards. Factors taken into account are, on the basis of the information supplied, essentially the same in all the calculation methods.

When the assumptions used in the UK calculation method, SAP 2005, are adjusted for the climate and internal temperature conditions that apply in

each country, the calculation of energy required for space heating is much more comparable with the methods used in the country concerned. Residual differences are likely to be connected mainly with differences in assumptions on occupancy etc. that are built into the calculation methods. The principal differences therefore lie in the specifications of U-values and airtightness for a house that would comply in the Nordic countries compared with the benchmark dwelling.

The findings provide an indication of the scale of effect on CO₂ emissions of adopting U-values that would typically be used to achieve compliance for the benchmark house with the Nordic energy standards. If the Swedish levels of U-values were to be adopted in the Scottish benchmark dwelling the space heating needs could be reduced by 23% and the total CO₂ emissions from the benchmark dwelling could be reduced by 13%. Adopting the airtightness standards used in Norway and Denmark, together with an efficient mechanical ventilation system with heat recovery to avoid condensation damage, could increase the reduction in CO₂ emissions to 19%.

Paton House, Montrose.
Architect: Neil Sutherland Architects.



D

Appendix D Low Carbon Equipment: Terminology

Definitions	
Micro-renewables	On-site or building integrated equipment using renewable sources only.
Micro-generation	On-site or building integrated equipment that generates electricity, but could include fossil fuels.
Low and zero carbon technologies	Development-wide, on site, or building integrated technologies that use renewable sources or fossil fuels (low CO ₂ emissions), or use only renewable sources (zero CO ₂ emissions).



Slateford Housing,
Edinburgh.
Architect:
Hackland & Dore
Architects

Categorisation of low carbon equipment	Micro-renewables	Micro-generation	Low and zero carbon technologies
Micro-wind with grid connection, battery storage or used to heat water	Yes	Yes	Yes
Solar photovoltaics	Yes	Yes	Yes
Micro-hydro with grid connection, battery storage or used to heat water	Yes	Yes	Yes
Solar thermal system to supply hot water (or space heating)	Yes ⁽¹⁾		Yes
Ground / geo-thermal / air / water source heat pump	Yes/no ⁽²⁾		Yes
Biomass boiler or stove	Yes/no ⁽³⁾		Yes
Heat exchange/recovery systems, (MVHR)			Yes
Fuel cells with grid connection, battery storage or used to heat water	Yes/no ⁽⁴⁾	Yes	Yes
Community heat and power (CHP) or micro CHP using fossil fuels (gas, oil, coal)		Yes	Yes
CHP or micro CHP using renewable sources	Yes/no ^(3, 5, 6)	Yes	Yes
CHP using organic waste, other waste	Yes	Yes	Yes

Notes

There are certain circumstances in which an otherwise renewable and energy efficient technology cannot be described as a micro-renewable.

To be described as a truly renewable technology:

- (1) solar thermal systems need to have the pump powered by a renewable source of electricity such as wind, hydro, or photovoltaics; however, the energy demand for the pump is relatively small and it is reasonable to count all solar thermal systems as a renewable, if not a zero carbon technology;
- (2) heat pumps need to be powered by a renewable source of electricity such as wind, hydro or photovoltaics; however heat pumps powered from grid electricity will become a more renewable technology as the carbon intensity of the grid is reduced;
- (3) biomass boilers and stoves, and CHP using 'renewable' sources need to use woody biomass that is locally sourced;
- (4) fuel cells should use a renewable source of electricity, not a fossil fuel;
- (5) CHP or micro CHP using waste heat from industrial processes need to use waste heat that is not derived from a carbon intensive fuel;
- (6) CHP using 'renewable' sources should not use biofuels unless if their growth is sustainable.



Appendix E

Glossary of Acronyms

- BRE – Building Research Establishment
- BSAC – Building Standards Advisory Committee
- CHP – Community Heat and Power
- CPD – Construction Products Directive
- EC – European Commission
- EPCs – Energy Performance Certificates
- EPBD – Energy Performance of Buildings Directive
- MVHR – Mechanical Ventilation with Heat Recovery
- SAP 2005 – Standard Assessment Procedure for Energy Performance
- SBSA – Scottish Building Standards Agency
- SPP6 – Scottish Planning Policy (Renewable Energy)
- TER – Target Emissions Rate

