Sustainable Construction and the Regulatory Framework – A Thinkpiece

Gaia Research
Edinburgh

in association with

Ecological Design Group
School of Architecture
University of Dundee

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Gaia Research
The Monastery
Hart Street Lane
Edinburgh
Scotland
EH1 3RG

Summary

Primary legislation, the Building (Scotland) Act 2003, makes the furtherance of sustainable development a new underpinning requirement.

In recognition of a broadening of the regulatory backdrop, this thinkpiece appraises current building legislation in Scotland and abroad as it affects the adoption and practice of sustainable construction techniques. The overall aim is to identify how building regulations might encourage sustainable construction.

There is a need to identify, embrace and promote those mechanisms that have allowed best practice to be delivered in Scotland such that it can become more typical of practice. Clients, designers and building occupants, as well as manufacturing industry, throughout Scotland can then reap the benefits.

The principal outputs are the identification of areas where the regulations could be expanded to take fuller account of the requirements of sustainable development, and policy recommendations for amendments to the standards. Attention is also drawn to the necessity for appropriate institutional structures between planning, environmental health departments and the building standards agency to be put in place in order to commission appropriate research, respond to findings and develop the policy that promotes these requirements.

The research work was procured when the Building (Scotland) Act 2003 was being drafted. This presented both problems and opportunities. Not least because, as a backdrop to the Bill, work is also currently being undertaken by the Executive that will result in the translation of technical standards (secondary legislation) into expanded functional standards by 2005 - with guidance material on performance requirements and prescriptive specifications. The change is significant. It will result in standards based on the six essential requirements derived from the European Construction Products Directive (CPD). These will replace the previous building regulatory requirements.

There was inevitably a lack of clarity in relation to the status and relevance of the existing framework and of the Technical Standards. However there was

also the opportunity for appropriate and timely inputs to aid development of an overall regulatory framework within which sustainable development can be encouraged. This could mean developing a strategic framework for sustainable construction going alongside a simple transposition of the current Technical Standards into new Functional Standards and Guidance and.

A significant issue in relation to sustainable construction is the inertia that has been apparent in dealing with potential and presumed threats. In respect of specific environmental threats, global warming was predicted in the 19^{th}C and the chemistry of ozone depletion resulting from CFC's was well known in adequate time to prevent much subsequent damage. Similar examples can be cited for social and economic aspects of sustainable construction, as well as environmental hazards. In an attempt to facilitate some degree of future proofing, and appropriate response provision within the Building Regulations, it has been necessary to identify those "pull" factors that will influence the Building Regulations and associated standards and guidance in relation to sustainable construction and contribute to determining the future direction of the building regulatory process. The issues are diverse and encompass international requirements, human needs and responsibilities, and technological change. They include climate change, resource conservation, waste minimisation, biodiversity and health & well-being of individuals and communities in and around buildings.

An extensive survey has considered Building Regulations in European countries, the USA, Canada, New Zealand and Australia and best practice in these countries in terms of addressing these "pull" factors to promote sustainable construction. The diversity of international standards, issues and requirements (as well as sub-clauses and context) does not allow their comparison 'at a glance'. Even common areas such as energy standards prove too diverse for simple tabulation. However, the survey revealed a number of specific, useful and replicable measures that should be adopted in the short term by the Buildings Standards Agency in order to promote sustainable construction at the design stage and throughout the lifetime of the building stock. Particular attention is drawn to regulation and practice in Norway, Sweden, Denmark, Germany and the Netherlands which appear to be significantly advanced in this area compared to the UK.

A sustainable construction industry cannot be seen in isolation from supply, construction processes and manufacturing. Neither can it be divorced from the proper management and maintenance of buildings in use and continual improvement over time. Sustainable construction should be seen as a process rather than a product delivered at handover. The need to manage the built environment as a process, rather than simply manage buildings as products will necessitate a step change in the way in which functional and performance standards are developed. Regulations must take a comprehensive approach to dealing with cradle to grave issues including the construction process, indoor climate and building hygiene.

A strategic approach to encapsulating the requirements of sustainable construction has been necessary and sustainability indicators, as documented in current government guidance, previous research and best practice have provided a framework. These have been compared and then distilled into a comprehensive list. This demonstrates a degree of consensus and overlap in the currently used parameters for defining sustainable construction in relation to sustainable development.

It has long been apparent that the Current Regulatory Framework in Scotland suffers from inadequacies at the boundaries of the responsibilities of its composite agencies and inevitably policy and development aspirations lead to conflicts and overlap. An ideal situation may be unachievable, but few would argue that no improvement was possible. The sustainable development agenda in particular has already brought many important issues and conflicts to the fore particularly in respect of planning and land use where better liaison would be advantageous. We anticipate that further such conflicts are inevitable in relation to issues such as waste streams, manufacturing, health and social justice. The current regulatory framework in Scotland has therefore been explored to identify areas for expansion and integration that can result in closing those gaps that adversely affecting the ability to deliver sustainable construction. This encompasses:

- the present status of sustainable development in the EU, UK and Scotland
- recent initiatives on the part of the Executive
- other non-regulatory initiatives
- incentives and obligations including best practice within the public sector

- best practice offered by other countries' construction regulations.

The interplay and overlap between the various Scottish regulatory systems, and those key players who influence policy and regulation in relation to sustainable construction, are identified and explored in order to identify the scope for integration to promote sustainable construction.

Research on sustainable development in relation to specific areas such as sustainable construction would benefit in future from being commissioned jointly by the relevant Scottish Executive departments rather than on an individual basis.

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Part 1: Introduction

1.1 Scope of the Building Regulations

The fundamental purpose of building control was originally the protection of the public interest with regard to health and safety. The scope has been extended over the years to include the welfare of people in and around buildings and furthering the conservation of fuel and power.

Primary legislation, the Building (Scotland) Act 2003, passed by the Scottish Parliament made the furtherance of sustainable development an underpinning requirement.

The Executive considered it timely to undertake a review to investigate the extent to which the regulatory framework, and other mechanisms, could be effectively applied in order to take cognisance of the emergence of sustainable development as a fundamental requirement. It was envisaged that more attention would be required to be given towards healthy buildings and environments, social inclusion, economic factors and to a more widespread understanding of protection of the environment than has been the case until now. A wide range of factors needed examination within the context of manufacture, briefing, design and planning policy.

1.2 Brief

In recognition of a broadening of the regulatory backdrop, the Scottish Executive funded a research project to appraise current building legislation as it affects the adoption and practice of sustainable construction techniques. The overall aim of this research was to identify how building regulations might encourage sustainable construction.

The objectives of the research were

- to undertake a literature review of existing publications and

- to examine current regulations and identify areas that could be expanded to include sustainable development and to recommend how these existing standards can be amended, including worked examples using text from the new Technical Standards.

1.3 Main issues

Sustainability, as presently defined by government initiatives, challenges industry to produce higher levels of output, while enhancing the quality of life for employees and other stakeholders, using lower levels of input and generating less waste & pollution. This is intended to ensure that a non-declining stock of capital assets, including environmental assets, exists to meet the needs of industry, individual consumers & society in the future.

Sustainable construction requires the integration of social, environmental and economic factors so as to ensure a healthy, affordable, efficient and joyous built environment. It requires designing buildings and built environments which:

* Enhance living, leisure and work environments;
* Support communities;
* Are affordable, manageable and maintainable in use;
* Do not endanger the health of the occupants, or others, through exposure to pollutants, the use of toxic materials or providing host environments to harmful organisms;
* Do not cause damage to the natural environment or consume a disproportionate amount of resources, including land, during construction, use or disposal;
* Do not cause unnecessary waste of energy, water or materials due to short life, poor design, inefficiency or less than ideal construction and manufacturing procedures of components;
* Minimise dependence on polluting forms of transport;
* Do not use materials from threatened species/environments.

Action at different levels is required:

- At *national and international* levels, developments in agreements, legislation and regulation are needed to promote biodiversity, intra-generational & inter-generational responsibility and social equity.

- At a *business level,* organisations need to motivate changes in patterns of behaviour that fully respect that achieving sustainability requires us to live within the earth's capacity to provide the materials for our activities and to absorb the waste and pollution that these activities generate.

- At an *industry level,* research, development and implementation of product and manufacturing and construction eco-efficiency is needed to reduce waste and eliminate toxins.

- At a *professional level,* more joined up thinking between disciplines and full attention to design quality and user needs.

- At the *societal* level, people and communities need to be more thoroughly engaged in procurement, management and design of their environments and also perhaps to alter their habits and expectations.

All of these levels need to be addressed to encourage clients, designers and building occupants, as well as manufacturing industry throughout Scotland to adopt best practice and thereby to help it to become more typical of practice, rather than exceptional. All concerned could reap substantial benefit.

Part 2: Pull Factors in Sustainable Development Affecting Guidance

2.1 Introduction

This part of the report focuses on various "pull" factors, which, it is anticipated, will influence the Building Regulations and associated standards and guidance in the next 20 years in relation to sustainable construction issues. The factors are predicated on emerging scenarios related to physical, social and economic changes that are taking place in Scotland. A number of these factors have already been anticipated by advanced building regulatory practice in other countries.

Each "pull" factor is considered in relation to the Building (Scotland) Act 2003 and the scope for modification of standards and guidance relating to the building regulations that may be required, either under Parts 1-6 or Schedule 1 of the Act.

Potential modifications are identified in terms of whether the standards and guidance will require amendment or additions. Where there are structural implications involving the regulations relating to different divisions or agencies associated with the Scottish Executive, this is also identified.

Table 1 summarises the "pull" factors in relation to the proposed building regulations, sustainable development indicators, and timescales for consideration.

Table 1: "Pull" Factors in relation to Building Regulations, Sustainable Development Indicators and Timescales			
"Pull" Factors identified	Sustainable Development Indicators in "Meeting the Needs" (or others)	Building (Scotland) Act 2003 Regulations Schedule 1 areas affected or other areas	Timescale for consideration Standards to be considered
Water Use	(rate of water use)	5(2)(m) services, fittings and equipment 5(2)(i) drainage	Immediate –performance standards
Climate Change: • Flooding Insurance Premiums • Lack of cover for flooding	(water conservation)	5(2) (d) resistance to moisture and decay 5(2) (p) access, including in particular access for disabled persons 5(2) (i) drainage Cross-reference to SEPA flooding guidance	Immediate –prescriptive standards
Climate Change: • Storm damage Insurance Premiums • Ground heave	(water conservation)	5(2) (b) strength and stability 5(2) (d) resistance to moisture and decay	Immediate –performance and prescriptive standards
Climate Change: Carbon emissions targets and energy use: • upgrading existing building stock • embodied energy and carbon emissions • primary energy use • power use • updateable energy standards • energy consumption per	Climate Change Energy:consumed Energy:renewable	5(2) (e) resistance to transmission of heat 5(2) (l) heating and artificial lighting 5(2)(m) services, fittings and equipment 5(2)(g)durability	Short term- performance standards, prescriptive standards and guidance

building • low energy domestic lighting • future proofing energy supplies Supply Chain • Embodied energy Maintenance • tracking carbon emissions			
Climate Change: Temperature change: • low energy ventilation strategies	Climate Change Energy:consumed	5(2) (j) ventilation	Medium term- performance standards and guidance
Waste Minimisation • "zero waste" buildings • buildings as a service not product • design for deconstruction • waste exchange databases • re-used and recycled materials "Whole life" regulations and life cycle analysis Electronic tagging of building products	Waste production Waste recycling Waste landfill	5(2)(s) re-use of building materials Cross-reference to SEPA waste plans 2003	Medium term-performance standards, guidance
"Whole life" regulations and life cycle analysis	Health (not for animals)	5(2)(n) measures affecting emissions 5(2)(l) heating and artificial lighting	Medium term-performance standards

Lighting • Daylighting and full spectrum lighting • User control of lighting Maintenance • ability to clean equipment • "MOT" inspections Indoor Air Quality • Monitoring Building Related Ill Health • Lower VOC emissions Demographic-vulnerable groups		5(2)(m) services, fittings and equipment Cross-reference to environmental health requirements	
"Whole life" regulations and life cycle analysis	Air quality	5(2)(n) measures affecting emissions	Long term –functional standards, performance standards
"Whole life" regulations and life cycle analysis	Water quality	5(2)(n) measures affecting emissions	Long term –functional standards, performance standards
"Whole life" regulations and life cycle analysis	(soil pollution)	5(2)(n) measures affecting emissions	Long term –functional standards, performance standards
•			
Biodiversity and Ecotoxity • "final destination" biodegradeability • protection of flora and fauna from construction effluents	10. Biodiversity	5(2)(a)preparation of sites Cross-reference to planning requirements, SNH biodiversity audits Guidance on non ecotoxic materials	Long term-performance standards and guidance
Finite Resource Use	(finite resource use)	No obvious area in Schedule 1	Long term –functional standards and

• Threatened supplies		Cross-reference to planning requirements, SNH resource audits Guidance on non threatened materials	guidance
Use of Local Materials • Environmental accounting Supply Chain • Local materials • Embodied energy • Mass Balance flows • Certification of sustainable sourcing of materials	Travel -industry	No obvious area in Schedule 1 Cross-reference to planning requirements Guidance on embodied energy Guidance on certification of sustainable sourcing	Long term –functional standards, performance standards and guidance

2.2 Climate Change

There is an increasing need to be proactive on issues relating to climate change, particularly in respect of detailing to withstand storm –damage, flooding, mitigation of temperature rises and significant reduction of carbon emissions from buildings.

2.2.1 Storm damage-robust detailing

Although initial research has been carried out by BRE (Scotlab) on the consequences of climate change for detailing on buildings this has not culminated in any substantive policy or guidance to date. Robust detailing against storm damage will need to include:

- stronger roof fixings and barriers to moisture (abandoning the English practice of using battens rather than sarking under roof finishes)
- robust detailing to avoid horizontal rain penetration
- increased gutter and downpipe sizing for stormwater
- increased structural loading for wind uplift
- designing roofing to aid flood management
- designing for increased surface water run off.

Building performance standards would need to take account of this through amended CE/BS standards. There will also need to be guidance on strength and stability as well as moisture penetration in relation to climate change under regulations 5(2) (b) and (d), and it may be necessary to introduce some prescriptive guidance for smaller buildings.

2.2.2 Flooding

Recent research indicates that substantial areas of Scotland are liable to be flooded to a much greater extent over the next century with an anticipated rise in sea-level of 20cm by 2050 and a 20-40% increase in rainfall by 2100.[1]

It will be necessary to introduce prescriptive standards and guidance under the Building (Scotland) Act 2003, Schedule 1, regulation 5(2)(d) detailing resistance to flooding, extending the current requirement to resist moisture ingress.

This would involve the applicant determining if the building concerned is within a flood zone, according to maps now provided by SEPA, and if so what measures need to be taken. Guidance in the standards would need to cover moisture ingress from the ground as well as potential water ingress through walling due to predicted raised water levels. A greater degree of co-ordination is required here between SEPA, the relevant Planning Division and the Building Standards Division to define this guidance.

2.2.3 Temperature change

The current assumption is that the rise in temperature that has already occurred over the last century is set to continue and this is predicted to result, in the short to medium term, in warmer summers and wetter, warmer winters in the long term.[2] This will have an effect on energy use in buildings and may promote increased use of mechanical cooling and air-conditioning to deal with the internal heat loads, unless there is legislation to avoid this.[3] Norwegian regulations currently restrict the use of mechanical cooling, which can only be installed where other passive and low energy cooling measures cannot maintain satisfactory conditions. There is now substantial design guidance that could underpin appropriate regulation.

With the pressure on energy efficiency increasing, mechanical cooling and air-conditioning will need to be replaced by passive design, shading, displacement ventilation, thermal mass and heat sinks in the earth where possible.

These technologies will need to be incorporated into the building performance standards and guidance under regulations 5(2) (e)(j) and (l) with a policy that favours passive use of energy in tandem with intelligent fabric, form and microclimate strategies.

It is not possible to predict the effects of climate change on the Scottish climate in the long term. One scenario predicted is that changes that lead to alterations to the Gulf stream would lead to a sudden cold drop in temperatures and bring the UK in line with the Scandinavian climate. It would be prudent for building

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[1] Hulme, M. Crossley, J. and Lu, X. (2001) *An Exploration of Regional Climate Change Scenarios for Scotland* Scottish Executive CRU, 2001
[2] Hume, Crossley, Lu, 2001

standards to provide for low energy strategies for a range of possible eventualities relating to climate change, including the possibility of cooling as well as heating.

New techniques are emerging that apply passive and low energy ventilation techniques such as dynamic insulation, which can reduce carbon emissions from ventilation systems. Norwegian regulations currently place an energy limit on ventilation while at the same time paying attention to embodied pollution in materials such as VOCs. Guidance is available to underpin new standards.

Functional standards and guidance under regulation 5(2)(j) will need to reflect a presumption towards low-energy use ventilation systems working in tandem with the appropriately specified building fabric.

2.2.4 Carbon Emissions Targets and Energy Use

The UK government has committed itself to a 60% cut in carbon emissions by 2050 with an aim to achieve 20% renewable energy supply by 2020.[4] Both of these measures will have a profound effect on the building industry, as buildings are responsible for nearly half of all carbon emissions in the UK. The targets will drive even higher energy conservation targets as well as embodied energy efficiency gains in resource use, and encourage opportunities to better implement renewable energy strategies.

In terms of the Building (Scotland) Act 2003, these 'pull' factors will add weight to the call for the urgent retrospective general upgrading of existing buildings for energy efficiency where alterations or extensions are applied for.[5] "Given the incoming requirement under the EU Directive on Energy Performance of Buildings to certify the energy performance of all buildings, commercial and residential, new and old by 2006, certification at point of sale might also provide an ideal opportunity to instigate further upgrading as it is identified.[6].

MOT" type inspections to ensure that existing stock is rapidly brought up to current energy standards will need to be instigated under regulations 5(2)(e) and (l), as in German regulations (see Part 4 of this study), coupled with financial incentives.

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[3] EPSRC, 2003, "Building Knowledge for Changing Climate: the impacts of climate change on the built environment"- a research agenda, EPSRC p.13
[4] DTI White Paper on Energy dated 24th February 2003
[5] *Improving Building Standards: Proposals: A Consultation Paper* 2002 Scottish Executive.

A change in performance standards will also be required to achieve the 60% reduction in Carbon Emissions proposed. Primary energy is a more effective measure of sustainability than end use energy alone, particularly if decoupled from the renewable energy contributions as in Holland. Current regulatory performance standards for energy conservation in Scotland are still below several countries in Europe (Germany, Norway).

This will require a further tightening of energy calculations in performance standards under regulation 5(2)(e), which at present does not take account of primary energy use and the difference between using gas or electricity.

The Netherlands Regulations use one of the most advanced energy efficiency indicators in the world, the Energy Performance Co-efficient (EPC). It takes into account a wide variety of factors based on primary energy consumption and aims towards energy neutral buildings over time (see Part 4).

The Dutch EPC provides a simple means of quick update as standards demand and offers an excellent model for Scottish performance standards to adopt under regulation 5(2)(e).

Additional consideration will also have to be given to embodied energy and carbon emissions in construction materials, particularly as operational energy use diminishes and embodied energy becomes an increasing component of total energy consumption. Norwegian regulations already stipulate the need to take embodied energy into account. It will be necessary, however, to ensure that a relatively robust database is obtained on embodied energy before this is instigated.

Performance standards and guidance will need to address a complete lifecycle approach to the building under regulation 5(2)(s).

Given the uncertainty over future energy supplies and the proposed transition to renewable energy where possible, it will be necessary for the Executive to consider "future proofing" new buildings against changing energy supplies. Swedish building regulations already demand that heating systems are designed to facilitate changing the heating fuel.

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[6] National Energy Services (2003) *Selling the SAP*

Performance standards and guidance under regulation 5(2)(l) will need to address the requirement for heating systems to be able to switch energy supplies.

Power demand and delivery itself will become increasingly important as part of an overall strategy to reduce energy use. The actual amount of power delivered to buildings can have a significant effect on energy losses in terms of standby and transmission losses. Sweden is attempting to reduce the amount of power used in its buildings and Danish regulations also have requirements that aim to limit power.

Performance standards and guidance under regulations 5(2) (l) and (m) in Scotland will need to seriously address power requirements in addition to energy requirements in new dwellings and buildings.

In the future, it will be more important to measure the total amount of power a building demands and the energy a building consumes rather than simply the amount of energy consumed per square metre. This will put the onus on the efficient use of space and infrastructure as well as the efficient use of energy.

Energy use in the UK is actually going up, in part due the rising use of electrical and electronic appliances and changing demographics. This is leading to an increasing mismatch between space standards for single people and small families, which are increasing, and energy conservation standards. Further research should investigate this area in relation to the building regulations as a possible "pull" factor.[7]

2.3 Use of Local Materials

A key factor in "Meeting the Needs" is the reduction of transportation of goods. This applies to construction materials, given that as much energy is spent on moving them around the country as in manufacturing them in the first place.[8] This is also allied to a commitment by the Scottish Executive in the same document to "promote and reward methods of production which reduce resource and energy use and which minimise pollution". If transportation of goods can be minimised, this will also help address resource and pollution issues. There is a very real trade off between the environmental harm caused through the transportation of

[7] Berge, B. and Roalkvam, D (2003) Draft only
[8] Building a Better Quality of Life, 2000, p.17

materials and the harm caused by their production, which should be targeted by the regulations.

Promoting sustainable development through the regulated use of appropriate construction materials in the Building Regulations cannot be divorced from doing the same in Planning Regulations. The two areas are highly interlinked. An example of this can be seen in relation to sustainable sourcing of construction materials. In the Moray Local Plan for example, there is a requirement for developers to use construction materials sustainably, with a preference for local and low embodied energy materials.[9]

The Building Regulations and Planning Regulations could relate to each other on this issue with cross-referencing between them, to ensure that a developer cannot gain planning permission or a building warrant without reference to the requirement for the sourcing of local materials where possible.

A central tenet of the EU is a strengthening of regional economies and cultures as reflected in Agenda 21. At the same time, there is a drive towards harmonisation, through directives such as the CPD, to create a free-market for trading throughout the EU. There are contradictions between these two positions at times, particularly when a region attempts to promote and protect its indigenous products and local economies, and where sustainable development favours local use. EU directives insist on the right of substitution for any product that is "equal" as demonstrated by CE, or other standards, for construction projects over a certain size unless an exceptional case can be made on the basis of preserving local culture.

At present there are no regulations in the EU that make reference to the locality of materials, and it is recommended that further research and evaluation is carried out on this issue given the potential conflicts with CPD legislation.

From a sustainability point of view, there will be an increasing "pull" towards using locally manufactured products economically, as environmental accounting becomes the norm for construction products. Nevertheless, taxation alone cannot ensure that due cognisance is taken of using local materials, and it may be that this is an area for legislation in the future.

[9] Moray Local Plan, 2000, *New Building Design*, Policy No. l/IMP3 iv) Materials

2.4 Supply Chain

In "Meeting the Needs", the Executive states that it will **"insist on knowing where our raw materials came from and how their replenishment has been ensured".**

Within the next 20 years, data should improve considerably allowing specifiers to ascertain the exact provenance of construction materials as well as their environmental impact. Some regions have already begun to supply data on resource flow audits, which allow the environmental impact of construction materials to be assessed within a given region.[10]

The recently commissioned Scottish Mass Balance project will begin to address the data required for Scotland in order to promote a sustainable resource flow system.[11] It should be possible in future for applicants to use this data to demonstrate that the building process has been examined through its lifecycle. Guidance will need to be developed by SNH and others, to which the building regulations could then refer.

Supply chain management is anticipated to improve considerably within 20 years and it will be easier to certify building materials and products using sustainable sourcing schemes such as those pioneered by the Forestry Stewardship Council (FSC). Certification will be available for a much wider range of products and materials and could become a requirement of the Building Regulations through its functional standards and through reference to relevant guidance.

2.5 Biodiversity and Eco-toxicity

Together with resource use, the promotion of biodiversity is a key requisite of sustainable development as set out in "Meeting the Needs". The Scottish Executive is clearly aware of the importance of biodiversity yet this a neglected area in relation to sustainable construction at present, largely due to the lack of interdepartmental strategy and reporting as well as lack of data on environmental impact.

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[10] www.art.man.ac.uk/PLANNING/cure/research lists various initiatives on Mass Balance and Sustainability Indicators. See also, National Centre for Business and Sustainability, 2003 "Rocks to Rubble: Building a Sustainable Region" which analyses physical resource flows in the North West region.

[11] *Mass Balance of Scotland; Resource Flow and Ecological Footprint Analyses of Scotland* 30 month project commissioned in 2002 by Scottish Executive, WWF, SEPA, SNH as referred to in SEPA, 2003, National Waste Strategy.

Without biodiversity, the gene pool is reduced, species protection is decreased and the ability for the planet to adjust its ecosystems effectively and without major upheaval is impaired. This can lead to exponential failure of natural systems, which in turn can jeopardise higher forms of life, such as humans.

Despite the increasing emphasis on waste minimisation through recycling and re-use, *all* construction materials and products eventually have a "final destination", which requires them to be re-absorbed into natural ecosystems, either through soil, air or water emissions.

One increasing area of concern is leachates.[12] These are apparent in landfill and arise from a wide range of construction materials and products including concrete, plastics, paper and electrical goods. Heavy metals, such a chromium and stainless steel, used in the construction industry manufacturing process are a particular concern as are treatments and finishes that leach from buildings in use. Another area of concern is the final destination of unrecoverable non-biodegradeable wastes from building sites, such as plastics and plasticisers that release chemicals which are disruptive to ecosystems over time.

It is arguable that biodiversity will be promoted primarily through relevant planning legislation for development which takes account of environmental impact. Building Regulations should have a major role, however, through performance standards that must demand the environmental provenance of a construction material or product such that it does not harm biodiversity at any point during the building lifecycle through the effects of eco-toxicity.

2.6 Waste Minimisation

2.6.1 "Zero Waste" Buildings

The SEPA National Waste Plan promotes the concept of "zero" waste buildings in the future, where all waste is reabsorbed back into the building cycle. It presents a

[12] Amlo S et al Identification of PCB and decontamination of PCB-containing buildings in Norway.
Andersson A., Harmful Compounds in Paint leached from wooden facades
Andersson A., Long-tern leaching of environmentally hazardous substances in admixtures emitted from concreette.
Christensen NT Harmful substances in building waste in the future - Inventory and prediction of 12 substances

sound principle to operate from. Reducing waste also minimises carbon emissions, water consumption and pollution through reduced manufacturing.

The use of targets for waste minimisation in performance standards under regulation 5(2)(s) would allow for a ratchet effect to be achieved over time, increasing the percentage of construction materials reused or recycled year on year.

2.6.2 Designing for Deconstruction

Designing for deconstruction is an essential part of a waste-minimisation strategy for sustainable construction as it allows for easier maintenance, repair, recycling or possible re-use.

The market on its own will not drive deconstruction, despite developing pre-fabrication techniques. Prefabrication does not always imply deconstruction possibilities (glued elements are an example of prefabrication which is not readily deconstructable). Norwegian building regulations already demand that materials with a potential for re-use and recirculation should be chosen.

The strategic transfer from production-orientated manufacturing to service-orientated manufacturing has already taken place in certain sectors of the economy. It is quite normal now for contract carpet manufacturers to sell their carpets as a "service" rather than a "product" and in so doing, take responsibility for the products complete lifecycle, including maintenance, disposal and recycling.[13] All procurement including PFI should encourage developers and contractors to increasingly engage in a similar "service" approach to buildings, with efficiency gains that also benefit the environment.

Within 20 years, construction product manufacturers and material producers will need to have strategies developed for minimising waste during all stages of construction. Additionally, construction companies and developers will have further developed pre-fabrication techniques to allow for "factory-condition" production of buildings. If properly managed this could create the necessary conditions for "designing in" re-use of future construction products and materials through suitable, safe and benign deconstruction methods.

To maximise this opportunity for sustainable construction, the Building Regulations will need to move towards legislating for deconstruction under regulations 5(2)(s) using functional and performance standards as well as guidance.

2.6.3 Re-use and Recycling Materials

In order to achieve "zero waste" buildings, maximum use should be made of re-used and recycled materials. However such re-use must not be encouraged where it encourages the construction sector to become a repository for waste from other industries and fails to challenge those industries to improve their environmental performance. Neither should it be encouraged where the materials so used or the manner in which they are used gives rise to unhealthy buildings.

In the medium term, local authorities may take advantage of the opportunities offered by electronic GIS based databases to link planning permits for demolition with those for redevelopment. This will enable those who wish to use reclaimed materials from point of demolition to avoid double handling and landfill tax. Regionally based databases will be nationally available and should create a strong market for reclamation, where at present a relatively basic one exists.

The Building (Scotland) Act 2003 specifically provides for the consideration of re-use of construction materials under regulation 5(2)(s). Future performance standards, with guidance, should demand that applicants demonstrate that they have endeavoured to use reclaimed and recycled materials where practically possible.

2.7 "Whole Life" Building Regulations and Life Cycle Analysis

It is likely that the EU will continue to pursue ecological design beyond the current draft directive on "Eco-design for end-use products" and will seek to bring construction more closely in line with the proposals of this directive within the next 20 years. The current draft directive demands that manufacturers supply environmental assessments on their products to take account of the complete life cycle.

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[13] Von Weizsacker, E. Lovins, A. et al, (1995) *Factor Four: Doubling Wealth, Halving Resource Use* Earthscan

Waste minimisation and Life-cycle Costing developments in the UK such as "ENVEST 2" will enable building regulations to adopt a "whole life" strategy to include resource use and waste minimisation over the complete life of a building. In order to demonstrate compliance, it will be possible for the applicant to provide evidence of life-cycle analysis and costing strategies which take into account predicted resource use during the successive maintenance cycles and eventual deconstruction for re-use or recycling of both the building and its components.

It is not clear where such an environmental assessment fits within the Building (Scotland) Act 2003, Schedule 1 as currently constituted. Further work is required to identify how life cycle analysis can be incorporated into performance standards and guidance.

2.8 Lighting

Lighting is a key issue for sustainable construction. It can account for up to half the energy use in commercial buildings, a significant proportion of running costs and a very important element of human well-being in buildings.

2.8.1 Daylighting and Full Spectrum Lighting

Given that on average people now spend 90% of their time indoors, lighting is a major health issue, recognised by the increasing incidence of Seasonal Affective Disorder (SAD) in Scotland. Full-spectrum lighting that simulates natural daylighting has been recognised in the UK as promoting well-being. Norwegian regulations already recognise light quality and the need for daylighting. They have a requirement for an outdoor view in rooms with long-term occupancy.

At present in the UK, many commercial buildings have occupied rooms without daylight, whereas this is not the case in domestic buildings. Increasing litigation arising from building related ill-health will place pressure on authorities to provide daylighting for workers, and this will be reflected in legislation.

Performance Standards and guidance under regulation 5(2)(l) need to be developed take account of full-spectrum lighting and daylighting requirements in all occupied rooms.

2.8.2 User Control of Lighting

A major component of occupant ill health and dissatisfaction has been diagnosed as the inability of people to control their local environmental working conditions in terms of lighting, ventilation and temperature.[14] Recent amendments to the building regulations in the UK have begun to address aspects of user control in relation to energy efficiency. Research into occupancy satisfaction may lead to similar requirements in relation to occupant health and well-being.

Swedish building regulations stipulate the need for local control in rooms and to parts of multi-occupancy buildings. In Norway an openable window is a requirement.

The functional standards relating building regulations 5(2)(l) and (m) will need to stipulate the ability of building occupants to control their local environment in terms of lighting, ventilation and temperature, and compliment existing legislation which only sets specific limits for these.

2.8.3 Low Energy Lighting

At present there is no requirement for low-energy domestic lighting in the building regulations. In the future low energy lighting and the related reduction in power demand will become as important as low energy heating for all buildings, as the building envelope increasingly optimises for energy conservation. Domestic lighting will need to be targeted as well as commercial lighting.

Previous objections to legislation for low-energy domestic lighting have included the problem of residents replacing low-energy bulbs with cheaper less-efficient ones. The cost of low-energy light bulbs is rapidly reducing, diminishing the incentive to replace them with cheap alternatives.

Low-energy lighting requirements should be adopted as part of an Energy Performance Coefficient (EPC), similar to the one currently used under Netherlands building regulations as part of the performance standards relating to energy use. These requirements could be instigated in tandem with continuing tax incentives to install low-energy lighting.

[14] www.usablebuildings.co.uk provides information on post-occupancy studies in relation to buildings and references some of these findings.

Performance standards and guidance relating to regulation 5(2)(l) will need to be developed to address low-energy lighting in dwellings.

2.9 Maintenance and Life Cycle Costing

The maintenance and alteration of existing building stock is responsible for the vast majority of housing related construction activity in Scotland.[15] As the general building stock increases due to new build outweighing demolition of existing stock, and given the increasing frequency of alterations to buildings, this trend is likely to increase. Demands on carbon emission reduction and reduced resource use will pull the Building Regulations towards regulating the maintenance sector.

Under the proposed new performance standards it would be possible for applicants to be required to provide a predicted lifecycle costing for regulatory compliance *but fail to comply once the building is in use*. German regulations already require regular MOT type inspections of mechanical installations to ensure continuing regulatory compliance. In the near future it will be possible to instigate "spot checks" on equipment or components using smart software or other physical means of measurement.

Functional standards and guidance will need to be developed to demand regular building MOTs to track maintenance work and specification and to appraise life cycle cost predictions as well as continuing compliance.

2.10 Indoor Air Quality

As Scottish building regulations for air-tightness, construction performance, and energy efficiency have reached comparable standards to those at which problems have occurred in Sweden, it can be anticipated that there will be a similar increase in building related health problems. The building regulations will now need to positively pre-empt this in terms of improved ventilation standards, reduction of indoor pollutants as well as maintenance standards. There will need to be a premium on low energy ventilation strategies combined with air-cleansing action.

Increasing emphasis on health aspects of maintenance work and EU harmonisation will pull the building regulations in Scotland towards "designing out" health

[15] Stevenson and Williams, 2000

problems associated with maintenance. Swedish and Norwegian building regulations already demand a lifecycle approach to heating and ventilation with ease of maintenance and cleaning a prerequisite of design.

Performance standards and guidance under regulations 5(2) (l) and (m) will be needed to address maintenance requirements in relation to health.

Without mitigating regulation low-level pollutants will play an increasing role in health problems. Research has identified the presence of a wide range of chemicals interacting with each other within new buildings[16] with potentially harmful and unpredictable side effects. It is likely that the Executive will wish to set stricter thresholds for VOCs and other potentially harmful emissions within a building. Swedish building regulations already presume against the emissions of polluting gases and particles from structural and non-structural elements and products. Norwegian building regulations pay attention to embodied pollution in materials such that only a small degree of toxic or unhealthy substances can be released into the indoor or outdoor environment.

Increased performance standards and guidance under building regulations 5(2)(j) and (m) will need to ensure that indoor air quality does not threaten human health.

2.11 Building Related Ill-Health

It is likely that social attitudes towards health and productivity will demand increasing accountability. This will in turn affect building procurement. The ODPM is presently commissioning work into the impact of buildings on health. The project concerns development of an affordable low allergy building specification and is intended to provide increased opportunity to give the same importance in building design to breathing related disability as is presently the case for access for the physically disadvantaged.

Designing out health problems using a precautionary approach, together with increased monitoring and better maintenance strategies, is necessary and should

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[16] Crump,D et al, 1997, *Sources and Concentrations of Formaldehyde and Other Volatile Organic Compounds in the Indoor Air of Four Newly Built Unoccupied Test Houses* Built Environment, 1997, Issue 6, pp45-55. This identifies 254 different VOCs within the house, with the kitchen area being the worst for the "cocktail" effect.

be supported by regulation. Norwegian building regulations stipulate monitoring of ventilation plant to allow performance assessment in use.

Given that humidity levels are a major cause of building related ill health, this would be an immediately useful area for consideration as a performance standard under building regulations 5(2)(l) and (m).

The building regulatory division will need to work in tandem with the Environmental Health to develop integrated and proactive legislative strategies to prevent building related ill-health and ensure that regulations are accountable to users needs. Policy development is needed to establish exactly which dimensions of health should be covered by Building Regulations and which are more suitably covered by other legislation.

2.12 Demographic Changes

Priorities for health relating to the internal environment of buildings must address the concerns related to the increasing elderly population who spend a greater proportion of their time in buildings. Vulnerability of this population in relation to low-level pollutants will become increasingly important. The Building Standards Agency will need to work in tandem with environmental health specialists to develop proactive performance standards to address this issue with appropriate performance targets in terms of indoor air quality.

The building regulations will need to provide performance standards and guidance that take into account the vulnerability of the elderly in relation to indoor pollutants.

2.13 Insurance Premiums

With the continuing increase in flooding and storm incidents each year, the Insurance industry has undertaken research to assess the degree to which premiums can be predicted to increase. This has already resulted in homeowners becoming uninsurable in areas prone to flooding.

Within the next 10 years, the insurance industry is very likely to be demanding certification of buildings demonstrating their "future-proofing" against climate change, not only in terms of flooding but also storm-proofing and drought-proofing. This will test the extent to which the Executive has adequately legislated for improved building standards in relation to climate change.

Subsidence from clay heave due to the intermittent effects of flooding and drought will increasingly affect buildings. Insurers see this as a major risk area and further research is required in this area to define suitable performance standards under regulations 5(2)(a) and (b) in relation to ground heave.

2.14 Finite Resource Use

The market alone cannot be relied upon to ensure that threatened resources are not exhausted. This was recognised long ago as potentially leading to ecological collapse and failure without government intervention. Indeed this is one reason why environmental protection agencies were set up by the USA and UK. Many non-renewable resources used for construction are predicted to reduce to the point of non-availability in economic terms, at the current rate of use, over the next 10-50 years.[17] These include various metals and minerals such as zinc, which at the current rate of use may become unexploitable within 15 years.

In the near future, Building Regulations will need to demand optimised use of physical resources within a building through "Lean Construction" principles[18] such as waste minimisation, optimised supply chain management and sustainable maintenance regimes. It may however, also be necessary to legislate over time for restrictive use of certain finite resources within construction.

In terms of threatened materials supplied from overseas, this can be partly facilitated through sustainable sourcing certification, but will still be subject to foreign government policy on resource use.

A performance standard that augments environmental assessment with an additional requirement not to use materials from threatened supplies is needed under a suitable functional standard relating to fitness for purpose.

[17] Berge, B. (2000) *Ecology of Building Materials* Architectural Press
[18] *The Egan Report*

SNH have recently produced their strategy for protection of the Scottish Natural Heritage[19] with national assessments of the following areas:

- Biodiversity
- Earth Heritage
- Fresh Water
- Landscape
- Physical Characteristics
- Recreation and Access

These national assessments could be used in the future to inform the building regulations in terms of guidance defining any threatened supplies of natural materials in the UK.

It is important that closer integration is achieved over time between SNH and the building standards division concerning the use of construction materials, local products and availability of local natural resources.

2.15 Water Use

Although current water regulations demand an efficient supply of water, there is very little legislation for the conservation of water in buildings at present. In Scotland the average consumption of water per household is approximately 150 litres per day and is rising due to the increasing use of water intensive equipment. Simple measures such as spray taps and low flush toilets could substantial reduce water consumption.

All water entering domestic dwellings is treated to drinking water standards. It is arguable that drinking water quality is not required for many purposes and that these needs could be met or supplemented from another system of water supply (possibly waste water, or water collected from the building roof etc).

Norwegian building regulations already demand consideration of water use throughout the building cycle, although no targets have been set. Recent consultation in Scotland has indicated that the certification of water installations

[19] SNH, (2002) *Natural Heritage Futures* is a programme of 21 papers each covering an ecologically homogenous area of Scotland and discussing the key issues related to the conservation of natural heritage in that area.

should come under the building regulations.[20] This should oblige the applicants to consider water minimisation during the use of the building.

In the future, Building Regulations will need to address water conservation measures under a suitable functional standard in the same manner as current energy conservation measures i.e. on a whole building basis because of cost, infrastructure and climate change issues.

Performance standards will need to require the mandatory installation of water meters and will also need to address the retrofitting of meters to existing buildings. This could be tied in with the "point of sale" MOT for buildings in relation to energy use.

2.16 Electronic Tagging of Building Products and Reuse

Current research undertaken by the BRE indicates that with the next 10 years we will be able to electronically "tag" all new construction products and materials with an updateable "barcode" which will trace the history of use and treatment. This will reduce uncertainty in relation to professional indemnity for specifiers and stimulate the market for re-used materials and products. It is likely that within the next 20 years, the industry will adopt bar-coding wholesale as part of the production process.

From a health viewpoint it is vital that reclaimed and recycled products are fully traceable, with an available product history, so that dangerous products are not reintroduced into buildings. The current variable risk entailed in using re-used construction products has hampered attempts to gain acceptance for re-use at a EU level. Currently the EU CPD does not allow for re-use, only for recycling of materials and products.

Recycled materials are subject to strict factory production monitoring which allows for their verification. There is no recognition given to re-used products because their origin is unprovable and it is impossible at present to quantifiably and reliably assess reused products on a commercial basis. Once verification is possible for re-used products, the EU should readily adopt re-use, as it is preferable to recycling as an option in the EU Waste Hierarchy. It is envisaged that the CE standards will then need to be amended to allow for "provable" re-use.

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20 " Improving Building Standards:Proposals- A Consultation Paper", 2000

Bar-coding will also help to further legitimise design for deconstruction as best practice, by ensuring that verification is a part of the deconstruction process.

Regulation 5 (2) (5) of the Building (Scotland) Act specifically refers to the reuse of building materials. This is a completely new section in the building regulations that paves the way for legislation to "design out" waste through deconstruction and re-use in the construction sector. Further research and development will be required however before bar-coding is accepted practice.

2.17 Institutional change

It will be increasingly important to resolve the existing split of responsibilities between Planning and Building regulations which will in the future become more artificial given the sustainability imperatives outlined in "Meeting the Needs". Greater cross-consultation between planning, environmental health and the building standards departments would be particularly valuable in aiding sustainable construction. One-stop shops for planning and building regulations with a single integrated department overseeing both areas would also facilitate a move toward sustainable development.

Research on sustainable development in relation to specific areas such as construction would benefit in future from being commissioned jointly by the relevant Scottish Executive departments rather than on an individual sector/departmental basis. In this way research findings can act in a cross-cutting manner to assist in embedding sustainable development coherently into different departments' policy. Without identification and commissioning of such common research, appropriate responses will be harder to implement. Each of the "Pull" factors identified would benefit significantly from this type of inter-departmental and inter-agency response.

2.18 Conclusions and Recommendations

The requirements for new regulations and standards to ensure appropriate responses to the already recognised but unpredictable effects of environmental factors, such as climate change and resource use, are readily identified. Responses to increasing awareness of the impact of buildings and building materials on health, well being and economic development (locally and globally) are also required. In many cases, there are precedents to follow based on existing building regulations and best practice in other countries which are more advanced in their approach to sustainable construction.

- *It is strongly recommended that regulatory best practice in relation to sustainable construction from other countries, as highlighted in Part 4 of this report, is used to inform the development of new performance standards identified under each "pull" factor.*

Part 3: Context of Study

3.1 Models of Sustainable Development

A number of models of sustainable development were surveyed (see appendix 1). "The Natural Step" was perceived as the only one that truly integrates ecological, social and economic imperatives. It provides key vision statements that must be complied with for the purposes of sustainable development.

The 12 statements that make up "The Natural Step" are a logical expansion on the Brundtland definition of sustainable development and potentially provide a reference for a robust framework for legislation as they can also be related directly to absolute targets (e.g. rates of extraction, carrying capacity for ecosystems) in relation to sustainable construction.[21]

3.2 Sustainable Construction Indicators

Previous research has shown that a number of lifecycle analysis systems share similar appraisal parameters.[22] When these are taken into account, together with contemporary sets of sustainable development and sustainable construction indicators from Government policy, they can be compared and distilled into the parameters for evaluating current sustainable construction tools.

Two documents were chosen for comparison:

1. In respect of policy on sustainable development, the Scottish First Minister presented the devolved administration's revised policy in April 2002. It was published as "Meeting the Needs" (evaluated in Appendix 1).[23]

2. In respect of sustainable construction, comprehensive guidance has been produced by the Sustainable Construction Focus Group of the Construction Confederation.[24]

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[21] Brundtland, G. (1987) *Our Common Future,* World Commission on Environment and Development, Oxford

[22] Stevenson, F and Macrae, J. (1998) *Environmental Impact of the Specifications in the Technical Standards - Final Report to the Scottish Office Construction and Building Control Group*, The Robert Gordon University

[23] *Meeting the Needs….Priorities, Actions and Targets for sustainable development in Scotland* April 2002, paper 2002/14, Scottish Executive Environment Group

[24] *Towards Sustainability - A strategy for the Construction Industry* April 2000 Sustainable Construction Focus Group of the Construction Confederation

The indicators from these two documents along with the output of previous research are distilled into the six parameters shown in table 3. The factors to be addressed in promoting sustainable construction are then identified in relation to these distilled parameters

Table 3: Distilled Parameters[25] for Evaluating Sustainable Construction	
Principle Parameters	**Sample Factors to consider**
1. Design for Effective Resource Use	Waste minimisation in production, recycling and landfill Conserve non-renewable resources Minimising rate of use of renewable resources Design for lean construction, repair, re-use, flexibility and deconstruction Re-use and improve existing built assets Design with climate/microclimate Design for soil retention
2. Minimising Pollution	Minimise air, water and land pollution in relation to building use and design specification Relate land-use planning to transport infrastructure and strategy Locate appropriately Minimise light pollution Life Cycle studies Waste minimisation and treatment
3. Respect for People, Communities, and Local Environment	Design quality Benefiting local economy and ecology Minimise Fuel poverty Access/Safety issues
4. Promoting Biodiversity	Global ecology and production of materials and components Habitat creation and conservation Water features/SUDS Locate buildings appropriately (local) Preserve and enhance existing local biodiversity
5. Creating Healthy Environments	Optimise humidity levels Minimise toxicity Indoor air quality Optimise natural ventilation Optimise light quality Optimise personal control of environment
6. Managing the Build Process	Contractor requirements (sustainable const.) Future proofing –legislation Critical Path, tools and benchmarks Log books Pre- and Post Occupancy Evaluation

[25] Halliday S.P.: Sustainable Construction CPD Gaia Research, 2004

All six parameters and identified factors in table 3 need to be considered:

- at the level of the building itself in relation to its site,
- in relation to the components of the building over their lifetime and
- in relation to the components of the building over the building lifetime.

These parameters begin to define a preliminary framework for the evaluation of sustainable construction.

3.3 Evaluation of Tools for Promoting Sustainable Construction

The techniques discussed below[26] are shown as a natural hierarchy of evaluation in terms of eco-systemic thinking. Process-orientated tools are the most important as they are more closely related to sustainable construction as a process. The lower level tools and techniques tend to represent relatively non-systematic opportunities for sustainable construction as a product, delivered at handover. See Appendix 1 for further evaluation of some of these techniques.

> **Critical Path Tools...promote awareness of the process and intervention at the right time** - These are intended to offers clients, designers and specifiers a means of controlling their design process to improve control, minimise adverse environmental impact and overcome decision paralysis. Examples include the *Environmental Code of Practice for Buildings and Their Services, The CIBSE Log Book, The Green Guide to the Architect's Job Book, The Sustainable Neighbourhood Audit Technique and the ISO 14000 Environmental Management Series*. They are currently the highest level of appraisal.
>
> **Targeting Tools...use absolute standards** - These use standards based on the best available science at any time that changes as information improves. They include LCA tools such as *NABERS, ENVEST,* pollution targets and some government indicators. They are increasingly used to set development guidelines for Flagship projects to exceed poor regulatory standards. The required development is to develop dynamic modelling to predict behaviour and thereby establish real limits against which to set targets [cf: "Limits to Growth" in the 1970's and 90's.]

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[26] Source: Sustainable Construction CPD Module 14: Appraisal Tools and Techniques, Gaia Research, 2004

Software simulation packages for buildings in their environments are still primitive. Factor 4 and 10 are useful targets though not based on real limits.

Benchmarking…enable projects to be compared - Establishing and measuring performance in relation to agreed indicators enables projects, products and processes to be compared. Examples include the *Construction Best Practice Programme* initiative aimed at improving the overall performance of the construction industry using *Key Performance Indicators* (KPI), and *Design Quality Indicators* (DQI & QIDS). Benchmarking is however consensus based and makes no attempt to establish absolute targets. It cannot be relied upon to promote the necessary or even best possible improvements. *PROBE* is an example of an initiative that uses other benchmarked performance data in its assessments.

Labels & Certification…reward best practice against traceable performance standards - These come in many forms from a range of product labels for products and services to labels for buildings such as *SEAM, BREEAM, EcoHomes or GreenCalc, CEEQUAL,* for civil engineering projects and the *Considerate Constructors Scheme* for construction activity. The current trial of a professional accreditation scheme for architects in Scotland is also an example. They exist for materials (Bau-Biology, *FSC, Green Guide to Specification*). There is also a range of energy certification/labelling systems for products. These are useful where regulatory standards are inadequate to recognise, promote or reward best practice.

Checklists…highlight issues as actionable - These are the simplest way for specifiers to adopt best practice for sustainable construction and there has been a proliferation of them. Examples include Communities Scotland's Sustainable *Housing Design Guide*, The Environmental Handbooks and Council checklists for contractors/designers including Agenda 21 guidance.

Awards…raise awareness of issues - These promote best practice in specific aspects of sustainable construction e.g. business operation, waste minimisation, design quality or energy use but not in a systematic way. They include a range of product, professional or business awards such as *VIBES* for business practice and *Dynamic Places* for design quality.

Regulation … the lowest common denominator - An attempt to embrace the issues perceived as relevant and controllable at a pace the industry will tolerate. Increasingly used in some countries to support the radical changes required.

Government Policy…the stated priorities, aims and objectives.

From the above survey it can be seen that there is a vast and expanding array of tools available to promote and evaluate sustainable construction with distinctly different approaches. It would be most desirable to use integrated methodologies with absolute targets, but many of these have yet to mature beyond defining principles. Details and evaluation of some of these tools can be found in Appendix 1.

The ENVEST programme developed by BRE appears to be the most integrated model and methodology in the UK for assessing some of these physical parameters of sustainable construction. ENVEST is however limited, insofar as it does not take into account social or economic dimensions of sustainable construction. It is a software tool that draws on building design data and choices of elements and aims to identify those elements with the most influence on the building's environmental impact. It shows the effects of selecting different materials. It also predicts the environmental impact of various strategies for heating, cooling and operating a building. BRE is developing ENVEST 2 for estimating whole life costs as well as environmental impact.[27]

BREEAM, a voluntary environmental assessment method for buildings, also offers a good range of indicators against which the functional requirements for sustainable construction could be checked. It assesses the performance of a variety of building types in the following areas:

- *management*: overall management policy, commissioning site management and procedural issues
- *energy use*: operational energy and carbon dioxide (CO_2) issues

[27] http://projects.bre.co.uk/ConDiv/tool/default.html

- *health and well-being*: indoor and external issues affecting health and well-being
- *pollution*: air and water pollution issues
- *transport:* transport-related CO_2 and location-related factors
- *land use*: greenfield and brownfield sites
- *ecology*: ecological value conservation and enhancement of the site
- *materials*: environmental implication of building materials, including life-cycle impacts
- *water*: consumption and water efficiency

Credits are awarded according to performance and weighted to produce a single overall score. The performance targets and weightings are derived from *consensus* obtained from selected members of the building community, including manufacturers, which gives this method the disadvantage of not providing an absolute standard or being completely objective.

ECOHOMES is another variant on BREEAM, specifically for housing, which is being promoted by the Housing Corporation and English Partnerships. It is regularly being used by procurers as a requirement, with the standard ratcheted up from "Pass" level in 2003, to "Good" level in 2004.

BREEAM and EcoHomes offer a good range of indicators against which the functional requirements for sustainable construction could be checked although it lacks any robust social component. It is timely to consider using ENVEST, BREEAM and EcoHomes in the same manner as SAP i.e.: as guidance which should be complied with to satisfy the functional standards. This shifts the onus from voluntary compliance with sustainable construction imperatives, which have delivered little, to the regulatory compliance required to deliver a sustainable building stock.

3.4 Policy Drivers

There are a number of policy drivers both at a European, UK and Scottish level that are determining the push towards sustainable construction in Scotland.

3.4.1 The European Union Drivers

The EU (European Union) has been responsible for a significant raft of environmental legislation that has impacted directly on the construction industry.

The UK government has been obliged to incorporate this legislation into its own framework within a given period of time.

Construction Products Directive (CPD) 1989

This directive was primarily introduced by the European Economic Community in 1989 in order to reduce barriers to free trade in construction products through harmonisation of standards. It requires member states to replace their national standards for construction products (British Standards, in the case of the UK) with European Technical Assessments (ETA) leading to European Certification (CEN). Building legislation in Scotland is obliged to take account of the CPD specifications.

The key headings for conformity are:

1. Mechanical resistance and stability
2. Safety in case of fire
3. Hygiene, health and the environment
4. Safety in use
5. Protection against noise
6. Energy economy and heat retention

At present the CPD does not address the lifecycle costs of products in relation to disposal and reuse. Energy is only considered in relation to use rather than over the complete lifecycle of the construction. Neither does the CPD address the requirements of the EU Precautionary Principle, which requires us to take account of the risk of unforeseeable consequences. In the long term, however, environmental requirements will be integrated in the harmonised specifications (ETA and CEN).

6th Environment Action Programme 2002

The EC 6th Environment Action Programme, launched in 2002, provides an overarching framework within which all EC environmental policy is to be developed and covers the period from 2001-2010.[28] Four priority areas are identified:

- climate change
- biodiversity
- environment and health

[28] EU Sixth Environment Action Programme: Environment 2010: *Our future, our choice*

- sustainable management of natural resources and waste

Key issues which relate directly to the promotion of sustainable construction include: improvement of environmental standards of inspection, integration mechanisms, further development of indicators, wider uptake of EMAS (Eco-management and Audit Scheme), integrated products policy, promotion of the eco-labelling scheme, promotion of green procurement, a new Noise Directive, adoption of legislation on environmental liability and improving the implementation of the EIS (Environmental Impact Statement) Directive.

The Programme proposes a number of clear targets in relation to each priority area, which member states will be obliged to respond to in relation to proposed new EU legislation.

Energy Performance of Buildings Directive 2002

The EU directive on energy performance of buildings has been approved by energy ministers and will be implemented at the end of 2005. It aims to have a framework for calculating the integrated energy performance of buildings. The broad aim is to provide a level playing field for judging the efforts of member states in achieving energy savings and providing transparency for prospective building owners and tenants across Europe. It is intended that each EU country set a minimum performance levels at its own discretion.

The directive will apply to new buildings, large existing buildings facing major renovation, energy certification of buildings at point of sale or transfer and will involve mandatory inspections of boilers and air conditioning systems. It will put pressure on energy requirements to be applied to existing buildings, as is now the case in a number of European countries.

Waste Electrical and Electronic Equipment (WEEE) Directive 2002

This Directive introduces the concept of cradle-to-grave environmental considerations for products, in a bid to reduce hazardous waste from the industry. The directive, which will come into force in 2005, states that all manufacturers must retain responsibility for their products throughout their lifecycles. This means that take-back and collection schemes for obsolete products will be more commonplace, as companies recycle their branded goods.

The aim of the scheme is to encourage an increase in recycling, and sustainable production. Some of the most hazardous products when landfilled are invariably electronic and electrical, however the new law will force manufacturers to look at more environmentally friendly material and processes if the responsibility of recycling is down to them.

Individual member states will be responsible for how the WEEE Directive is implemented in their specific regions, and regular EU regulation laws will apply.

The key text is quoted below:

Manufacturers…will provide information on the material composition and the consumption of energy and/or resources of their components…and, where available, the results of environmental assessments and/or case reference studies which concern the use and end-of-life management of the components….
(Article 11.2)

It should be used as a benchmark for future legislation related to CEN marking which could cover all construction products in the same way. The impact of this being extended to all building components would be profound. It should also inform Scottish policy on sustainable development, as outlined in "Meeting the Needs", particularly in relation to energy and resource use.

3.4.2 UK Policy Drivers

Building a better quality of life: A strategy for more sustainable construction in the UK.[29] indicates that a sustainable construction approach involves all the following actions:

- delivering buildings and structures that provide greater satisfaction, well-being and value to customers and users;
- respecting and treating its stakeholders more fairly;
- enhancing and better-protecting the natural environment;
- minimising its impact on the consumption of energy (especially carbon-based energy) and natural resources;
- being more profitable and more competitive.

[29] DETR (2000) *Building a Better Quality of Life: A Strategy for More Sustainable Construction the UK*, The Stationery Office, London (www.construction.detr.gov.uk).

In 2001 The UK Government's Sustainable Construction Strategy and the Construction Federation's Focus Group set out *in Towards Sustainability – A strategy for the Construction Industry*, 13 practical measures that could & should be taken immediately.[30]

Waste Minimisation has also been a key driver for sustainable construction in the UK following the Egan Report, published in 2000, which emphasised the need to reduce waste, and established landfill tax legislation, which penalises the dumping of construction wastes in landfill sites.

The UK government white paper on Energy aims for a 60% cut in carbon dioxide emissions by 2050 and also to achieve a 20% renewable energy supply by 2020.[31] Given that buildings are responsible for over half of all carbon dioxide emissions, this proposed legislation should have a profound effect on construction legislation.

3.4.3 Policy Drivers in Scotland

While Scotland has taken the lead in some areas of sustainable development such as the use of renewable energy, much of Scotland's policy and initiatives in relation to sustainable development have either been developed in parallel or followed on from the lead taken by UK legislation. The Scottish First Minister presented the devolved administration's revised policy on sustainable development in April 2002. It was published as "Meeting the Needs" (evaluated in Appendix 1).[32] "Meeting the Needs" has indicators under the headings of resource use, energy and transport that can be directly related to sustainable construction.[33]

The Scottish Executive has set itself sustainability targets for its own estate that are monitored year on year as a result of its "Greening Government Policy" published in 2001.

[30] *Towards Sustainability - A strategy for the Construction Industry* April 2000 Sustainable Construction Focus Group of the Construction Confederation
[31] DTI white paper on Energy published 24th February 2003
[32] *Meeting the Needs....Priorities, Actions and Targets for sustainable development in Scotland* April 2002, paper 2002/14, Scottish Executive Environment Group
[33] *Sustainability Indicators for Waste, Energy and Travel for Scotland* Entec UK Ltd, 2001

3.5 Conclusions and Recommendations

The new Buildings (Scotland) Act 2003 has a direct reference to sustainable development. There is now a major opportunity for the Scottish Executive to develop appropriate policy in the area of sustainable construction.

UK policy on sustainable development and sustainable construction is well developed in series of government papers. Sustainable construction is being addressed through a number of strategic initiatives by the DTI, DEFRA, the Office of the Deputy Prime Minister and the Government Construction Clients Panel.

Within Scotland, policy is now developing rapidly in relation to sustainable development with extensive plans for energy and waste resources. These are potentially major drivers for sustainable construction. Policy on resource use and biodiversity in relation to planning and transportation requires greater attention, as these are not yet effective as drivers for sustainable construction. Policy on sustainable construction in Scotland is relatively undeveloped despite a number of independent initiatives by NGO's and local authorities.

European policy drivers will continue to have a major effect on sustainable construction through the introduction of various directives such as the CPD, energy certification and EIA. The 6th Environment Action Plan will drive policy on sustainable construction in the UK.

- *It is recommended that a further study be undertaken to comprehensively audit the Building Standards for integration and compliance with the policy drivers on sustainable development at a European, UK and Scottish level.*

Despite a large number of tools now available for evaluating sustainable construction, this area is still in relative infancy in relation to ecological evaluation in part due to lack of reliable data. The use of sustainability indicators demonstrates that there is, however, some degree of consensus in terms of the parameters for defining sustainable construction in relation to sustainable development.

At present, the BRE ENVEST Model appears to be the most integrated methodology in the UK for measuring sustainable construction. BREEAM and

EcoHomes offer a good range of indicators for checking the functional requirements for sustainable construction.

- *It is recommended that ENVEST, BREEAM and EcoHomes are incorporated into guidance for the functional standards of the new Building Regulations (see benchmarking tools in Appendix 1.2).*

This study has provided a set of 6 distilled parameters, drawn together from key policy documentation, for evaluating sustainable construction. The factors to consider within these parameters provide a suitable vehicle for establishing a set of indicators for sustainable construction in Scotland.

- *It is recommended that, in the short term, BSAC produce a set of sustainable construction indicators specifically related to the Building Regulations, which can be monitored with specific targets related to 6 key parameters: effective resource use, minimising pollution, respect for people, communities and the local environment, promoting biodiversity, creating healthy environments and managing the build process.*

A variety of competing models exist which attempt to define sustainable development. The Natural Step sets out guiding principles for sustainable construction within sustainable development and is one of the few models that identify ecological limits in terms of *rates* of use, carrying capacity, and biodiversity. These are base-line measures for sustainability. Without the means for monitoring and sustaining our natural resources, neither the social or economic aspects of sustainable development are tenable. Other models are not so explicit and do not provide such broad principles which can nevertheless be directly calibrated against actual targets.

- *It is recommended that The Natural Step be adopted as a reference for a framework to define sustainable construction.*

Part 4: Review of Regulatory Frameworks

4. 1 Introduction

This section compares and contrasts how building regulations in other countries are supporting sustainable development. The aim is to identify how the Scottish Regulations might be developed in the future in this respect.

It comprises an extensive review of regulations from Europe with similar or more severe climates to the UK (including Norway). Regulations in the USA, Australia, New Zealand and Canada are also reviewed. Further information from Austria, Switzerland and Finland would also inform development of the Scottish Regulations.

The form, scope and nature of the regulations in each country are identified, and how these have been amended in recent years to respond to the requirements of sustainable construction. Additional incentives, disincentives and sources of best practice guidance by way of publications and web sites have also been noted where they might contribute to policy development.

Those issues of most relevance to development of the research study are documented on a country-by-country basis and summarised here. The information has been compiled from a range of web sites, professional contacts and a limited number of public domain comparative studies.

Accessing information on some regulations has been hampered by limited published information, sometimes exacerbated by language barriers. Work on the harmonisation of European Regulations would appear to make a central source of public domain information on building regulations in different countries invaluable, at least to prevent duplication of effort. It has not been possible to identify such a source.

Many of the regulations are in the process of being updated or are subject to planned ongoing update. Some are only available in part-translation without the latest updates. Even the most recent reviews cannot hope to reflect the current state of affairs at the time of reading.

The diversity of standards, issues and requirements (as well as sub-clauses and context) does not allow the cross-comparison of regulator standards 'at a glance'. Even common areas such as energy standards prove too diverse for simple tabulation. The criteria are expressed in different ways in different regulations such that translations may not adequately interpret the use and context of apparently common words. Climate is a factor; building types vary, as do units, in ways that do not allow for easy comparison. For example building air-tightness can be expressed in a range of different units at a range of locally specified specific pressure differentials and there are occasionally complex pay offs between different aspects. The energy generation mix differs from country to country and the consequent environmental impacts can be difficult to compare. Within Europe the EU framework aims to overcome these problems and is specifically targeting regulation so as to make comparison easier.

The review has highlighted guidance of a generic nature including a number of useful and replicable mechanisms for promoting sustainable construction at design and throughout the lifetime of the building stock.

4.2 Literature Survey - Comparative Studies

Undertaking comparative studies is resource intensive - in part because of language barriers, but also because of the innate differences in approach and frameworks between countries. This makes them time consuming and presents problems of contemporaneousness. A knock on effect is that they are often confidential because of issues about consultation processes or because of an implied value. It is likely that those closely involved in the regulatory processes have access to contemporary information that has not been made available to the research team. A footnote covers a number of these studies.[34] Those that highlight

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34 The Conseil International du Batiment (CIB) undertook an international survey in 1998 into the development of Performance based codes and standards.[34]

Other studies attempt comparisons on a country-by-country basis. *The Review of Foreign Regulatory Practice* (1999) undertaken for the DETR covered The Netherlands, Denmark, Sweden and Germany which were selected because of their perceived leadership in energy efficiency standards and their geographical proximity. It was commissioned to assist in the development of the English & Welsh Regulations and it is understood that this work has not been updated or extended.[34]

The AIVC (Air Infiltration & Ventilation Centre) undertook *A Review of International Ventilation, Air Tightness, Thermal Insulation and Indoor Air Quality Criteria* (2001) for the IEA (International Energy Agency) covering: Belgium, Denmark, Finland, France, Germany, Greece, Netherlands, New Zealand, Norway, Sweden, UK. USA.[34] This is a useful and comprehensive comparative study albeit of a limited range of issues. Note: The Scottish regulations are not uniquely identified and UK regulations are referred to throughout.

particular issues are addressed in a short summary of what is known about some comparative studies both public and non-public domain follows.

IBCO (Institute of Building Control) undertook *a review of building controls, regulatory systems and technical provisions in the major Member States of the European Community and EFTA countries.*[35] This review was last updated in 1998 and included 15 countries: Austria, Belgium, Denmark, Finland, France, Germany, The Netherlands, Norway, Sweden and the UK are all represented. Note: It is unclear whether Scotland is uniquely identified in the report. The IBCO produced a document for each country and a Summary document covering all countries. The review, which is not freely available in the public domain, provides comparative information on the Building Control Systems, including Building Control Law, Building Regulations, National Standards and their status and the Qualifications required for building work and provides comparative information on the following requirements: -

1. Mechanical resistance and structural stability
2. Safety in case of Fire
3. Hygiene, health & the environment
4. Safety in Use - NB: to include Access
5. Protection against noise
6. Energy economy and heat retention
7. Access and facilities for the disabled
8. Other requirements

Another paper comprises a consultation on *The national requirements and design guidelines for energy and environmental issues in the refurbishment of educational buildings*.[34] The participants were Austria, Denmark, Finland, France, Germany, Italy, Poland, UK, and USA. Again the Scottish regulations are not uniquely identified and UK regulations are referred to throughout.

The Future for Pre-cast Concrete in low-rise housing investigates the Construction Products Directive in relation to Topic 1. Mechanical resistance and structural stability; Topic 2. Safety in case of Fire; Topic 5. Protection against noise and Topic 6. Energy economy and heat retention and their relevance to favouring concrete construction.[34] There are probably a number of other such commercial studies that are not in the public domain.

*Sustainable Housing Policies in Europ*e is a report of a meeting that brought together 27 European countries to look for common insights which would elaborate the concept of sustainable housing, share in and catalogue interests and seek areas for common action.[34]

[35] *A review of building controls, regulatory systems and technical provisions in the major Member States of the European Community and EFTA countries* (1998) IBCO

The first six requirements are those on which the new Scottish regulations are to be based and will replace the existing building regulatory requirements in or around 2005. They are derived from the European Construction Products Directive that is seeking a "common European framework that presents no barriers to trade". Given the rapidly changing nature of regulations in relation to sustainable construction the study is unlikely to be of significant interest although it may be useful to identify any planned updates of this review.

One report specifically addresses the technical specifications of the CPD and looks at progress in environmental product declaration schemes in the Construction Sector with a view towards harmonisation.[36] The Interim Report acknowledges that environmental product declarations and calculation tools have emerged in uncoordinated ways and identifies the need in a number of countries for credible and reliable information on environmental performance of products for product comparison and as input to building assessments where such information becomes a requirement. The management summary identifies the limited framework of the study. It then misguidedly states:- "the environmental impact of buildings is mainly related to the energy use during the use phase of a building". This view is totally incompatible with the nature of the emerging tools for appraisal of buildings that seek to give attention to a wide range of social, environmental and economic impacts throughout a buildings' life, including impacts on health and community. It erroneously undermines and curtails further study. No final report is in the public domain and its influence is unknown but should be determined for the purpose of ensuring accuracy of reportage.

All of the studies that have been identified either cover a large number of countries but with little detail, or cover a smaller number whilst focussing on a narrow range of issues. Some of these publications are not as contemporary as would be desirable but they do provide useful insights. None of the studies surveyed accurately represent the current state of affairs and many treat Scotland as part of the UK, exacerbating problems of interpretation of both data and recommendations.

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[36] PWC (June 2002) *Comparative Study of national schemes aiming to analyse the problems of LCA tools and the environmental aspects in harmonised standards. - Interim Report and Options for Harmonisation.* private

4.3 Best Practice

Expanding the current remit of the building regulations to take on board wider environmental concerns can be informed by reference to other regulations and initiatives. The specific regulatory elements that can contribute to a sustainable built environment are of interest as are the frameworks that provide the mechanism for implementing ongoing changes towards agreed national and international goals.

This review identified that the approach to the building regulations in some countries tends towards a "light touch". The UK, USA, Canada, Australia and New Zealand do not have any substantive environmental requirements in their building regulation. In these countries either the environment is considered to be of low importance or it is left to other legislation and initiatives to deal with. In New Zealand the Code explicitly does not deal with resource management as this is seen as "the responsibility of the owner".

A number of other countries tend towards a more rapid implementation of environmental and social policy and have sought to upgrade their building regulations in the light of emerging policy on sustainable development. Such countries include Germany, Norway, Denmark, Sweden and the Netherlands. As well as dealing with new construction, most of these countries have already begun to address issues of the existing building stock in recognition that this is essential to meeting commitments and aspirations. In some countries mechanisms have been introduced which provide a framework for continual improvements over time. Some of the strategies used in these countries place increasing responsibility on owners and/or purchasers to undertake improvements in performance and these are often supported by incentives and subsidy. These countries also place great emphasis on providing the technical guidance to underpin improvement through research and development. It is the latter category - the pro- active approach - that is of most interest.

A pro-active approach to developing the building regulations to promote sustainable construction will be a significant contribution to providing Scotland with advances in built quality, quality of life and energy efficiency at a pace that will assist in meeting the policy objectives of "furthering sustainable development".

4.3.1 Financial Incentives

As well as regulations, and often in tandem with them, there are also wide-ranging non-regulatory incentives to save energy, use clean and renewable energies, upgrade properties and invest in new equipment.

All the counties investigated except the USA and New Zealand appear to use forms of incentives such as taxes, levies and grants to promote changes in practice. Grants vary widely from design team incentives (Canada), to subsidies for owners to upgrade properties (Sweden and The Netherlands) and design advice services provided free to clients and practitioners (UK). Taxes and levies on energy are widespread in Europe and include levies on fossil fuel generated electricity, zero tax ratings on clean energy generation including bio-fuels, and subsidies for using low carbon fuels such as gas. There are widespread fiscal incentives to encourage waste recycling. Infrastructural incentives include the Renewables Obligation and Renewables Obligation Scotland used in the UK, and a similar scheme in Australia, promote clean energy supply. Incentives tend to change quite rapidly and require careful management.

In the Netherlands there is an intention to shift the burden of taxation from labour and capital based income towards the use of the environment. This is a now a well-established aspect of long term approaches to promoting sustainable economic development.

4.3.2 Voluntary schemes

Building assessment tools and guidance are increasingly used at a voluntary level. All of the countries studied have in place some form of assessment procedure (such as BREEAM in the UK) to encourage a voluntary programme of environmental building design and management.[37] There are increasing demands that the public sector and government clients take a lead by using these in building procurement, design and management to set standards at the highest level.

Views on schemes vary widely. It is difficult to get robust and independent information on how useful they are in practice beyond raising awareness of the issues. There is invariably conflict between those who feel that requirements should tend to be more stringent in order to promote necessary change and those

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[37] BREEAM - The Building Research Establishment Environmental Assessment Method Various publications.

who feel that they are too challenging. There is no real evidence that voluntary schemes have had a significant influence on practice. However, best practice does provide an indication of what is possible and is therefore a useful benchmark when considering regulation.

In Australia it is the State and Local Government that is imposing ad-hoc energy and environmental performance requirements through local planning regulations and developing their own rating and certification schemes. NABERS (National Australian Buildings and Environmental Rating System) is the most interesting developments for promoting sustainable construction in Australia. It gives buildings a yearly rating in relation to the building performance and the user performance. It gives an overall score based on a wide range of parameters. It is designed for use on a voluntary basis and is applicable to *all* buildings both new and existing. It is unique in its aim to be an accurate, quantitative assessment process based on the use of performative clauses. The use of performance clauses, rather than checklists or prescriptive measures, helps to ensure that it has the potential to undergo a continual process of evolution and upgrading.

Another notable scheme is the 'National Package' introduced in the Netherlands in 1994. It contains a list of both compulsory and voluntary measures for sustainable building for use by communities. It is used on a voluntary basis in most cities and regions. In general the community initiates the use of the National Package and developers agree to implement it. The use of compulsory and voluntary measures provides a degree of choice to developers and architects. It includes energy, water, materials, indoor air quality, green space around buildings, waste management and some social aspects. The National Package has diversified with time and there are 'packages' for new residential buildings, existing residential buildings, non-residential, urban design and infrastructure. Attitudes to the package vary. As with many such schemes designers, clients and building consultants claim the requirements are too low compared to what might be achieved whilst many developers consider them too onerous and restrictive. The existence of the National Package has placed sustainability issues high on the agenda. It may, by involving occupants and owners in procurement and decision-making, have greater opportunity for success that for instance the UK market based assessment tools that have been largely ineffective.

The American LEED is a voluntary environmental assessment system for building design that also offers a number of pointers that might be considered to be incorporated into the Scottish Building Regulations (e.g. water saving and waste recycling). It aims to evaluate environmental performance over a building's life cycle to provide a definitive standard for what constitutes a "green building". The sub-sections are a mixture of performative and prescriptive requirements and are currently restricted in their coverage. Whilst ambitious, it will be some time before it can be considered to provide a definitive guideline.

There are still a very limited number of appraisal tools related to material and product selection. In the UK and more broadly in Europe this aspect of design tends to be dealt with by limited pockets of professional expertise, specialist supply routes and membership organisations providing manufacturer and product information. There are established techniques for material appraisal in Germany where declaration of product performance and constituents is a requirement. A scheme in the USA, BEES (Building for Environmental and Economic Sustainability) is intended to support selection of cost-effective green building products. Still in its infancy it does include actual environmental and economic performance data for over 65 building products. It assesses 4 environmental impacts for a handful of these products: ozone depletion, smog, ecological toxicity, and human toxicity. For all products, global warming, acid rain, eutrophication, natural resource depletion, indoor air quality, and solid waste are assessed.

4.3.3 Form of the Regulations

At present the regulations in Scotland have both performance and prescriptive standards. The latter tend to date very quickly and are relatively inflexible whereas the former allow flexibility while maintaining key principles.

A number of countries have pursued the performance approach to regulation, while one country, Canada, has dropped performance codes as unworkable, and is pursuing an objective based code with a mixture of performance and prescriptive approaches. In Canada it is the right of the provinces and territories to adopt or adapt, interpret and enforce the regulations and as yet there is little interest in regulatory approaches to sustainable development. A new objective based code planned for 2004 is likely to continue to be confined to a narrow interpretation of health and safety.

The Australian Building Codes Board (ABCB) administers the Building Code of Australia (BCA) that is 'neutral' in regard to sustainability aiming to neither hinder nor facilitate its inclusion. The BCA is structured under Objective, Functional Requirements and Performance Requirements with solutions provided.

"Deemed to Satisfy" provisions are used to simplify the Code in a similar manner to those used in the Scottish Technical Standards. The Building Codes Board of Australia are currently drafting the next/future version of the Australian Building Code, and they are looking at the inclusion of sustainability as both a theme (overarching principle approach) and a goal (specific sustainability requirement approach). They decide at the end of May 2003. However, in Australia local governments are mainly responsible for implementing specific state legislation, but may also impose their own regulations. So integration and administration of environmental law imposes some challenges.

The USA Building Codes are still primarily prescriptive and do not offer much to reflect on in terms of promoting sustainable construction when compared to the Scottish regulations. However, the method for updating the codes, although cumbersome, is interesting and could, if well monitored, help to rationalise the current approach to updating the building regulations in Scotland, which is not so transparently organised. Public hearings are held on a regular basis throughout the country and any interested party or individual may make representations for changes to the codes. The representations are then considered by a panel of experts and advisors and the deliberations and decisions announced via the web. At one such public hearing in 2002 ASHRAE proposed that "energy from renewable energy sources collected on site shall be omitted from the annual energy use of proposed design" to encourage designers to specify renewable energy products.

All the European countries examined except Germany set national standards making it relatively easy to make amendments and changes to regulations. The extent of variation in the German Regulations between the 16 regions is not clear.

In The Netherlands regulations are established on a national level that cover all buildings, new and existing, in which people are housed - not just dwellings. Municipalities cannot impose separate requirements. It allows new technical requirements to be introduced very quickly. The requirements are performance based and there is provision for Dutch Standards (NEN's) to be replaced by harmonised European Standards (EN's) in time. This is a useful piece of forward planning.

The Norwegians have adopted a performance based building code which goes through an overhaul every 5 to 8 years. The Guidance Documents are maintained - always within the bounds of the functional requirements of the Regulations - and are used to spread new knowledge, to suggest solutions and to give general guidance. This is a useful model that could be used for establishing and updating best practice. The Danish standards also undergo continual amendments within the framework of the 1995 Code.

4.3.4 Specific Regulatory Issues

Existing Building Stock

German regulations now require boilers, hot water appliances, heat distribution and building insulation of existing properties with more than 2 flats to be upgraded. Smaller properties are required to be upgraded on change of ownership. In the event of refurbishment current elemental U-Values are required to be achieved where more than 20% of a building is subject to refurbishment. Alterations to heating systems (or building components) that would reduce the energy performance of the building are forbidden and regular maintenance is a requirement. Germany has taken these measures in response to concerns that voluntary measures and incentives were failing to achieve targets.

In Sweden there is regulation that requires installations to be kept in good working order and thereby allows for continuing monitoring of buildings in use. This has provided the mechanism for a national programme of inspection and testing of ventilation systems that have long been recognised as a source of poor indoor air quality and a threat to building fabric integrity. However the most important energy efficiency improvements in existing buildings in Sweden have resulted from interest subsidies and tax incentives rather than regulation.

The Netherlands has recently introduced energy performance standards for existing buildings. These aim to bring all buildings up to an agreed standard (1975 regulation benchmark) at point of sale. There are regulations covering minimum checks on compliance for existing buildings and authorities can demand improvements. This will be included in the new Scottish regulations as a safety measure and it is worth considering its use for health and energy related issues.

In Denmark condition surveys are required at point of sale to include an energy rating and opportunities for energy efficiency. Annual energy and water audits are required for buildings over 1500m2.

In Norway the environment, energy and health are considered widely during all phases of the life cycle including the construction works and post-occupancy. There is wide ranging regulation covering existing buildings. There are requirements on efficient operation and on indoor environmental quality related to daylight, ventilation and hygiene. Ventilation plant operation has to be provided with adequate facilities for monitoring to allow performance assessment in use and must be designed for good hygiene with access for cleaning of supply and exhaust air. Plant has to be easily adjusted and easy to maintain. Heating and refrigeration controls are required to allow the output to be adapted to the demand, and to allow heating to be reduced or interrupted in periods of no demand, including sub-division for different areas. There is also a requirement for buildings to be provided with operating instructions to facilitate proper operation and management. Some of these issues are covered in some countries in working environments by labour laws.

There are no regulatory requirements for existing buildings in NZ, USA, Canada and Australia.

<u>Energy efficiency - New Buildings</u>

The way in which different countries seek compliance on energy use of buildings varies enormously throughout Europe and has been summarised in four categories.[38] [39] [40]

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[38] 1. <u>Unit approach - imposing maximum u-values to construction elements</u>
This is one of the ways of complying in Denmark, E&W, Scotland, Austria, Finland, Luxembourg (<200m2) and Ireland. [In E&W and Scotland the 2002 Regulations is extended with standards for minimum efficiencies of hot water and heating installation systems] It is the main method of compliance in E&W, Scotland, Austria, Finland, Luxembourg and Ireland although in E&W, Scotland other methods are available. In Denmark there are also two other methods of compliance and this is the least used.

<u>2. Heat loss calculations - considers transmission through the building shell</u>
Meeting a minimum average insulation level is possible in Belgium, Denmark, E&W, Scotland, Finland, Sweden, Luxembourg and Ireland). It is the main method used in Belgium, Sweden (additional requirements are also imposed) and Luxembourg (>200m2)

3. <u>Heat demand calculations - transmission through the building shell + ventilation + internal heat production + passive solar energy</u>
This is a possible method of compliance in Wallonia (Belgium), Denmark, Austria and Sweden. In Sweden there is a presumption against electric heating. Only in Denmark is it the most commonly used method. Individual metering of electricity, gas, hot and cold water and heat is also required.

4. <u>Energy Use Calculation - transmission through the building shell + ventilation + internal heat production + passive solar energy + efficiency of installations for hot water heating and ventilation</u>
This method can be used in England & Ireland, In Germany, the Netherlands and France it is now the only method. In Germany new buildings are required to have an 'Energiepass' stating the energy requirements of the building much like the petrol consumption of a car and pressure testing is one of the verification checks that the owner can call for. Houses with mechanical ventilation are required to be tighter than those with natural ventilation. Heat recovery ventilation is a requirement above a certain size. Also in Germany consideration of primary energy as part of the energy in use

A fifth category describes the aim of the *EC Draft directive COM (2001) 226 energy performance of buildings in the residential and tertiary sector.*

> Energy performance calculation = transmission through the building shell + ventilation + internal heat production + passive solar energy + efficiency of installations for hot water heating and ventilation + cooling installation + lighting + position and orientation of the building + heat recovery + active solar gain + other renewable energy sources.

The Netherlands has the most extensive type of energy use calculation in the world. For all new buildings a calculation has to be carried out to determine the energy index. There are two tools one for residential and one for non-residential. Maximum thermal transmittance values are set but the main requirement is an overall energy performance known as the Energy Performance Coefficient (EPC). The EPC index was introduced in 1994 in response to awareness of sustainability. It includes the elements identified in the most advanced method above (heating, DHW, ventilation, pumps, lighting and cooling) but also includes humidification. It is based on primary energy consumption and energy used from renewables is not counted. The policy is to periodically tighten the EPC standard until energy neutral buildings are obtained. The EPC was set at 1.4 in 1995, 1.2 in 1998 and 1.0 in 2000. There is now a consideration of introducing something similar for drinking water and for the use of materials.

In the German regulations improvements are tied to an economic efficiency criterion, i.e. the value of the energy savings must recoup the cost of the measure during its normal life expectancy. This avoids the tendency to apply prohibitively short payback times or to apply luxury measures over cheaper ones.

In Norway embodied energy of materials is considered together with energy in use to give the total energy usage of a building. It must be shown as being probable that "the total energy consumption for production of materials, operation of the building and abolishment of the materials does not exceed an agreed level."

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calculation for buildings is an important driver towards an integrated energy efficiency approach and one that could be usefully considered for the Scottish Regulations.

[39] Beerepoot M., *Veldonderzoek energiezuinigheid woningbouw in buurland (Energy efficiency in residential buildings in countries surrounding the Netherlands)* 2002

Water

The Danish regulations require water as well as energy audits for buildings above a certain size.

The Norwegian regulations state that wastage of water is to be avoided.

The recent English & Welsh and the Scottish Regulations have begun to address water conservation issues although these are still largely within the realms of the voluntary codes. A number of regulations address issues of surface water and this is now an element of the Scottish Regulations.

Electrical Power

Power (as opposed to energy) is often ignored yet infrastructural implications, standby loads and emf's etc are all extremely important issues with health, energy and cost implications.

Standby power for electrical equipment - sometimes called leaking electricity or phantom loads - is the electricity consumed by appliances when they are switched off or not performing their primary function. Standby power consumption is an increasing fraction of the world's energy use and is thought to account for between 5% and 15% of power used in homes in OECD countries. The issue, as with other demand side issues, is rarely fully addressed but clearly it is foolhardy to be designing with expensive renewable technologies and putting further pressure on heat related issues without addressing widespread standby issues (fax, cordless phone, hi-fi, cooker clock, wall clock, answering machine, TV, computer). The situation is likely to be exacerbated as home-working increases.

Also because electricity cannot easily be stored, the size, and cost, of the supporting infrastructure is usually governed by the maximum instantaneous load on the system and not the amount of energy that is consumed. Consequently, for most of the day and most of the year expensive infrastructure, transmission and distribution power grids, are under-utilised, and generating capacity is idle.

Utility companies are generally obliged to bear the cost of supplying new buildings with electricity. This may involve laying new cable, constructing a transformer and sub-station or even reinforcing the local electrical distribution network. As a consequence tariffs are also used to discourage designers from over-sizing

[40] www.renarch.info/7_comparison

electrical installations. Suppliers also try to balance out the load by cost structures. This may involve setting a 'maximum demand tariff' with excess penalties or levying high charges during periods of peak demand to encourage off-peak use. Other regulatory incentives or regulations could be considered for new housing that would enable infrastructural requirements and costs to be minimised.

The Danish have requirements that aim to limit electrical consumptions such as facilities for monitoring of ventilation systems and regulations covering specific fan powers. The English regulations now contain standards for sufficient controls to turn off electric lighting. In Sweden grants are available for installing more efficient electrical equipment, provided the connected load on the grid is reduced (i.e. a smaller incoming fuse is installed).

Cooling

Denmark and Norway have restriction on the use of mechanical cooling in buildings and in Scotland there is a requirement that mechanical cooling is minimised and equipment is reasonably efficient and controllable.

Waste

Waste management is still largely addressed within voluntary standards although specific aspects are being dealt with through European regulation including the recently introduced regulation on Waste Electrical and Electronic Equipment.

A number of European regulations (the Netherlands, Norway and Germany) encourage construction waste recycling. Germany has a target to reduce construction-generated waste by 50% and regulation on the monitoring and disposal of waste has helped to significantly increase the level of recycling. It is arguable that this regulation should be part of the building regulations in Scotland linked to more general environmental regulations on waste. In the Netherlands and the UK the landfill tax is currently being applied to encourage improved practice. The Norwegian regulations specifically require facilities for source separation of waste.

Environmental Toxicity and Indoor Environment

Although separate these issues are closely related. A number of recent amendments in European countries apply to the issue of emissions from building products and materials. The implication is both protection of human and animal health within buildings but also the impact on the environment of leaching during use and at the end of their useful life.[41]

In Germany a concept paper is presently being discussed which should rate products (particularly those used in foundations) according to their effect on ground water and soil. A number of tests including one determining influence on flora, worms and algae are proposed. Also in Germany regulation is in place to reduce solvent emissions by a fifth. Production plants have to comply with specific limits. Businesses can comply by reducing the amount of solvents used in production by using lacquers, paints and glues with reduced solvent content.

In Sweden, the Netherlands and Norway there are requirements for ventilation humidification and cooling plant to be designed and connected so that they do not entail a risk that harmful microorganisms or harmful substances will be released into the indoor air. There is also a requirement in Norway for an opening to fresh air and daylight in buildings intended for permanent occupation.

In Sweden there is acknowledgement of danger from emissions of gases and particles from structural and non-structural elements and a presumption against products emitting high levels of pollutants. Also in Sweden ducts and other components cannot be made of, or treated with materials that may release contaminants into the indoor air. Prescribed ventilation rates are based on use of building materials with low emissions.

In Norway there are an extensive range of criteria applied to building materials. Embodied energy of materials is considered together with energy in use to give total energy usage of building. There is a requirement that materials and products for use in construction works are to be manufactured with justifiable use of energy and with the aim of preventing unnecessary pollution, and that materials and products with a potential for re-use and recycling should be chosen. Buildings have to be cleaned prior to use and the Regulations stipulate that designs must minimise build up of dirt by appropriate detailing and selection of materials. They

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[41] Amlo, S. et al (2002) *Identification of PCB and decontamination of PCB-containing buildings in Norway.*CIB Sustainable Building 2003
Andersson, A. (2002) *Harmful Compounds in Paint leached from wooden facades* CIB Sustainable Building 2003
Andersson, A. (2002) *Long-tern leaching of environmentally hazardous substances in admixtures emitted from concrete.*CIB Sustainable Building 2003
Christensen, NT. (2002) *Harmful substances in building waste in the future - Inventory and prediction of 12 substances* CIB Sustainable Building 2003

must also facilitate access for cleaning and maintenance. “Surfaces and surfacing materials are to be chosen so that dirt is not hidden or unnecessarily accumulated.”

The life cycle approach to indoor air quality and the efficient operation of buildings adopted in Norway is particularly relevant to addressing sustainable development. Regulations promote both energy efficiency and good hygiene through simple and efficient maintenance and cleaning and the selection of appropriate materials. Building and surface coating materials are regulated so as not emit contamination to the indoor air, in concentrations known to be harmful with respect to health hazards and irritation. They are required to be fit for normal use and to be produced, handled, stored and applied in such manner that emissions of contamination and smell to the air in rooms are as low as possible. The requirement of ventilation air in commercial and public buildings is determined by the choice of materials as well as the number of occupants and the activities. The ventilation rate can be reduced if low emission materials are specified.

The Danish Regulations take a very firm precautionary stance on contamination. There is a requirement that ‘use should always be made of building materials with the lowest possible emission of contaminants” Special concerns apply to mineral wool and formaldehyde and potentially radioactive materials. Building materials must not emit gases, vapours, particles or ionising radiation that can cause an unhealthy indoor climate.

Precaution against the permeation of toxic fumes from insulating material into any building occupied by people has just been introduced into the English & Welsh and Scottish regulations. This relates to risks to health of persons from formaldehyde fumes given off by urea formaldehyde foams. If these foams are to be used there must be a continuous barrier to minimise, as far as practicable, the passage of fumes to acceptable parts of the building.

Building Process

In most countries construction works are regulated by health and safety and some environmental regulation. In Norway a number of aspects are dealt with through the regulations including emissions from materials, choice of materials for low emissions, waste avoidance, effluent and energy consumption during construction and demolition.

Planning

In some regulatory frameworks links are already apparent between planning and building regulation in relation to requirements to integrate with local plans for district heating (Sweden & Norway) or provide flexibility for future changes and regulations on outdoor space including parking. Inevitably fulfilling the requirements of furthering sustainable development will require closer integration between issues typically dealt with through regulations and planning issues.

4.4 Conclusions and Recommendations

Appraisal of regulations in other countries indicates that there is significant opportunity to pro-actively set objectives and to develop the appropriate mechanisms for achieving them. There are examples throughout the world, and particularly in Norway, Sweden, Germany and The Netherlands, of credible means for promoting sustainable development objectives through a Building Regulatory Framework particularly when supplemented by other incentives (see appendix 2). Setting targets across a range of issues with potential for improvement on a regular basis, and underpinned by incentives, offers an appropriate and timely means for achieving a sustainable, quality built environment.

The Norwegian regulations are most comprehensive in dealing with cradle to grave issues including indoor climate and building hygiene. Along with the Swedish regulations they have a broad view of environmental protection that extends to the exterior environment. Norway also has outdoor space requirements within the regulatory framework. In both countries the regulations incorporate links to planning in respect of local plans to avoid future alteration work and bureaucracy.

- *It is recommended that the current Scottish Regulation that provides opportunities to carry out minimum checks on compliance for existing buildings, and to demand improvements, be extended to deal with a range of issues including hazards due to floods and upgrading to meet energy targets (see German, Dutch, Danish, Swedish regulations in appendix 2). This could an in principal extension with aspects introduced over time.*

- *It is recommended that a thorough review of the gaps between planning and building regulation is undertaken with a view to closer integration where this will assist in furthering sustainable development (see Norwegian regulations in appendix 2)*

- *It is recommended that a review is undertaken to identify opportunities for more closely regulating the building process including emissions from materials, choice of materials for low emissions, waste avoidance, effluent and energy consumption during construction and demolition (see Norwegian regulations in appendix 2).*

- *It is recommended that targets are introduced for waste recycling from construction.*

- *It is recommended that inclusion of facilities for waste separation in established as a requirement in all new development.*

- *It is recommended that a requirement is introduced to ensure the provision of uncontaminated and clean air from ventilation systems (see Norwegian regulations in appendix 2).*

- *It is recommended that a requirement is introduced that makes provision for good indoor air quality, daylight and adequate ventilation in buildings for permanent occupation (see Norwegian regulations in appendix 2).*

The German and Dutch regulatory frameworks are the most extensive in respect of reducing energy consumption in existing buildings. At present only 1% of the public housing stock is renewed each year in Scotland. This means that to achieve any significant impact on the building stock the Building Regulations must, as in Germany, Denmark, the Netherlands and Sweden address the upgrading of the existing stock within a framework of appropriate incentives. Elements from each of these countries could be adopted as guidance on upgrading for energy efficiency.

- *It is recommended that an energy performance standard for existing buildings is introduced that will require all buildings to be brought up to an agreed standard by a set time or at point of sale. The measure could be supported by incentives. The requirement could readily be underpinned by guidance on appropriate and effective measures (see German and Dutch regulations in appendix 2).*

- *The use of an economic efficiency criterion, i.e. the value of the energy savings must recoup the cost of the measure during its normal life expectancy is recommended.*

The Energy Performance Coefficient (EPC) used in the Dutch regulations is particularly advanced in setting an energy framework for new buildings that is both comprehensive and establishes the principal of continual improvement. The consideration of primary energy as part of the energy-in-use calculation for buildings is an important driver towards an integrated energy efficiency approach and one that could be usefully considered for the Scottish Regulations.

- *It is recommended that an Energy Performance Coefficient (EPC) such as that used in the Netherlands is developed with provision for continual upgrading (see Dutch regulations in appendix 2).*

Energy consumption of buildings is a complex issue and means of regulatory compliance is moving towards systems that truly reflect environmental impact in use, which can be significantly affected by design and management.

- *It is recommended that limits on electrical power loadings are applied to all new development to include specific fan power, electrical equipment controls, and demand switching. The requirement can be underpinned by development of deemed to satisfy guidance.*

- *It is recommended that cooling and dehumidification energy consumption are included into an overall Energy Performance Coefficient (EPC) to encourage attention to design detail. There is a lot of information available on low energy cooling and humidity control and these could be developed into guidance documents.*

- *It is recommended that compliance is based on primary energy consumption such that energy used from renewable sources of energy is not counted.*

The EPC is a valuable model for overall regulation that could be applied across a range of issues. The Dutch are already considering applying it to drinking water and to materials.

- *It is recommended that consideration could be given to extension of the method of the Dutch EPC to water use in buildings. If it reflected the EPC energy model it could enable a base level to be introduced with the opportunity to apply more stringent criteria over time. The requirement could readily be underpinned by guidance on water conservation and use of low water use elements (see Dutch regulations in appendix 2).*

- *It is recommended that consideration is given to applying the method of the Dutch EPC to a range of other indicators embodied energy, toxicity, ventilation and contamination and space around building.*

Product declaration is a requirement in German building regulations which should be emulated and advanced methods of material appraisal should be explored such as those used in Germany and Switzerland.

- *It is recommended that a requirement is introduced for declaration of material and product content (see German regulations in appendix 2).*

Best Practice and voluntary guidance has an important role to play in most countries in raising awareness of issues and setting guidelines. However, on their own voluntary measures have little practical and meaningful influence on the majority of practice. The Dutch "National Package" offers a comprehensive and interesting approach to how best practice measures might be bedded within an appropriate framework of sustainable development. It comprises both voluntary and mandatory measures and is designed to be adopted and implemented by communities. It includes energy, water, materials, indoor air quality, green space around buildings and waste management. Its ownership by a community enables it to embrace social aspects. The evident problem is knowing where to place benchmarks such that they do not aim lower than is necessary if the serious changes that are required to meet sustainability objectives are to be achieved. Most industry inevitably resists change not least because the incentives for pursuing and embracing innovation are poor at best and derisory at worst. Rewards for innovation as well as penalties for poor practice would help.

The most useful tool developed outwith the UK that can usefully inform the "Green Label" as a rating scheme is the Australian NABERS (National Australian Buildings and Environmental Rating System)[42] methodology because of its ability

[42] www.ea.gov.au/industry/waste/construction/final-draft.html

to address existing building stock using absolute targets rather than consensus benchmarking. This should be examined to see if it could be used in tandem with ENVEST (for new buildings) as additional performance standard guidance.

- *It is recommended that the NABERS system developed in Australia is considered for possible development into a "labelling" system for use in the Building Regulations (see targeting tools in Appendix 1.2).*

- *It is recommended that consideration is given to the investigation of community based tools which can be integrated with construction activity, in the same way that the Dutch "National Package" comprises both voluntary and mandatory measures and is designed to be adopted and implemented by communities. This aspect is currently very much at the boundary of responsibility of the Regulatory framework and would benefit from sensible integration to improve quality of life in respect to built development.*

Part 5: Current Regulatory Framework in Scotland

In this section the interplay and overlap between Scottish environmental regulatory systems and key players is explored to identify the scope for integration to promote sustainable construction.

The scope of the current building regulatory framework is considered strategically in terms of the distilled parameters from Part 3 (table 3) and the global survey in Part 4. Existing legislation is highlighted in relation to these to show where missing areas exist and the potential for expanding the building standards and guidance is briefly explored under the six headings for the EU Construction Products Directive which are driving the new regulations: structure, fire, environment, safety, noise and energy. Finally, the existing Technical Standard for Sanitary Facilities (Domestic) is examined in relation to the proposed replacement Functional Standard (as of September 2003) and a suggested replacement text is offered, to show how other Functional Standards and associated guidance might incorporate factors relating to sustainable construction.

5.1 Linking Agency Thinking on Sustainable Construction

The scope for the integration of environmental regulation within the building regulations is debatable. It has been argued that, as in some other countries, the building regulations should remain a "light touch" in order to minimise the requirements for the development of buildings and so promote cost-effectiveness and innovation.[43] However voluntary measures are proving ineffective in improving the majority of practice. Regulatory as well as other mechanisms are needed so that Scotland can reap the benefits of a sustainable built environment.

This issue was highlighted in a report, to the WWF in 2001 on the Scottish Executive's progress on sustainable development.[44] It addressed the limitation of government mechanisms to promote sustainable development. It suggested that the Executive produce a Framework for Environmental Development as a precursor to any policies on sustainable development. Such a framework could unite those players who can assist in the promotion of sustainable construction as a cross-cutting theme. Both SEPA and SNH are already statutorily consulted on planning matters in relation to environmental impact. Given that the Building Regulations have been extended to cover environmental consequences, these

[43] See for example, Canada and New Zealand regulatory approaches in appendix 2 of this report.

bodies could potentially advise directly on matters such as water use, biodiversity and resource use in relation to building performance.

SEPA and SNH have signed a joint initiative requiring them to consult each other and take joint action on Agenda 21 and waste strategies. A similar initiative should be undertaken whereby the Building Standards Division directly consults SEPA and SNH when drafting new standards or revisions to ensure they promote sustainable construction.

The National Waste Plan for Scotland was published by SEPA in 2003 and is directly related to the European Union's 6^{th} Environmental Action Programme key actions for the sustainable use of resources. At present there are no regulatory proposals in the National Waste Plan for dealing with construction waste, which relies primarily on voluntary market initiatives and financial incentives via the landfill tax. This is despite the fact that the construction industry is the biggest non-municipal waste producer in Scotland (6,284 tonnes in 2000 with 41% going to landfill) and produces ten times more waste than the next biggest non-municipal waste producer. There is a major opportunity to target construction waste through the building regulatory process by demanding construction methods that minimise waste. This prevents an "end of pipe" approach to waste minimisation.

The current legislation for water use, as enforced by SEPA, obliges water authorities to provide an "efficient" supply that minimises waste, but this does not extend to use within a building. Consultation on the new building regulations[45] has shown strong support for the certification of water installations in buildings. This offers an excellent opportunity for the Functional standards to address themselves to the sustainable use of water within buildings as part of sustainable construction.

5.2 Scope in Relation to Planning

The Building (Scotland) Bill gained Royal Assent in April 2003. The policy objectives of the Bill are to modernize the Scottish Building Control system (now to be known as Building Standards) to provide for greater flexibility, consistency and innovation.

[44] Birley, T *Reality Check: A Review of Scottish Executive activity on sustainable development* 2001, WWF

One significant aspect of the new Bill is that it makes provision for Ministers to make building regulations for the purpose of 'furthering the achievement of sustainable development'. By going beyond the framework of purely 'sustainable construction' the bill acknowledges the role of buildings and the built environment in responding to social, cultural and economic imperatives. This has potentially widespread implications in respect of building procurement, design, management and operation, which are beyond the scope of this report.

There are also major implications for the relationship of building and planning regulations, if the regulatory framework is to be proactive in seeking to meet national and international objectives for sustainable development. Two key issues are environmental impact assessment (EIA) and local planning.

EIA

Current EIA at a planning level does not assess the long-term and wider environmental impact of the construction process in terms of either the building or products used. On the other hand, the regulatory constraints on the construction process, such as the landfill directive, building regulations, and construction design and management regulations (CDM), do not address the impacts of the construction process at a macro-level.

EIAs while useful at a macro-level are only required for larger projects and therefore do not provide any assessment mechanism for the large number of smaller buildings in Scotland in terms of their construction specification and its wider impact on the environment.[46]

Local Planning

Many local plans now make reference to sustainable development and have a variety of policies on saving energy and minimising environmental impact but there are little evidence of these policies being cross-related to sustainable construction. Legislation and guidance that tackles development planning[47] does not, for example, consider the transportation of construction materials with its consequential Co_2 emissions.

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[45] Ibid

[46] see Schedule 2 of Town and County Planning (Environmental Impact Assessment) Regulations 1988, updated in 1999

[47] for example, NPPG3 or NPPG6 which provide planning guidance to promote sustainable development

During the consultation[48] on proposals for the Building (Scotland) Bill 2003, the question of greater alignment between planning legislation and guidance and building standards legislation and guidance was raised, in particular with reference to statutory obligations to consult and joint planning/building warrant applications. This received strong endorsement but was dropped from the final Bill because of administrative issues. While it may not be practicable at this time to develop joint applications, there is nevertheless much scope for the Scottish Executive Planning and Building departments to develop strong bi-lateral referencing in the guidance documentation of each area, to ensure the greater integration required by sustainable development.

One example of this might be, the requirement for Planning guidance to make reference to building guidance on the sustainability of materials specified for the external appearance of a building. Another example might be mutual referencing relating to the planning and construction of district heating schemes. Norwegian building regulations, for example, are linked to planning requirements with a requirement for a district heating connection to be provided in a new building where an obligation in the local plan exists.

Encouragingly, initiatives are now being taken to try to integrate planning and building regulatory guidance on flooding in Scotland, with the appropriate cross-referencing where necessary. This followed from the Technical Advice Note 15 –"Development and Flood Risk", which was published in 2002 and NPPG7 on Planning and Flooding.

5.3 Potential Legal Barriers to Sustainable Construction

It must be recognised that some current legal provisions do not help moves towards more sustainable construction in Scotland. This problem has been highlighted in several reports to the Scottish Office.[49] These demonstrated that a number of building regulations and technical standards were effectively preventing the use of innovative and sustainable construction through their prescriptive requirements.

A recent Scottish Executive Report demonstrates that planning and building control provisions can sometimes be used or very strictly interpreted to stifle

[48] *Improving Building Standards – A Consultation Paper* July 2001, Scottish Executive, and *Improving Building Standards: Proposals-A Consultation Paper* August 2002, Scottish Executive
[49] Baxter and Liddell 1996, Stevenson and Macrae, 1998, Morton and Little, 2002

innovation and more-sustainable construction, not necessarily deliberately but nevertheless having the same effect.[50] Examples include the use of new materials, solar-orientated layouts, density of dwellings and alternative traffic arrangements. It also highlights that demonstrating that the alternative proposed has a similar or better equivalent effect (performance) to the regulation can lead to a change of heart on the part of the regulators. The problem is not unique to Scotland. Efforts are underway in the USA to address the issue of making their building codes more relevant and less restrictive towards sustainable construction.

On the broader environmental front, the definitions of waste can sometimes mitigate against a creative approach to solving resource-use issues. For example, it may become clear during the construction phase of a project that it would be possible and advantageous (to the environment as well as the developer) to use more of the excavation arisings on site than the original design had included, for example to create noise bunds. Very careful steps must be taken in conjunction with the regulatory authorities to ensure that such bunds are not designated as waste disposal sites nor intentionally used as such, thus requiring licensing and active management long into the future.

The performance guidance to be developed as part of the Building (Scotland) Act 2003 should be less inhibiting to sustainable construction. Prescriptive standards, by transposition from the current "Deemed to Satisfy" guidance will continue to exclude sustainable design approaches by omission rather than prohibition unless they are carefully re-considered.

5.4 Potential Expansion of Technical Standards and Guidance

"*Accomplishing sustainability is about much more than simply achieving energy efficiency, specifying "natural" materials and finishes, or delivering healthy buildings...At heart, it is about drastically reducing the amount of consumption caused, at every level, by the processes involved in the construction, use, maintenance and replacement of our built environment…"*
(Ian Cooper, Eclipse Research Consultants)

There is an urgent need to reduce the amount of resources used in construction. In practice this is being addressed to some degree through voluntary initiatives such

[50] Halliday, SP. And Pemberton, G. (2001) *Scottish House: A review of recent experience in building individual and small groups of houses with a view to sustainability, the use of traditional and new materials and innovative design* Central Research Unit, Scottish Executive

as BREEAM and EcoHomes, and other tools for predicting the environmental performance of buildings, as well as through legislation such as the Landfill Directive.

When other building regulatory systems and best practice are analysed in relation to the distilled parameters for sustainable construction established early in this report (table 3) a number of significant gaps appear in relation to sustainable construction which are not covered by current legislation in Scotland, as shown in table 4, and should be considered for inclusion in the building regulations and standards.

Table 4: Missing areas in Scottish Building Regulations in Relation to Sustainable Construction			
Distilled Parameters	Sustainable Development Indicators in "Meeting the Needs"	EU and UK Legislation Covering This Area	Missing areas in building regulations
1. Design for Effective Resource Use	• Climate Change • Energy: consumed • Energy: renewable • Waste production • Waste recycling • Waste landfill • Renewable Energy	Pollution control law, IPCC 1974 HECA, 1995 Proposed UK govt white paper on Energy, 2003 EU Directive on Energy Performance of Buildings, 2002 Waste laws Landfill Directive 1996 WEEE Directive UK govt paper on Energy, 2003 Water Act 1989	• consideration of energy use during whole life cycle of building • use renewable where possible in pref. to non-renewable energy sources • minimising transportation of goods • retrospective legislation for existing buildings and equipment • embodied Co_2 in construction • domestic energy efficient lighting • domestic air leakage • consideration of primary energy use • link to planning law for centralised heating strategies (CHP+district) • limits on power use • avoidance of unnecessary cooling power • heating controls to avoid overheating and minimise heating when building not in use • refrigeration controls • energy limit on ventilation • monitoring for performance in use • heating systems designed to switch fuels • consideration of waste minimisation during whole lifecycle of building • design for repair, re-use and deconstruction • design for waste minimisation in manufacture • waste water minimisation • waste separation and waste storage at source • presumption for re-usable and

			recyclable materials • life cycle approach to efficient operation of power plant, maintenance and cleaning • minimising water use in buildings • design for soil retention
2. **Minimising pollution**	• Air quality • Water quality • Travel -industry	Pollution control law, IPCC 1974 Environmental Impact Analysis Directive Environmental Pollution Act 1990 Dumping at sea Water pollution control law Water Act 1989 contaminated land law Landfill Directive Planning law NPPG3 NPPG6	• minimise VOCs in buildings • cleaning buildings prior to occupation • life cycle approach to indoor air quality-measurability and cleanability of ventilation plant • monitoring of ventilation and heating plant in use • minimising transportation of construction materials • light pollution
3. **Respect for People, Communities and Local Environments**			• use of local products and materials • links to planning acts concerning minimum outdoor space
4. **Promotion of biodiversity**	• Biodiversity	Environmental Impact Analysis Directive	• end-of –use disposal for products • environmental impact of construction on global ecology • biodegradeability • habitat conservation and creation • water features/SUDS
5. **Creating Healthy Environments**	• Health (not for animals)	IPCC 1974 CDM	• electromagnetic radiation in buildings • attention to light quality, daylight, an outward view and opening to fresh air • temperature controls on hot water taps to prevent injury
6. **Managing the Process**			• adoption of tools and benchmarks (NABERS, BREEAM, EcoHomes etc) • log books • Post Occupancy Evaluation • contractors requirements

Each of the six areas of regulation under the new Building (Scotland) Act 2003, as defined by the EU Construction Products Directive will require new guidance and these are now briefly examined in terms of the impact of sustainability requirements on that area in relation to some of the issues identified in table 4 (missing areas of building regulation). The examination of these areas is not definitive but simply acts as a pointer for further comprehensive research that is urgently required in order to ensure that the building standards and guidance fulfil sustainable construction imperatives.

5.4.1 Structure

Previous research[51] has identified BS standards and testing as potentially inhibiting the use of more sustainable alternatives for construction, but this should be remedied by the use of performance standards rather than prescriptive standards in this section.

It will also be necessary to consider CE standards in terms of recycled and re-used materials for structural purposes as well the ability for a structure to be deconstructed.

More prescriptive guidance will be required in relation to climate change to take account of the increasing requirement for thermal mass in relation to rising temperatures in the short term, as well as flooding, and increased storm conditions. CE testing requirements are potentially prohibitive for new environmental materials, but alternative conformity is available.

5.4.2 Fire

One area that will require performance standards and possible guidance concerns the spread of fire in relation to turf roofs, which does not exist at present.

Another area of concern relates to the off-gassing of chemical fire retardants in relation to Indoor Air Quality. This will require further research.

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[51] Stevenson and Macrae, 1998

The issue of compartmentation in relation to flexibility of use should also be examined to address the need for buildings to be able to change use rather than face demolition.

5.4.3 Environment

This is a major area of consideration for the new regulations and guidance because it clearly embraces sustainable construction.

The Technical Standards only cover the scope of the "environment" in matters related to "health and safety". The new guidance and regulations must clearly define "environment" in relation to sustainable construction and expand the definition of safety to include, not only humans, but also flora and fauna as well as the natural resource base. Given that sustainable construction must be predicated on processes that maintain natural resources over time, it will be necessary for the standards to consider buildings in terms of their whole lifecycle.

The EC 6th EAP calls on members to take measures to ensure minimal climate change, natural biodiversity, environmental and heath consideration, as well as sustainable use of natural resources and waste management. Although other legislation can cover these aspects in relation to sustainable construction retrospectively, *only the building regulations in tandem with planning regulations can ensure that sustainability measures are "designed in" from the outset.* A good example of this is the need to promote design for deconstruction, not through the CDM regulations but through the building regulations, which come prior to CDM in the design process.

At present there is no consideration of biodiversity in the construction standards because it is supposedly covered in the planning process through EIA. This ignores the major contribution that building design itself can make to promoting biodiversity. This can be both through the specification of materials (which affects biodiversity at the material source point and affects global ecology) and the construction of a building (which promotes or discourages biodiversity –for example, a flat turf roof can encourage wildlife, a metal finish roof will not). Other examples for promoting biodiversity include the use of indigenous flora around a building, building in bat boxes, providing external water features and using SUDS (sustainable urban drainage systems).

A key area for consideration is SITE PREPARATION which should be expanded to include preservation or extension of existing ecosystems, depending on how much flora and fauna already exists on the site. This section should also be directly linked to the requirement for EIA under planning regulations. EIA at present does not cover all eventualities for buildings as it is only considered over a certain cost of the built works.

FLOODING AND GROUNDWATER as a section should be linked directly to planning guidance and take account of predicted flooding under climate change. Prescriptive standards may be appropriate here in terms of harmonising with planning guidance for buildings in flood prone areas. These would include setting the minimum ground floor level in relation to the predicted flood level.

COMBUSTION APPLIANCES as section needs to be expanded to include sustainability as well as safety and avoid harm to the environment as well as people. This means reducing Nox emissions to an absolute minimum. The use of SEDBUK standards for boilers is a step forward, but oversizing of boilers, with its corresponding inefficiencies, is a frequent problem not currently dealt with by the current regulations The need for regular maintenance inspections to ensure compliance should be cited here. A lifecycle approach should be adopted in the standards.

PRECIPITATION as a section needs to take account of predicted climate change in relation to detailing. Guidance and revised prescriptive standards will be necessary to demonstrate performance compliance in terms of and storm risks.

HEATING as a section needs to address efficiency and sustainability with reference to the primary source of energy and the need to minimise CO_2 emissions to certain standards. The emphasis should be on conservation of primary fuels rather than heating itself. This will also address fuel poverty by encouraging the use of renewable energy and reducing fuel bills. A lifecycle approach should be adopted in the standards for maintenance. The standards should relate to planning guidance and ensure that buildings can be "future" proofed for connection to district heating schemes as they develop. Prescriptive standards will be required to include means of compliance with emissions targets.

VENTILATION as a section needs to be expanded to refer to sustainability through energy efficient methods and appliances. A life cycle approach should be adopted to maintenance of ventilation systems with an emphasis on accessibility and cleaning to promote good indoor air quality. Limits on power use should be explicit and specific. An example of this would be to limit fan power. Prescriptive standards will be required in terms of limited air changes per hour and the means of ensuring airtightness. These will need to consider both natural and mechanical means of ventilation. Prescriptive standards on monitoring carbon dioxide emissions as well as the cleaning of ventilation equipment will also be required. Prescriptive guidance will be required to demonstrate how a building should address passive means of natural ventilation and the need for appropriate shading, thermal mass etc. before resorting to mechanical means of ventilating and cooling a building.

NATURAL LIGHTING as a section should stress the need to optimise daylighting in preference to artificial lighting in order to conserve energy and resources where practicable. Adequate daylighting should be a requirement in terms of human health in all buildings. The current prescriptive requirement for minimum opening sizes to ensure adequate daylight will need to take account of the requirement to reduce overheating in both domestic and non-domestic dwelling given the predicted climate change in the short term.

WASTEWATER as a section needs to introduce the concept of water conservation. This is not presently covered by the Water Acts, which require an efficient delivery of water, but do not address what happens to water once it is inside a building. Water conservation within a building is more properly addressed by the building regulations. The requirement for a water meter for domestic dwellings should be effected immediately to reduce water consumption. Additional prescriptive standards should be set for water appliances such as taps and toilets to ensure that measures for waste minimisation of water are implemented. In effect, as far as the regulations are concerned water conservation should be treated in the same way as energy conservation.

SANITARY FACILITIES should be expanded to take account of the need to minimise water use as part of reducing environmental impact.

SOLID WASTE STORAGE should be expanded to include the requirement for adequate waste storage facilities for recycling and reclamation purposes. At present the National Waste Strategy (which falls under the remit of SEPA) does not specifically address construction waste in detail. It can be argued that legislation is also required to ensure that construction waste is suitably managed and avoided where possible. The landfill tax has already altered the behaviour of contractors towards waste minimisation on site, but it has only altered the behaviour of some designers who are now beginning to look at how they can minimise waste by design. Thus waste is still mainly being tackled at the end of the "pipe" rather than being designed out in the first place.

It is recommended that the Solid Waste Storage section is renamed SOLID WASTE to allow consideration of the complete building lifecycle in relation to waste minimisation with a demand to "achieve optimum construction waste efficiency during the whole building lifecycle" in a similar manner to the wording adopted for energy efficiency. Performance standards will be required for this.

The expansion of the functional standards in this area will require prescriptive standards to ensure adequate provision of storage space for recycling (separation of waste at source, which takes up more space). The requirement for deconstruction as part of the lifecycle analysis of the building will require prescriptive standards which align with CDM requirements for safe disposal of buildings.

The new functional standards suggested in 6.4 to align with the 6th EAP will require some prescriptive standards initially until the performance requirements are fully embedded in the construction culture. In particular, examples of how to promote biodiversity through construction may be given in relation to SITE PREPARATION with a demonstrable link to EIA legislation and SNH guidance.

5.4.4 Safety

Much of this area is covered by CDM regulations in terms of safety, but there are numerous health considerations which need to be considered. There are also considerable overlaps between the issues of health and safety and those concerned with the environment. Numerous of the regulatory areas touched on under section 6.4.3, environment, will need to also be considered under section 6.4.4, in terms of health and safety.

One area that needs changing in relation to ensuring sustainable construction is the consideration of electrical magnetic fields in a precautionary manner.

ELECTRICAL INSTALLATIONS as section should be expanded to include health as a consideration. Recent opinion given by the EU (ref) has suggested that there may be a link between ill health and low level radiation such as that produced by electrical cabling. It would be prudent for the regulations to consider the use of circuit breakers or other devices to minimise human exposure to ELF.

Another area that need consideration is the avoidance of specifying hazardous materials in buildings, including the re-use of potentially hazardous materials. There is still relatively little understanding of the "cocktail" effect of low-level emissions from building materials and products on human health and until this is understood at a more detailed level, a precautionary approach should be adopted in terms of specification and disposal.

5.4.5 Noise

This area of the regulations will require some modification to ensure sustainable construction. In terms of health it will be necessary to include reduction of noise from the external environment as well as between buildings, as noise is the fastest rising source of environmental pollution in the EU at present.

The issue of noise reduction requirements within the building will also have to be addressed to allow for maximum flexibility of use for the future life of the building, to prevent early demolition due to change of use.

5.4.6 Energy

This is another key area, in tandem with the area on environment, which has a direct bearing on sustainable development and sustainable construction. The recent government white paper on energy has committed the UK to a carbon emission reduction of 60% by 2050 with "significant progress" by 2020. The building standards should properly reflect this requirement. Prescriptive standards for compliance will need to be addressed in order to raise standards such as SAP to 100 (as recommended by the Royal Commission for Environmental Pollution) in the first instance with provision for continuous upgrading thereafter, together with consideration of a new performance method for compliance as discussed in Part 4.

Targets for saving carbon dioxide emissions have been identified in the white paper[52] totalling 21.9 MTC. Improvements are targeted and show the focus areas to be wall insulation, boilers, solar water heating, lighting, double glazing and loft insulation. The section on energy in the regulations should be expanded to take account of these targets, together with related cost incentives.

It is vital that any reference to energy efficiency refers to the consideration of primary energy generation rather than the amount of energy that is used within the building. This will address the current distortion between gas and electricity as well as renewables in terms of true energy consumption.

In terms of energy related to dwellings it is important that low energy lighting is a requirement and that mention is made of the requirement for air-tight construction to be tested to 50 pascals air pressure in all buildings.

Restrictions on power use, which has a major impact in terms of transmission losses and through standby power use (estimated at up to 15% of total power use), should be introduced in the standards. Performance standards are required for lighting and mechanical installations (both for alternating and direct current) which ensure that power use is minimised.

There should be a presumption for low energy natural and passive ventilation strategies and mechanical ventilation should only be resorted to once shading, thermal mass and other options have been considered, in order to reduce energy use. This would be in accord with other European building legislation.

The government response to the Royal Commission on Environmental Pollution report on Energy (2000) acknowledged the desirability of CHP and district heating strategies. The section on energy in the regulations should be expanded to include reference to the requirement for energy efficient infrastructure and directly related to planning guidance on sustainable development layouts.

Presently, energy standards are measured per square metre rather than on a whole building basis. This means that the total amount of energy a building can consume is unrestricted providing a certain level of energy efficiency is achieved. This does not address overall energy targets and prevent the unnecessary current growth in size of certain buildings. In future, performance standards should consider energy targets in terms of building typologies.

A key aspect of energy efficiency is the need to address the inefficiencies of the existing building stock, given the slow rate of renewal which will only give 0.3% carbon emission savings a year. Ideally the building performance standards should address both the existing stock as well as new stock specifically in relation to energy efficiency such that any alteration would automatically trigger a requirement to upgrade the applicants building to current standards of energy efficiency.

A new section on retrofitting existing domestic stock at point of sale to comply with current energy standards will be required to describe exactly how replacement can comply in the following areas:

[52] BRE "Carbon Emission Reductions from Energy Efficiency Improvements to the UK Housing

- window and door replacement
- central heating replacement or equivalent heating source
- insulation upgrading to ceilings, walls and floors
- draught proofing
- air-tight construction
- roof replacement, including insulation upgrading
- ventilation replacement such as heat exchanger extractors

Additionally performance standards should address the upgrading of existing stock to current energy standards at point of sale, as in German regulations. This will be necessary if government targets of 60% reduction in carbon dioxide emissions are to be realistically achieved.

By adopting a "whole life" approach to energy efficiency it will be necessary to expand the functional standards to consider both maintenance requirements and embodied energy and carbon dioxide emissions for buildings as in other European building regulatory standards. The introduction of a requirement to minimise embodied carbon dioxide emissions in the construction of buildings will require a degree of consensus. The building regulations should provide guidance on embodied emissions, and leave the onus on the applicant to prove mitigation if this is required.

5.4.7 Worked Example From Technical Standards: Sanitary Facilities (Domestic)

Current Functional Standard 3.12 (as of September 2003): **"Every building must be designed and constructed in such a way that sanitary facilities are provided for all occupants of, and visitors to, the building and that there is no threat to the health and safety of occupants or visitors"**

The following table illustrates issues that need to be addressed by this Functional Standard using the distilled parameters from Table 3 in this report. The issues are related to the Functional Standards (as proposed in September 2003) to address sustainable construction. We are aware that these will have been updated since the time when this original research was completed in September 2003.

Stock" BRE, 2001

Table 5: Summary of Issues Raised by Sustainability Parameters for 3.12 Functional Standard and Guidance			
Distilled Parameters for Sustainability (from table 3)	Issues for 3.12	Priority Actions	Pull Factor –future proofing
1. Design for Effective Resource Use 6. Managing the Build Process	• Fan-assisted waterless closets • Mechanical and pumped systems • Infrastructure burden • Design and installation of sanitary ware and maintenance • Hot water consumption • Embodied energy in components • Change of use • Re-use/recycling • Upgrading	• Water metering • Develop strategy for existing W.Cs uprgrading • Promote renewable energy use for fan-assisted waterless closets and mechanical systems/pumps at appropriate scale • Minimise energy use in construction cycle • Energy recovery from shower • Max flow rates for water for taps and showerheads • Change min. req to shower only • Select products and construction processes for deconstruction, re-use, recycling, and spatial flexibility • Update BS6465 to standardise for non-destructive upgrading of facilities • Upgrade Water regulations (6litre max for WC reduce and allow for dual flush and 1 litre flush) • Adopt Norwegian regs 8-1, 8-5. • Guidance on rainwater harvesting/grey water use	• Climate Change – reduced carbon emission targets (60%) • Life Cycle Analysis - Update BS 6465 Part 1 for ref to ecolabelling of products (energy use) –future targets • Institutional Change –regulations related to SEPA waste strategies • Waste minimisation - future targets • Demographic changes –require flexibility • Maintenance and lifecycle costing • Electronic tagging of products • Minimise finite resource use

2. **Minimise Pollution**	• Reduce toxicity burdens (urban) through design and construction • Principle of non-dilution where possible (waterless/minimum flush wc's) • Transportation distances for specified sanitaryware to site	• Adopt generic precautionary principles in Norwegian regs 8-1, 8-5 • Contain pollutants within waste system –guidance for rainharvesting/greywater • Upgrade BS6465 to take account of minimising transportation • Adopt Norwegian regs 8-1, 8-5.	• Biodiversity and Eco-toxicity – adopt indicators in M4I KPI's as part of guidance • Promote low embodied energy materials • Sustainable supply chain - resource flow systems with regions
3. **Respect for People, Communities and Local Environment** 5. **Creating Healthy Environments**	• Use of non-polluting materials in sanitary ware • Minimise need for chemical treatments by good design –self cleaning. • Noise and privacy • Accessibility for maintenance (in BS but should be in guidance)	• Adopt principles from Norwegian regs 9-1 for accessibility • Upgrade sound insulation requirements to sanitary facilities • Upgrade BS6465 to take account of minimising chemical cleaning through design	• Indoor Air Quality • Building related ill-health • Maintenance and life-cycle costing • Biodiversity and ecotoxity –leakage from septic tanks
4. **Promoting Biodiversity and ecosystems**	• Re-nutrifying of site landscape through local treatement • Local treatment of concentrated pollutants.v. dispersal by water • Burden on watertables.	• Amend presumption against waterless closets where there is main sewer connection • Adopt Norwegian regs 8-1, 8-5	• Institutional Change –stronger links with SNH biodiversity plans • Biodiversity –soil depletion,mineral depletion • CBPP Biodiversity Indicators

Design for Effective Resource Use, Managing the Build Process

Water conservation is an example of a cross-cutting sustainability theme that requires the Scottish Executive to take action at a number of levels if measures are to be effective and support eachother. The debate centres on whether the regulation should fall under the current water (fittings) regulations or building regulations or both. It is suggested here that water conservation within buildings rightly belongs under the Building Regulations rather than the Water Regulations, because of the design consequences and effects on the building process of introducing water conservation requirements.

It is not anticipated that the Building Regulations will have a requirement for new or existing housing to have water metering in Scotland before 2007. The current Water Regulations do not require the use of domestic metering of water use. This is a major obstacle to water conservation, because users are unaware of the amount of water they are consuming. Until water is metered there is little incentive for clients to ensure their buildings promote water conservation. It also prevents the use of quantified data to provide a ratchet effect for driving down water consumption through more and more stringent standards.

The use of greywater/rainwater harvesting, discussed under Minimising Pollution in terms of helping contain pollution, is equally important in terms of water conservation measures.

There is now extensive research and guidance on greywater/rainwater harvesting in relation to sanitary facilities (ref Vales, Rainwaterharvesting, H2O etc) which suggests that these systems require careful design and integration into the building if they are not to be energy intensive. Although the current regulations do not prevent harvesting from being implemented, they do not encourage it, or plan for it in the future, either. Guidance and reference to best practice would be seen to promote sustainable construction

The need for flow-restrictors in taps and showerheads as discussed under energy use, is equally important from a water conservation viewpoint.

At present the Water Regulations allow for WC cisterns of upto 6 litres, whereas the British Standards are written for 7.5 litres. Both of these cisterns use excessive amounts of water. There are now numerous 1 litre flushing systems on the market, several of which have been extensively tested in Norway and Sweden. There are also numerous pans which separate liquid from solid waste. Guidance should be provided on these through new British/European standards and the Water regulations amended accordingly.

Section 3.12.1 Functional Standard currently requires that dwellings should have as a basic minimum either a bath or shower. In terms of water conservation, it would be advantageous for this section to be amended to specify a shower as the basic minimum only. This will ensure that all new dwellings have a shower, which is more water efficient than a bath, as a basic minimum. Should developers wish to incorporate a bath into the dwelling, they would also be required to supply a shower as an alternative from the outset.

The consideration of energy efficiency in sanitary ware extends beyond the building and component lifecycles themselves and is intimately connected with the energy burden that the sanitary specification places on other infrastructures.

Ordinarily, sanitary systems in domestic dwellings are gravity fed, or pressure induced. If there is a requirement for either a pumped system or fan-assistance (as in the case of water-less closets), consideration should be given to the use of renewable energy as a supply source. This may apply particularly to rural domestic situations where there is no mains electricity.

This matter is perhaps more properly dealt with generically under the Section dealing with energy in the Functional Standards but it is pointed out here to illustrate the issue.

If excessive material is used during the construction, maintenance and deconstruction of sanitary ware, this will have energy implications in terms of transportation energy and embodied energy requirements for the extra material brought to site. The embodied energy content of the specified sanitary ware itself should be considered and use made of EU approved ecolabelling where possible. BS6465 (1994) Part 1, which relates specifically to the specification and installation of sanitary fittings, acknowledges that fireclay is the predominant material for sanitaryware, but also mentions stainless steel and GRP without distinguishing between them from an environmental point of view.

W.c's currently use 27% of all public water supplies in the UK with showers using 5% (www.ukepic.com).If an excessive amount of water is flushed down the w.c. each time, it also increases the amount of energy needed to pump the water to the installation as well the amount of embodied energy in the infrastructure required to supply and store the water.

The use of hot water in baths, sinks, basins and showers should be minimised using flow restrictors[53] to aid energy efficiency. Additionally guidance should be offered on extraction of heat from waste water[54].

The design and installation of sanitary ware should take into account the potential for the closet space to change function in the future (into a cupboard, or part of another space). Sanitary fittings should be easily demountable without breakage. Where sanitary fittings are built in, the housing should be easily dismantleable. There are a number of initiatives investigating design for deconstruction[55] and it is arguable that Building Standards and Guidance should reinforce these voluntary initiatives with an overarching statement that supports resource efficient construction and promotes future-proofing.

At present there are no BS –EN standards which relate to design for deconstruction in relation to sanitary ware and it is difficult to see how the Functional Standards and guidance could go beyond a broad requirement for efficient construction, until the BS's are updated.

BS6465 (1994) Part 1 contains no requirement for fixings and fittings to be fully demountable for the purposes of re-use or recycling. Section 12.3.2 on

[53] DEFRA is already investigating this through its Market Transformation Programme (www.ukepic.com) with policy briefs on showers, baths and w.c.'s. It is recommending that all showers should be fitted with adjustable flow restrictors by 2011.

[54] Heat exchange systems for wastewater from bath and showers are available from H2O Solutions (Nick Grant).

installation of w.c.'s notes that there are flexible connectors which enable wc pans to be removed, but this is not recommended as such.

The embodied energy of sanitary ware should also factor in the distance for transportation from factory to site. The Scottish Executive has commissioned a "Resource Balance" project in association with Best Foot Forward to map the flow of materials in Scotland[56]. Once this has been completed, both Planning and Building Regulation guidance can use this as a reference document for helping specifiers to minimise transportation of materials to site.

Minimise Pollution

Although section 3.12 does not deal directly with waste treatment, the ill considered design of sanitary facilities themselves can prevent the possibility of introducing greywater /rainwater harvesting and/or waterless closets in the future which can reduce water pollution.

The use of greywater collected from baths and wash hand basins for flushing w.c.'s has been carried out for a number of years on innovatory housing schemes in the UK[57]. In the USA, the EPA Green Building Programme endorses the use of recycled water as a means of environmental conservation on several levels:

- Reduced burden on existing water tables
- Reduced burden on water supply infrastructure
- The containment of potential pollutants within the waste cycle

Rainwater harvesting for sanitary use can ensure that pollutants contained in rainwater are kept within a contained waste-cycle where necessary.

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[55] BRE Deconstruction Cluster Group: bre.org.uk, CIRIA projects on Waste Minimisation: www.ciria.org.uk , Construction Best Practice Programme: www. cbpp.org.uk

[56] As discussed in SEPA's National Waste Strategy (2003) under construction waste.

[57] See for example The Housing Forum, www.thehousingforum.org.uk/re/publications/reports/HF_E-factor.pdf, which has numerous project examples.

The use of rainwater/greywater systems for sanitary facilities requires planning at an early stage in the design process. Guidance in the Building Regulations can assist this.

Guidance should also be given on how to choose whether or not to connect to an existing sewer main. There are strong arguments in many instances for preventing the dispersal of sewage pollutants through a water borne system. A waterless system is highly effective way of treating concentrated organic waste locally with composting destroying pathogens at source.

Respect for People, Communities and Local Environment, Creating Healthy Environments

Conventional sanitary ware has been designed specifically with the preservation of human health in mind by preventing vapours from the disposal pipe escaping through the use of water traps.

Although BS6465 (1994) Part 1 describes the design of wc pans for efficient flushing, it does not relate pan design, or indeed design of any sanitary ware, to avoid the need for strong, harmful cleaning chemicals. The chemical burden from cleaning agents for sanitary ware is a major consideration, and, over the lifetime of the building, may far outweigh other ecotoxicity issues.

It is noted that BS6465 (1994) Part 1 also refers to the use of fungicides in sealants for sanitaryware (section 8.1.6). Sanitary ware installation design should obviate the need for fungicides in sealants. If a fungicide kills fungi, it can destroy vital fungi in an ecosystem once it leaves the construction lifecycle, and finds its way to landfill.

Promoting Biodiversity

Biodiversity is an important dimension in the consideration of regulation and guidance relating to sanitary facilities. A key feature of biodiversity is appropriate soil-enrichment and soil re-mineralisation in relation to a given site.

The Construction Best Practice Programme has recently published a report which identifies biodiversity indicators at the level of site, construction process and production[58]. The indicators form a check list which the client, contractor and designer can use to ascertain whether best practice has been followed. At present the building regulatory process does not take account of biodiversity indicators and there is an opportunity in Section 3.12 to refer to guidance on this in relation to sanitary facilities.

Section 3.12.2 is overly restrictive at present in allowing waterless closets only where a connection to a public sewage system cannot practically be made. This ignores the wider dimension of using waterless closets to reduce water consumption and to promote the generation of nutrients on a local basis to replenish ecosystems. It may be the case, that despite a sewage connection being available, the promotion of biodiversity would benefit more from a waterless closet system which was able to discharge it's nutrients to the site on a regular basis, thus "closing the loop" locally.

[58] "Biodiversity Indicators for Construction Projects" CIRIA W005 July 2003, incorporated into the DTI "Constructing Excellence KPI Pack (June 2003)

Relevant Regulations, Standards, Codes of Practice

Water Regulations:

The Water Fittings Regulations 1999 (or Byelaws 2000 in Scotland) are national requirements for the design, installation and maintenance of plumbing systems, water fittings and water-using appliances. Their purpose is to prevent misuse, waste, undue consumption or erroneous measurement of water and, most importantly, to prevent contamination of drinking water. They replace the former Water Supply Byelaws which each water supplier has administered for similar purposes for many years.

The relevant text from the Regulations is Part II Requirements 3.

(2) No water fitting shall be installed, connected, arranged or used in such a manner that it causes or is likely to cause-

(i) waste, misuse, undue consumption or contamination of water supplied by a water undertaker; or

WC's, flushing devices and urinals
25. - (1) Subject to the following provisions of this paragraph-

(d) no flushing device installed for use with a WC pan shall give a single flush exceeding 6 litres;

(e) no flushing device designed to give flushes of different volumes shall have a lesser flush exceeding two-thirds of the largest flush volume;

There is no commentary in the Water fitting regulations that addresses waste minimisation as such, or the statutory requirement for spray taps, low-flush W.C.'s, etc. or design for deconstruction.

Classification of rainwater as category 4 fluid, significant hazard due to presence of environment organisms, doesn't help rainharvesting for w.c. use.

British and European Standards:

The following standards are applicable to Guidance on Sanitary Facilities (not exhaustive!)

BS6700 (1997) Design and Installation of Domestic Water Services
BS 12056-2 (2000) Sanitary Pipework
BS 6465 Part 1 (1994) Code of Practice for provision, selection, and installation of sanitary appliances
BS 5889 Sealants
BS1125 WC Cisterns
BS5388 (1976) Specification for Spray Taps
BS EN 246(1992) Sanitary Tapware. General Technical Specifications for Single and Mixer Taps
BS EN 246 (1992) Sanitary Tapware. General Specification for Flow Rate Regulators
BS5504:Part 3 and 4 (1990) Specification for Wc's For Use with 7.5 Litre Maximum Flush Capacity Cisterns.
BS 6340 (1983) Specification for Shower Units Parts 1-8.

Other Standards:

NSF 41 (1996)Wastewater recycling/re-use
NSF 41 (1999) Non-Liquid Saturated Treatment Systems

Suggested Replacement Text: Functional Standard 3.12

The text below offers an example of re-wording the Functional Standards (as proposed in September 2003) to address sustainable construction. Changes are shown in italics.

"Every *building* must be designed and *constructed* in such a way that reliable *sanitary facilities efficient in the use of water* are provided for all occupants of, and visitors to, the *building; that wastes are safely removed* and that there is no threat to the health and safety of occupants or visitors, or to the environment.

Leaks should be easily discovered and not cause unnecessary damage to building or other components. Shut off facilities should be provided where buildings may be unoccupied for some time.

Due regard should be given to replacement of and to re-use of components.

Wastage of water should be avoided and good energy economy promoted.

Tap points should provide water at a safe temperature.

3.12.0 Introduction
Since April 2000 there has been a requirement for all *dwellings*, to be accessible to *disabled people*, unless it is not *reasonably practicable*. The intention is to allow people to be able to invite *disabled people* to visit them, without assistance, in their homes.

Since May 2003 there has been a requirement for the building regulations to support sustainable development. The intention is to ensure the maintenance and continual improvement in the quality of the built environment whilst eliminating adverse impacts on the natural environment.

Visitability standard
Accessible requirements for new *dwellings* include a step-free approach to an entrance, a level threshold at the entrance, suitable corridor and door widths to permit wheelchair circulation on the entrance *storey*, and the provision of a WC on the entrance *storey*. The provision of a fully accessible wheelchair accessible WC is not practicable, particularly in small *dwellings* but the space requirements will allow the majority of *disabled people* to use the facilities. It should be noted that the internal requirements apply even if a level access is not practicable. Although not

specifically aimed at the needs of the elderly it is hoped that the requirements will allow homeowners to be able to remain in their own homes longer despite increasing age-related infirmity. They also cater for those who may become temporarily disabled. Access to *houses* for disabled visitors is limited to the ground or entrance *storey* at present, because of the difficulty of ensuring safe escape for *disabled people* from *upper storeys* in the event of fire. In the case of conversions, as defined by Regulation 3, the *building* as *converted* must meet the requirements of this standard (Regulation 12, Schedule 6).

Sustainable Development

"The life of works shall in all phases ie execution, usage and demolition be managed with a reasonable load on resources and the environment and without worsening quality of life and living conditions. Materials and products for use in construction works shall be manufactured with attention to energy and water efficiency and with the aim of preventing pollution. Construction works shall be designed and executed so that minimum energy is consumed and minimum pollution caused during the life of the works, including demolition[59].

Sustainability requirements for new dwellings include provision for resource conservation and pollution avoidance. The precautionary principle also requires us to take account of possible future changes including weather patterns and demographic changes.

The provision of facilities for monitoring water consumption should mandatory and there should be a presumption in favour of *water and energy conservation and use of low water use elements,* a preference for products and materials that can be recycled, ease of replacement and refitting, provision for cleaning with minimum use of chemicals and detergents.

Sanitary facilities should be design in such a manner that the *design and construction methods adopted for assembly of components and materials* allow for efficient deconstruction to enable re-use of products and materials, and potential flexibility of space.

Where there is a specific targets for water consumption then estimates must be submitted. Verification may be sought.

[59] Much of this text is drawn from the Functional Standards in the Norwegian building regulations discussed in Phase 1 of this report.

Where there are specific requirements for waste recycling from construction then information on the source of components and their planned installation must be submitted.
Where there are specific requirements for declaration of material and product content then this should be provided.
At point of sale, WC facilities must be upgraded and water metering introduced to meet set targets (to be established by BSAC in consultation with others).

In the case of conversions as defined by Regulation 3, the *building* as *converted* must meet the requirements of this standard (Regulation 12, Schedule 6).

3.12.1 Sanitary provision (M4.1)
Every *dwelling* should be provided with *sanitary facilities*. The minimum facilities acceptable would be 1 watercloset, or waterless closet together with 1 washbasin per watercloset, or waterless closet, 1 shower and 1
sink. It would be normal for the sink to be located in the *kitchen*. In larger *dwellings* where there will be accommodation for 5 or more persons, it would be preferable to provide an additional watercloset, or waterless closet, to achieve a more convenient arrangement.

All fittings should conform to BS6465 Part 1 (1994): Code of Practice for the provision, selection, installation of sanitary appliances.

Wherever possible, sanitary facilities should be located to facilitate natural ventilation through an openable window or skylight to prevent condensation without undue energy use (this has been taken from BS6465 and re-emphasised).

Consideration should be given to potential heat-recovery from hot waste water from all sanitary ware.

3.12.2 Water closets
If a water closet is to be installed, in addition to complying with BS6465, provision should be made to reduce water use through installation of a dual-flush system or minimal water system (1 litre flush).

3.12.2 Waterless closets (M4.2)
In a *dwelling*, where it is not possible or desirable to connect a *wastewater* drainage system to a public sewerage system (for example, if the distance is too far, or an expensive pumped *wastewater* system would be needed or water conservation is an

objective), a waterless closet may be installed. If a waterless closet is installed it should be to a safe and hygienic design such as:

a. National Sanitation Federation Certification to Standard NFS 41: '*wastewater* recycling/reuse and water conservation devices; or
b. NFS International Standard ANSI/NSF 41-1999: 'non-liquid saturated treatment systems'; or
c. to the conditions of a certification by a *notified body*.

Although some European countries manufacture waterless closets, they have not as yet been tested to any recognised standard. This does not mean that they are unacceptable, just that care should be taken in their choice to ensure they are both safe and hygienic in use.

3.12.3 Accessible *toilet* (M4.3)
A *toilet* should be accessible for visitors who may be disabled, i.e. it should be accessed directly from a public space and not via a bedroom. Every *dwelling* therefore, should have at least 1 watercloset, or waterless closet on the accessible entrance *storey*. There should also be an activity space clear of any door swing, of at least 750 mm long x 800 mm wide in front of, but not necessarily centred on, the watercloset, or waterless closet. A wall-hung washbasin may project into the activity space without restricting the space too much. An activity space should be provided in accordance with the following diagram: The accessible *toilet* should be accessible from public areas in a *dwelling* and should not be provided en-suite.

However, if access for *disabled people* is not provided to a *dwelling* because, say, the main entrance level is on an upper level,*sanitary facilities* should still be provided, either:

a. on the *storey* accessible to *disabled people*; or
b. where there are no *apartments* on the *storey* accessible to *disabled people*, on the first *storey* above or below this *storey* containing an *apartment*.

3.12.4 Washbasin provision (M4.10b)
There should always be a washbasin provided close to a watercloset. This washbasin should either be located in the *toilet* itself, or in an adjacent space providing the sole means of access to the *toilet*. Taps for the washbasin should minimise use of water and have adjustable flow restrictors which comply with the set standards.

In circumstances where a waterless closet is necessary or preferred, then the requirement for a washbasin may be waived provided that adequate arrangements are made in respect of meeting hygiene standards located in the *toilet* itself, or in an adjacent space providing the sole means of access to the *toilet*.

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There should also be a door separating the watercloset, or waterless closet, from a *room* or space used for the preparation or consumption of food, normally the *kitchen* or dining *room*.

3.12.5 Shower provision

There should be an adjustable flow restrictor built into the shower head to ensure efficient water use with a maximum flow rate.

3.12.6 Conversions and alterations

The provision of additional *toilets* should be considered in relation to the other *sanitary accommodation* available in the *dwelling*. If an alteration or extension is being undertaken, such as the provision of a new bedroom that will increase the number of persons in a *dwelling*, there is no need to provide an additional *toilet*.

Where a new *toilet* is to be provided, then:

a. if a *toilet* already exists on the entrance *storey* that has been designed as an accessible *toilet* (see clauses 3.12.3,and 4.2.2), the new *toilet* need not meet these recommendations; but

b. if there is no accessible *toilet*, then the new *toilet* should be designed as an accessible *toilet*.

When an existing *toilet* is to be altered, then:

a. if the *toilet* has been designed as an accessible *toilet*, it should continue to do so after alteration; but

b. if it has not been designed as an accessible *toilet*, it need not be altered, unless the alterations include the door position, or the activity space. In which case the new door and/or activity space should be designed to the recommendations for an accessible *toilet*. Where it is intended to move an existing accessible *toilet* (meeting the guidance in clause 3.12.3), from the entrance *storey* to another *storey*, then a replacement accessible *toilet* should be provided on the entrance *storey*. This is because a *building* must not fail to a greater degree as a result of the alteration. However, if it is intended to relocate an existing *toilet* that is not in accordance with the guidance in clause 3.12.3 from the entrance *storey* to another *storey*, then there is no need to provide on the entrance *storey* a replacement accessible *toilet*. In this case the *dwelling* is not failing to a greater degree.

5.5 Conclusions and Recommendations

A Framework for Environmental Development is required in order to develop cross-cutting sustainable development policy in the Scottish Executive. Such a framework could unite the presently disparate policy on sustainable construction.

- *It is recommended that the Executive produce a Framework for Environmental Development as a precursor to any policies on sustainable construction within sustainable development.*

- *It is recommended that the Scottish Building Standards Agency directly consults SEPA, in relation to waste and pollution, and SNH, in relation to natural resources, when drafting new standards or revisions to ensure they promote sustainable construction.*

A key area for increased integration lies between planning and building legislation and guidance. While it may not be practicable at this time to develop joint applications, there is nevertheless much scope for the Scottish Executive Planning and Building departments to develop strong bi-lateral referencing in the guidance documentation of each area, to ensure the greater integration required by sustainable development.

- *It is recommended that the Scottish Building Standards Agency and Scottish Executive Planning Division set up a joint working party to investigate the particular "gaps" between them identified in this report in relation to EIA and other infrastructure issues such as transportation in relation to sustainable construction.*

There is now significant scope, with the inclusion of sustainable development as an aim in the Building (Scotland) Act 2003 for the building regulation guidance to take on board sustainable construction issues that have been identified by other Scottish agencies. A prime example of this is the need to reduce construction waste. Although taxes have had some effect, this does not "design out" the problem, for which building legislation and guidance is much more effective. Another area for consideration is the use of water within buildings.

Various missing areas in the current building regulations have also been identified by reference to best practice and regulatory systems elsewhere. Prescriptive standards, by transposition from the current "Deemed to Satisfy" guidance will continue to exclude sustainable design approaches by omission rather than prohibition unless they are carefully re-considered.

- *It is recommended that the Scottish Building Standards Agency urgently consider all the issues identified as missing areas in the building regulations and standards in relation to sustainable construction, in consultation with the relevant parties both within the Executive and other agencies, and develop new standards and guidance accordingly.*

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www.hmso.gov.uk
www.environment-agency.gov.uk
www.sepa.org.uk

<u>For UK Government policy:</u>

www.sustainable-development.gov.uk
Department for Environment, Food and Rural Affairs www.defra.gov.uk
Department of Trade & Industry www.dti.gov.uk
Archived site of now reorganised DETR - www.detr.gov.uk

<u>National Waste Plan for Scotland</u>

www.sepa.org.uk

<u>Best Practice Sites</u>

ENVEST: http://projects.bre.co.uk/ConDiv/tool/default.html
BREEAM: www.products.bre.co.uk/breeam
Environmental Performance Indicators: www.m4i.org.uk
European Harmonised Indicators: www.sustainablecities.org/indicators
Quality of Life Indicators: www.sustainable-development.gov.uk
Ecological Footprints: www.bestfootforward.com
NABERS: www.ea.gov.au/industry/waste/construction/final-draft.html
Construction Best Practice: www.cbpp.org.uk
Lean Construction: www.leanconstruction.org
Association for Environment Conscious Building www.aecb.net
Scottish National Heritage www.snh.org.uk
Construction Industry Research and Information Association
www.ciria.org.uk

Sources of Information for Building Regulations:

Australia
www.abcb.gov.au and www.yourhome.gov
www.ea.gov.au/industry/waste/construction/final-draft.html

Austria
www.eva.wsr.ac.at/projekte/epolicy.htm

Denmark
www.boligministeriet.dk/uk/pub/bygregl/bygreg12.pdf

England & Wales
www.bre.co.uk/referencefile
www.dti.gov.uk/construction/news
www.safety.odpm.gov.uk/bregs/brpub
www.odpm.gov.uk/about/eemas/bregs/index.htm

Germany
www.asue.de

Netherlands
www.nibe.org
www.vrom.nl/international

New Zealand
www.eeca,govt.nz
www.nzia.co.nz/environ

Scotland
www.thestationeryoffice.com
www.scotland.gov.uk

Norway
www.be.no/beweb/english/englishtop.html

Sweden
www.boverket.se
www.naturvardsverket.se

USA
www.boca.org/pdf/ibc_2000_tc.pdf
www.ci.austin.tx.uk/smartgrowth
www.greenbuilder.com

EU
http://europa.eu.int/comm/enterprise/construcion/suscon

Acronyms

ABCB	Australian Building Codes Board
AIA	American Institute of Architects
AIVC	Air Infiltration and Ventilation Centre
BCA	Building Codes of Australia
BEES	Building for Environmental and Economic Stability
BRE	Building Research Establishment
BREEAM	BRE Environmental AssessmentMethod
BS	British Standard
BSAC	Building Standards Advisory Committee
CDM	Construction Design and Management
CE	European harmonised label
CEN	European Organisation for Standards
CHP	Combined Heat and Power
CIRIA	Construction Industry Research and Information Association
CPD	Construction Product Directive
DCAT	Development Centre for Appropriate Technology
DDA	Disability Discrimination Act
DEFRA	Department of Environment, Food and Rural Affairs
DETR	Department of Environment, Transport and the Regions
DTI	Department of Transport and Industry
EAP	Environment Action Programme
EC	European Community
EPC	Environment Performance Coefficient
EIA	Environmental Impact Analysis
EIS	Environmental Impact Statement
ELF	Electromagnetic Low Frequency
EMAS	Environmental Management and Auditing System
EN	European harmonised standard
ENVEST	Environmental Estimation Model
EPA	Environmental Pollution Act
ETA	European Technical Assessment
EU	European Union
FSC	Forestry Stewardship Council
GIS	Global Information System
HECA	Home Energy Conservation Act
IBCO	Institute of Building Control
ICC	International Code Council
IPPC	Prevention and Pollution Control
ISO	International Standards Organisation
LCA	Life Cycle Assessment
LEED	Leadership in Energy and Environmental Design
MNECB	Model National Energy Codes of Canada for Buildings
NABERS	National Australian Buildings Environmental Rating System
NGO	Non Government Organisation
NPPG	National Planning Guidance
NZBC	New Zealand Building Code
ODPM	Office of the Deputy Prime Minister
PCB	Polychlorinated biphenyl
PROBE	Post-Occupancy Evaluation of Buildings and their Engineering
ROC	Renewable Obligation Certificate
SAD	Seasonal Affective Disorder
SAP	Standard Assessment Procedure
SEPA	Scottish Environmental Protection Agency
SNH	Scottish Natural Heritage
SUDS	Sustainable Urban Drainage System
UN	United Nations
VAT	Value Added Tax
VOC	Volatile Organic Compound
WWF	World Wildlife Fund

Appendix 1:
Background to Sustainable Development

Appendix 1.1 Models of Sustainable Development

The Natural Step
Factor 4
Factor 10/MIPS
A Better Quality of Life
Meeting the Needs

Appendix 1.2 Techniques for Appraising Sustainable Construction

Critical Path Tools
Targeting Tools
Benchmarking Tools
Checklists

A1.1 Models of Sustainable Development

❑ The Natural Step

The Natural Step is an evolving framework for sustainable development that was developed by scientists in Sweden in 1999. The UK NGO "Forum for the Future" has adopted the methodology and identified 12 features to describe what a sustainable society should look like. These are intended to help organisations evaluate the sustainability of their projects.

Table 2: "The Natural Step": 12 Statements for Sustainable Development

Natural Capital.	
1	In their extraction and use, substances taken from the earth do not exceed the environment's capacity to disperse, absorb, recycle or otherwise neutralise their harmful effects (to humans and/or the environment)
2	In their manufacture and use, artificial substances do not exceed the environment's capacity to disperse, absorb, recycle or otherwise neutralise their harmful effects (to humans and/or the environment)
3	The capacity of the environment to provide ecological system integrity, biological diversity and productivity is protected or enhanced
Human Capital	
4	At all ages, individuals enjoy a high standard of health
5	Individuals are adept at relationships and social participation, and throughout life set and achieve high personal standards of their development and learning
6	There is access to varied and satisfying opportunities for work, personal creativity, and recreation
Social Capital	
7	There are trusted and accessible systems of governance and justice
8	Communities and society at large share key positive values and a sense of purpose
9	The structures and institutions of society promote stewardship of natural resources and development of people
10	Homes, communities and society at large provide safe, supportive living and working environments
Manufactured Capital	
11	All infrastructure, technologies and processes make minimum use of natural resources and maximum use of human innovation and skills
Financial Capital	
12	Financial capital accurately represents the value of natural, human, social and manufactured capital

The “features” can be seen as vision statements but they can also be related directly to absolute targets (e.g. rates of extraction, carrying capacity for ecosystems) in relation to sustainable construction. An example might be the maximum rate of extraction of timber from tropical forests for construction use. The "features" are categorised by five "capitals" to represent the outcome of a successful capital investment strategy for sustainable development - that is, a sustainable society.

In terms of sustainable construction, The Natural Step provides an overall framework within which to discuss policy and ties in with the eco-centric model described above.

The statements were designed in partnership with Keele University, with an ESRC project grant and are comprehensive, internally consistent and culturally neutral.[60]

- <u>Factor 4</u>

This report to the Club of Rome in 1997 by Ernst von Weizsacker, Amory Lovins and L Hunter Lovins, makes a case for economic reform which taxes resource use rather than financial gain in order to promote sustainable development. The authors use the ecological premises developed by Meadows & Meadows[61] to argue that wealth can be increased fourfold by reducing consumption twofold and by a twofold increase in efficiency in the use of resources. They term this “resource productivity”. It demonstrates a number of efficiency-gains in the construction life-cycle of buildings which challenge the convention on building regulation criteria.

One of the weaknesses of the report is that the established baseline of a fourfold decrease in resource use is not related to any specific assessment of the actual requirements for planetary resource use in relation to sustainability[62].

- <u>Factor 10/MIPS</u>

In 1994 Schmidt-Bleek established the Material Intensity Per Service (MIPS) concept as a way of measuring material efficiency. This is a model which can

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[60] www.forumdirectory.org.uk

[61] Meadows, D. et al. (1972) *The Limits to Growth,* Signet, London and Meadows, D., Meadows, D. and Randers, J. (1992) *Beyond the Limits,* Earthscan, London

calculate the material flow in tonnes on a cradle-to grave basis for all types of goods and services. The "weight ratio" of the final goods/services in terms of its sources is termed the "ecological rucksack". An example would be a 10 gram gold ring being equivalent to 3 tonnes of original resources required to make it. Used in this way MIPS can be a rough way of calculating ecological impact, although it is acknowledged that it is not comprehensive, omitting, for example, toxicity and emissions. A key issue here is increased longevity which reduces the MIPS figure for goods and services. In terms of construction goods and services, MIPS can be used to calculate the environmental rucksack for a variety of materials and construction processes.

Schmidt–Bleek went on to establish the Factor 10 concept that recognises that OECD countries per capita consumption is five times that of developing countries. Consequently OECD countries must reduce their resource consumption ten times if global sustainability is to be achieved. The Factor 10 concept has been used to argue for significant increases in construction efficiency both in terms of energy consumption in buildings and the construction material resource use.

Factor 10 as a concept has greater credibility than Factor 4, due its inclusion of social justice, but suffers from the same weakness insofar as it is still not predicated on a baseline related to actual, measured, sustainability requirements.

❑

A Better Quality of Life

In May 1999 the UK Government published " A Better Quality of Life – a strategy for sustainable development for the United Kingdom". This document is again predicated on a growth –scenario using GDP as currently defined and includes the following priorities:

- more investment in people and equipment for a competitive economy
- achieving higher growth whilst reducing pollution and use of resources
- sharing the benefits of growth more widely and more fairly
- improving our towns and cities and protecting the quality of the countryside
- contributing to sustainable development internationally

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[62] Entec UK Ltd, 2001

The weakness in this report is its failure to expand on the ecological imperatives outlined in Statements 1-3 of "The Natural Step". Nevertheless, this report has become the essential basis from which other government policy development on sustainable development is taking its lead.

- <u>Meeting the Needs</u>

The latest position statement by the devolved administration for Scotland on its plans for sustainable development in "Meeting the Needs"[63] published in 2002, is relatively anthropocentric. Sustainable Development is predicated on three areas; Resources, Energy and Transportation. These are linked to the concept of social justice and environmental justice. It recognises the need for humans to live within the carrying capacity of the planet, but relies on separate indicators rather than any integrated systemic analysis, which is still in its relative infancy. This results in a disaggregated view of performance in terms of our actual impact. There is still a baseline of economic growth, despite exhortations to live within limits, which some would argue is a contradictory position to adopt.

[63] "Meeting the Needs….Priorities, Actions and Targets for sustainable development in Scotland" April 2002, paper2002/14, Scottish Executive Environment Group

A1.2 Techniques for Appraising Sustainable Construction

In order to evaluate the degree to which sustainability is being achieved, it is necessary not only to establish a consensual model but to clarify the boundaries within which the model's systems operate. This has been a source of continuing contention at every level and to date there is still no agreement on what the boundary conditions are for the successful measurement of sustainability. It is an issue that has both fed and dogged the international Life Cycle Analysis research community for many years.

There are numerous different approaches to the evaluation of sustainable construction which are assessed in this section of the report. Each approach has different system boundaries which makes cross-comparison difficult. For this reason, the Sustainability Indicators offered in "Meeting the Needs" together with other missing indicators for Scotland, identified by the authors, will be used as a matrix for comparison.

Key techniques for measuring sustainable construction include:

- critical path
- targets
- benchmarking
- checklists

The techniques above are shown as a natural hierarchy of evaluation in terms of eco-systemic thinking, with the process-orientated tools being the most important as they are more closely related to sustainable construction as a process. The lower level checklists tend to represent relatively non-systematic opportunities for sustainable construction as a product, delivered at handover.

Best practice is an outcome which can be used to guide sustainable construction but the lack of evaluation using higher order techniques can potentially lead to misunderstanding.

Critical Path Tools

This means of analysis of environmental impact offers designers and specifiers a means of controlling their design process to minimise environmental impact.

LEAN CONSTRUCTION

Following the publication of the Egan report in 2000, there has been a significant growth in the construction industry of Lean Construction initiatives which attempt to provide best practice and methodology for ensuring that waste is minimised in construction while at the same time providing the best value for the client. The DTI hosts a number of initiatives via its Construction Best Practice website[64] including the Lean Construction Institute in the USA[65]. Emphasis is based on critical path analysis to ensure optimum supply chain management, manufacture and assembly.

Although Lean Construction addresses some aspects of sustainable construction such as waste, it does not explicitly focus on other environmental concerns and is thus too narrow as a methodology at present for use in measuring sustainable construction.

GREEN GUIDE TO THE ARCHITECT'S JOB BOOK

This seminal guide[66] outlines the various critical steps required to ensure an environmental approach to the design of the built environment. It primarily aimed at architects but can be used by clients also. It is the first definitive attempt to ensure the process of sustainable design is correctly followed through by the designer. The guide does not attempt to evaluate sustainable construction per se but provides a series of signposts in terms of sustainable construction which potentially compliment the Building Regulations by providing a "route" rather than "rules".

[64] www.cbpp.org.uk
[65] www.leanconstruction.org
[66] Halliday, SP. *The Green Guide to the Architects Job Book* RIBA Publications 2000

Targeting Tools

Following from dynamic modelling and critical path activities, targets represent absolute standards in sustainable construction that are not consensus driven, but based on the best available science at the time they are established. As a result, they invariably change over time as information improves in relation to sustainable construction.

ECOLOGICAL SPACE (E-SPACE)

This model was developed in 1992 by a Dutch team under Manus van Brakel and Maria Buitenkamp and estimates the ecological space claimed by an average citizen in any given country based on the global resources they consume in a year. From this, limits to per capita resource use have been developed based on an equitable and sustainable distribution of global resources between countries. The model can be used to calculate the global share out for construction resources and energy use on a per capita basis which can then be compared to the actual distribution with identified targets for reduction where there is excessive consumption.

ECOLOGICAL FOOTPRINTS

This model was developed in 1994 by a Canadian under William Rees and estimates the area of productive land required to produce the material and energy needed for, and to absorb the waste produced by, specific patterns of material consumption. The approach showed that in 1996 the average North American needed 10-12 acres of productive land to support his or her consumer lifestyle whereas an average citizen from a developing country only needed about 2 acres. Using this information it is possible to estimate the ecological footprint of an entire population or economy. It is also possible to calculate the amount of land required to support the construction of any given building. Thus while one building may only have an ecological footprint several times the size of its physical footprint, another energy-intensive building may have one several hundred times the size.

Both of these techniques have been questioned in a recent report to the Scottish Executive which assessed a variety of methods for establishing indicators (Entec UK Ltd, 2001). As a result, the methodologies have not been embraced by government to date. Although the criticism of E-space, that it does not take account of imported resources is fair, the case made against Ecological Footprints is primarily on the basis of lack of data, which does not detract from it as a potentially useful tool. Both of these tools are recognised as "strong" sustainability indicators which take account of international and intergenerational concerns but which are seen as not enjoying "public consensus".

ENVEST

ENVEST is a UK software tool that simplifies the otherwise very complex process of designing environmentally friendly buildings. It draws on environmental impact data and takes into account eco-systemic capacity but it does not explicitly model this.

Designers input their building designs (height, number of storeys, window area, etc) and choices of elements (external wall, roof covering, etc). ENVEST aims to identify those elements with the most influence on the building's environmental impact, and shows the effects of selecting different materials. It also predicts the environmental impact of various strategies for heating, cooling and operating a building. BRE is developing ENVEST 2[67] for estimating whole life costs as well as environmental impact. It is worthy of further investigation.

NABERS

NABERS (National Australian Buildings and Environmental Rating System)[68] is a building rating tool that is based on two typical building typologies, domestic and commercial. It is a very "broad brush" and comprehensive tool that includes transportation and location as well as a very wide number of other sustainability parameters. It is designed to take account of existing buildings and uses absolute targets rather than consensus benchmarking. It is intended to be adopted by all building control authorities and was field-tested at the end of 2001.

Although NABERS is not specifically a design tool, it would be relatively easy for its structure to be adapted to the UK and could be used as a means of compliance with the requirements outlined in "Meeting the Needs" through performance standards.

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[67] http://projects.bre.co.uk/ConDiv/tool/default.html

[68] www.ea.gov.au/industry/waste/construction/final-draft.html

LIFE CYCLE ANALYSIS

Life Cycle Analysis is a methodology for analysing the environmental impact which construction materials and buildings have over their entire lifecycle. The impact is directly related to defined eco-system parameters. It is a limited methodology as it does not take account of social or economic aspects of sustainability and suffers from a lack of consensus in the scientific community on the actual data and system parameters to be used.

Life cycle analysis has been successfully used, however, to establish orders of magnitude for the environmental impact of certain construction materials to date. It also forms the basis of a variety of benchmarking tools for sustainable construction.

Current research is underway to identify some of the barriers to "harmonising" lifecycle analysis boundaries across the EU for comparability purposes.[69] Lifecycle Analysis as such does not offer a basis on its own for assessing sustainable construction in relation to sustainable development.

GOVERNMENT INDICATORS FOR SUSTAINABLE DEVELOPMENT

The UK government and the Scottish Executive have both attempted to define an initial set of indicators related to specific targets that measure progress towards sustainable development. In the case of the UK, the 15 sustainable development headline indicators[70] are difficult to relate directly to construction. More useful are the six Environmental Performance Indicators (EPI's) championed by the M4I in relation to sustainable construction[71]. These are based on targets which are established on the basis of consensus rather than absolute values, and fall under the following headings:

1. Operational carbon dioxide emissions
2. Embodied carbon dioxide emissions
3. Water use
4. Waste in Construction
5. Biodiversity
6. Transport

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[69] PWC *Comparative Study of national schemes aiming to analyse the problems of LCA tools and the environmental aspects in harmonised standards. - Interim Report and Options for Harmonisation.* June 2002

[70] DETR (1999) *A Better Quality of Life: A Strategy for Sustainable Development for the UK*, The Stationery Office, London

[71] www.m4i.org.uk/rc/publications/reports/m4I_epi_report2001.pdf

Although clear targets are available for the first four indicators for the UK, it has still not been possible to establish targets for Biodiversity and Transportation. There are limitations with EPI's because they do not take account of health or toxicity.

In the case of the Scottish Executive, it is acknowledged that the 24 headline indicators adopted in "Meeting the Needs" are at an early stage, and will need continual refinement. There is no specific indicator in relation to sustainable construction although a number can be potentially related to it.

The key dilemma facing agencies attempting to define appropriate indicators for sustainable construction in the UK lies in the *definition of parameters* for measurement. Accurate figures can only be obtained if resource use (energy and material) is traced back to source and includes the life cycle of the building itself[72]

On a global basis, there are now over 200 sets of indicators for sustainable development being developed, with the number continually growing. There are now attempts to harmonise these indicators to some degree[73].

Indicators can act as useful interim boundaries for the consideration of sustainable construction within sustainable development, while at the same time recognising the need to progressively develop them. They have a good overlap generally with the principles identified in The Natural Step.

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[72] Until recently work in the UK on environmental impact has not been related to the complete building lifecycle as advocated by Roger Fay and Robert Vale in their work in Australia.
[73] 10 common indicators for Europe have been identified in recent research work –see www.sustainablecities.org/indicators

Benchmarking Tools

By linking best practice with clearly identified indicators, it is possible to benchmark sustainable construction in relation to accepted best practice standards. Benchmarking is a valuable tool by which to encourage a construction team to keep up with the leaders in the area. The draw back with benchmarking is that it is primarily consensus based and can only operate at the pace at which the industry is developing. It makes no attempt to establish absolute targets that are actually related to the problem in hand. An example of this is the best practice standards for energy use which come no where near to the actual 90% energy reduction required in the UK construction industry to stabilise global warming in relation to other countries[74]

BREEAM

Developed by the BRE and assesses the performance of a variety of building types in the following areas:

- *management*: overall management policy, commissioning site management and procedural issues
- *energy use*: operational energy and carbon dioxide (CO_2) issues
- *health and well-being*: indoor and external issues affecting health and well-being
- *pollution*: air and water pollution issues
- *transport:* transport-related CO_2 and location-related factors
- *land use*: greenfield and brownfield sites
- *ecology*: ecological value conservation and enhancement of the site
- *materials*: environmental implication of building materials, including life-cycle impacts
- *water*: consumption and water efficiency

Credits are awarded in each area according to performance. A set of environmental weightings then enables the credits to be added together to produce a single overall score. The building is then rated on a scale of PASS, GOOD, VERY GOOD or EXCELLENT. The performance targets and weightings are benchmarks derived from consensus obtained from selected members of the building community, including manufacturers, which has the

[74] Twinn C., *Sustainability –the Cutting Edge* RIBA 2001 - based on the need for developed countries to reduce their emissions to allow less develop countries to aspire to higher standards of living.

possible disadvantage of not being an absolute standard or completely objective.

ENVIRONMENTAL SPECIFICATION GUIDES

BRE have produced two key guides to environmental specification of construction materials that adopt benchmark targets established by consensus[75]. Both guides use a simple category of A, B or C ratings for a variety of construction elements such as windows, doors and wall constructions. These categories have been disputed in some instances, because the manufacturing industry has played a defining role in the analysis and has compromised the independence of the assessments.

Communities Scotland has developed a Housing Quality Assessment Tool to guide Registered Social Landlords towards best practice for sustainable development. The tool works on the basis of self-assessment and uses a variety of benchmarks. There are approximately 150 indicators but the actual benchmarks used are not explicit which makes it difficult to judge the efficacy of this guide. A number of RSL's have remarked that it is unwieldy and commissioned alternative research into policy setting.

AECB has developed a specification guide for 800 environmental products called "GreenPro" which loosely evaluates each product under six categories of impact[76].

The Environmental Specification Guides mentioned should be treated with caution in terms of defining targets or benchmarks, but they do provide a useful pointer to the boundary conditions for Sustainable Construction. None of the guides specifically "blacklist" any products or materials, but they do present powerful arguments for avoiding certain materials such as PVC for a variety of reasons.

[75] Green Specification Guide and Green Specification Guide for Housing, BRE.
[76] see www.newbuilder.co.uk for information on GreenPro.

Checklists

Checklists for sustainable construction have been develop through best practice. These are the simplest way for specifiers to adopt best practice for sustainable construction, but they are very limited because they have no integrative aspect and provide no targets.

Agenda 21, as well as providing a framework for sustainable development for countries to use, is essentially a checklist which sets out comprehensively the various interrelated dimensions that must be tackled together in order to promote sustainable development. Sustainable construction is specifically referred to in Chapter 7 "Sustainable Settlements" which mentions the use of local materials, labour-intensive methods, informal self-help methods, energy efficient design, and protection of ecologically sensitive zones. The use of economic instruments to promote recycled materials and discourage environmentally damaging ones is also encouraged.

As a result of Agenda 21, Communities Scotland and Local Authorities as well as the Scottish Executive have developed various checklists to promote sustainable construction. These include "The Sustainable Housing Design Guide for Scotland"[77], which includes approximately 150 "pointers" for sustainable design.

The Building Standards Agency could usefully take into account the checklists used by the Scottish Executive to promote sustainable development in relation to its own stock when considering the framework for the redrafting of guidance[78].

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[77] Stevenson, F. and Williams, N. *Sustainable Housing Design Guide for Scotland* Stationary Office, 2000.

[78] *The Executive's Environmental Report 2000/2001*, Scottish Executive,

Appendix 2
Regulatory Frameworks – A Global Survey

Building Regulations Surveyed on Country-by-Country basis

This survey covers the following countries:

- Australia
- Canada
- Denmark
- England & Wales
- Germany
- The Netherlands
- New Zealand
- Norway
- Sweden
- USA
- Scotland

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Australia[79]

Australia is currently the world's highest per capita emitter of greenhouse gases at 27.6tCO_2/a (USA 21.1, EUavg 10.3) It has not yet ratified the Kyoto Protocol signed in 1998 which would limit its 2010 emissions to 8% above those in 1990. It has the 6th largest land clearance in the world. Australia generates more waste per capita, 776kg/a than any other country (USA 730kg, EUavg 430kg).

Australia does have some best practice examples of sustainable development but is challenged in making these the norm. Legislation is being introduced but incentives are still required to move most practice which is resistant to regulation and prefers voluntary codes. The effectiveness of voluntary codes in other sectors is not encouraging. Australian policy has developed largely in response to international policy but slower.

Local governments are mainly responsible for implementing specific state legislation, but may also impose their own regulations. So integration and administration of environmental law imposes some challenges. The Intergovernmental Agreement on the Environment (1992) gave rise to the Australian Building Codes Board (ABCB) to develop, amongst other things, nationally uniform technical building requirements. The ABCB unites the 8 territorial building code boards that administer local regulations and codes and administers The Building Code of Australia (BCA)1996. It is in two volumes that deal with different classifications of buildings and can be viewed online (www.abcb.gov.au).

The aim of the ABCB is to promote "Health, safety and amenity" while the "BCA extends no further than is necessary in the public interest, is cost effective, easily understood and not needlessly onerous in its application". The

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[79] Clark, D (2002) *Sustainable Buildings in Australia: Challenges, Incentives and Successes* CIB Sustainable Building 2002
Australian Conservation Foundation (2001) *Auatralian Land Clearing - a global perspective latest facts and figures* ACF
UNEP (1999) *Global Environmental Outlook* Earthscan
Uher TE. Runeson G. (2002) *The Regulatory Framework for Sustainable Development in the Australian Construction Industry* CIB Sustainable Building 2002
Scafer, BI. *How to Obtain a Sustainable Environment Using Performance Based Regulations and Appraisals* CIB Sustainable Building 2002
www.yourhome.gov

ABCB works very closely with the Australian construction industry which is resistant to over-regulation and advocates the use of voluntary codes. The effectiveness of voluntary codes in other sectors is not encouraging.

The BCA primarily deals with fire and structural safety and is somewhat limited in scope compared to building codes in other countries. Until recently it had no requirements for energy efficiency, disabled access or waste management. These are currently being developed. New energy efficiency measures for houses were scheduled for introduction in the BCA on 1 January 2003. The aim is to eliminate worst practice and encourage voluntary best practice.

There are Energy Rating schemes available for housing and commercial buildings, some subsidies for renewables and a scheme, which is comparable to our own Renewables Obligation Certificates (ROCs) Programme - currently at 2%. There is no intention to implement the Climate Change Levy or Aggregates Levy. There is currently some attention being given to the diminishing quality of the urban environment.

In the absence of stringent requirements in the BCA it is the State and Local Government that is imposing ad-hoc energy and environmental performance requirements through local planning regulations and developing their own rating and certification schemes.

NABERS (National Australian Buildings and Environmental Rating System) is the most interesting of the recent developments for promoting sustainable construction in Australia. NABERS is designed as an accurate, quantitative assessment process that gives buildings a yearly rating in relation to the building performance and the user performance. It gives an overall score based on a wide range of parameters and has the potential to undergo a continual process of evolution and upgrading. The use of performance clauses, rather than checklists or prescriptive measures, helps to ensure this process. It is intended to be used on a voluntary basis and applied to *all* buildings both new and existing. It is currently being tested by local authorities. The aim is that all local authorities will adopt the system in tandem with the building codes. www.ea.gov.au/industry/waste/construction/final-draft.html.

The building regulations in Australia have little to offer in the way of developing new policy and practice to promote sustainable construction in the Scottish Building Regulations. Indeed they could take us backwards from our current position.

Canada

The Canadian Commission on Building and Fire Codes (with support from the Canadian Codes Center part of the Institute for Research in Construction) is responsible for the National Building Code of Canada (1995). Under Canada's Constitution Act, the authority to regulate the construction of buildings is given to the provinces and territories. Most provinces and territories adopt or adapt, interpret and enforce the national building, plumbing, fire and farm building codes. The authorities having jurisdiction normally delegate responsibility to the building, plumbing and fire officials employed by the local municipality. The provinces and territories have not advised the Commission that they wish sustainability included as an objective.

The National Building Code, is therefore implemented with variations in various provincial jurisdictions (e.g. Ontario Building Code). In almost all cases, this kind of document confines itself to health and safety, although air exchange and minimal insulation levels fall within a broad interpretation of this requirement. Provinces also have labour legislation which all impose requirements regarding IAQ and illumination in non-domestic environments. In most cases they refer to Canadian Standards Association (CSA) documents or to ASHRAE Standards.

The Commission publishes the Model National Energy Codes of Canada for Buildings 1997 (MNECB). The MNECB is intended to apply to all buildings, other than houses of three storeys or less, and to additions of more than 10 m2 to such buildings. It provides maximum thermal transmittance levels for building envelope components per type of energy (oil, natural gas, electricity, wood, propane) for different regions of Canada. It gives regional U-values for windows, references energy-efficient equipment standards, and identifies when heat recovery from ventilation exhaust is required for dwelling units. These levels were determined using regional construction and heating energy costs in a life-cycle cost analysis. To allow flexibility in achieving a minimum level of energy efficiency, the code offers three compliance approaches: a Prescriptive Path; a Trade-off Path; and a Performance Path, along with the life-cycle cost effectiveness criterion and climatic variations. The building code is obtainable from the Canadian Codes Center.

The model national energy codes have not been implemented as requirements by most provinces or territories, but have played a useful role as design guides and as a reference point. To date, the Province of Ontario and the City of Vancouver have referenced the MNECB in their building regulations and enforce its requirements.

In respect of voluntary best practice guidelines there are internationally renowned programmes such as the Green Building Program and energy conservation for residential and commercial construction (the R2000 and C2000 programs). Natural Resources Canada's Commercial Building Incentive Program uses the MNECB energy efficiency levels as a reference baseline. It operates a scheme that provides money to help the design phase if an applicant can prove that there will be an improvement on the requirements of the MNECB of at least 25%.

The building code is at present being wholly revised and restructured to move from a primarily prescriptive basis to an objective-based code in 2004. The Commission has examined the development of performance based codes in other countries and found them wanting. It has identified particular problems with the need for qualitative functional criteria, which can often result in vague definitions. It feels that it is "not in a position to define performance based criteria" and would need to develop "qualitative performance statements". The new objective based code will have the following sections:

1. Functional requirements (qualitative)
2. Performance criteria (quantitative) related to existing standards where appropriate
3. Acceptable solutions

Denmark[80]

The 1995 Building Code aimed to reduce building heat requirement by 25% of the 1990 level by 2000. A research programme is underway to identify whether a target of a 50% reduction is practical. Measures have been introduced periodically to improve energy efficiency of existing and new buildings.

There is a levy of 0.05p/kWh on electricity to finance electricity conservation schemes. In addition to this, a green tax package is imposed on electricity and there is a VAT rate on fuel of 25%. Gas is subsidised to ensure it is always cheaper than oil. The government's aim is to reduce CO2 emissions by 20% of the 1988 level by 2005.

To achieve this the Danish Regulations set stringent standards of energy efficiency for new buildings and have taken significant steps to encourage improvements in existing buildings through the use of condition surveys and annual audits. Thermal insulation compliance may be carried out in three ways but there is not complete flexibility, maximum permissible U-values are defined for construction elements. There are also requirements that aim to limit electrical consumptions such as requirements for facilities for monitoring of ventilation systems and regulations covering maximum specific fan powers. Heat recovery or re-use is a requirement. There are also restrictions on the use of mechanical cooling. It can only be installed where other measures (shading, local heat extraction etc) cannot maintain satisfactory conditions. There is a requirement to Encourage waste recycling

For existing buildings there is a requirement for individual metering of electricity, gas, hot and cold water and heat and annual energy and water audits for buildings over 1500m2 Condition surveys, including an energy rating and opportunities for energy efficiency, are required at point of sale for all buildings.

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[80] SBI Report 232 *Indoor Climate Labelling of Building Products - Part 1 a prototype scheme*
SBI Report 233 *Indoor Climate Labelling of Building Products - Part 2 Technical documentation of a prototype scheme*
NHBA Denmark How to reduce nitrogen emissions from gas stoves

The Danish Regulations take a very firm precautionary stance on contamination from building materials including mineral wool and formaldehyde and prescribed ventilation rates are based on use of building materials with low emissions.

England & Wales

The amended Building Regulations 2001were published in November 2001 along with 4 new Approved Documents. These are Part L (Fuel Conservation and Power), now divided into L1 (dwellings) and L2 (other buildings); Part H (Drainage and Waste Disposal) and Part J (Combustion Appliances and Fuel Storage Systems). They impose requirements for carrying out certain building operations including the erection of new buildings or the making of a material change of use. The main changes in the 2000 Regulations and 2001 amendments are the enforcement of tougher standards for the energy rating of new buildings as well as alterations to existing buildings.

The new Regulations extend a number of regulations to commercial buildings and include requirements for insulation performance, size & orientation of windows, light fittings that take low-energy appliances only, and a "Carbon Performance Index" for air conditioned buildings. There are also requirements for sufficient controls to turn off electric lighting.

With regard to Toxic Substances, the Regulations state, "If insulating material is inserted into a cavity in a cavity wall reasonable precautions shall be taken to prevent the subsequent permeation of any toxic fumes from that material into any part of the building occupied by people". This relates to risks to health of persons from formaldehyde fumes given off by urea formaldehyde foams. If these foams are to be used there must be a continuous barrier to minimise, as far as practicable, the passage of fumes to occupiable parts of the building. No other information is given on indoor pollution from building materials and the infiltration of contaminants. The new CE mark for approved insulation products was introduced in March 2002 as the first phase of building materials marking.

The Regulations give the ventilation requirements of rooms for dwellings and other buildings, in terms of rapid, background and extract ventilation requirements. However, alternative approaches are given including designing for natural ventilation.There are new requirements and guidance on more sustainable forms of water drainage with information on the use of reed beds as a means of secondary treatment and on rainwater drainage. There is also a requirement for adequate means of storage and access to solid waste including the capacity, design and siting of solid waste storage facilities.

There are also wide-ranging non-regulatory incentives to save energy, use clean and renewable energies (to meet ambitious targets) including appropriately sized CHP, reduce CO_2 emissions and invest in new equipment. A design service is available free of charge to assist designers and clients to improve energy efficiency and environmental performance of existing and proposed buildings. Innovative projects are posted on a web site designed to provide clients and the construction industry with inspirational examples of 'sustainable and intelligent' buildings. www.bre.co.uk/referencefile

Germany [81]

The Federal Building Code includes both Building regulations (public health and safety) and planning law (design and layout of buildings and sites). The regulations apply to all buildings, to change of use and to demolition. It is issued by the Federal Government to the 16 regions that apply regional variations.

German energy policy is to reduce CO_2 emissions in former West Germany by 25% of the 1987 level by 2005. Higher goals have been set for the former East Germany. Because these targets are not being met, further improvements to the regulations, to improve standards by a further 25-30% relative to the 1995 regulation, are being considered with special emphasis to be given to improving the existing stock. Assistance programmes will be continued and stepped up where appropriate. Tax exemption on plant oils is being extended to all bio-fuels.

Energy efficiency regulations are tied to an economic efficiency criterion, i.e. the value of the energy savings must recoup the cost of the measure during its normal life expectancy.

New properties are required to have an 'Energiepass' stating the energy requirements of the building much like the petrol consumption of a car. The *primary* energy requirement for heating plus hot water is required to be below a set limit. Taking the primary energy requirement into account means, for example, that the energy lost in the power station to produce electricity is considered, not only the efficiency of the heating system in the building itself. The regulation therefore allows for different combinations of building fabric and fuel. Also defined are maximal permissible infiltration rates. Houses with mechanical ventilation are required to be tighter than those with natural ventilation. A test is not actually required and the infiltration rate can be calculated. However, a test is generally advised as it provides better results and the calculations err on the cautious side.

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[81] EnEv checklist fur Neubauplanung www.asue.de
Waermeschutzveordnung 1995 Regulation requiring heating requirement of new-build projects to be below a set maximum
Heizungsanlagenverordnung 1995 Regulation requiring compliance with aspects of installations of the system and use of pumps and controls

The existing stock contributes considerably to the overall energy loss and German regulations now require boilers, hot water appliances, heat distribution and building insulation of existing properties with more than 2 flats to be upgraded. Smaller properties are required to be upgraded on change of ownership. In the event of refurbishment current elemental U-Values are to be achieved where more than 20% of a building is subject to refurbishment. Alterations to heating systems (or building components) which would reduce the energy performance of the building are forbidden and regular maintenance is a requirement.

In respect of toxicity protection of the environment is a building requirement and buildings are to be designed and constructed so as to present no risk to humans, pets and goods. A paper is presently being discussed which should rate products (particularly those used in foundations) according to their effect on ground water and soil. A number of tests including one determining influence on flora, worms and algae are proposed. Regulation is in place to reduce solvent emissions by a fifth. Production plants have to comply with specific limits. Businesses can comply by reducing the amount of solvents used in production i.e. by using lacquers, paints and glues with reduced solvent content.

The German regulations would appear to offer several ways forward for promoting sustainable construction in the building regulations. At present only 1% of the public housing stock is renewed each year in Scotland. This means that to achieve any significant effect on the building stock in terms of sustainable construction the Building Regulations must, as in Germany, address the upgrading of the existing stock. The consideration of primary energy as part of the energy in use calculation for buildings is an important driver towards an integrated energy efficiency approach and one that could be usefully considered for the Scottish Regulations. Tax exemption on bio-fuels also supports a move to clean and carbon neutral economies.

The regulation on the monitoring and disposal of waste has helped to significantly increase the level of recycling in Germany. It is arguable that this regulation should be part of the building regulations in Scotland, in relation to more general environmental regulations on waste.

The Netherlands

The basis of Dutch law on building is the Housing Act (Woningwet) 1992 which covers all buildings in which people are housed, not just dwellings. It covers building permits, and administrations concerned with new and existing buildings.

The Building Decree (Bouwbesluit) 1992 is the nationally uniform technical legislation on safety, health and energy. It is organised on a national level (unlike Germany and Austria where different parts of the country have different regulations). Municipalities cannot impose separate requirements. It allows new technical requirements to be introduced very quickly. It comprises 14 chapters of technical regulations for new and existing construction which are continually being developed and revised. The requirements are performance based and there is provision for Dutch Standards (NEN's) to be replaced by harmonised European Standards (EN's) in time.. Planning legislation is separate. All building work has to comply although small works, repair and maintenance do not have to be notified. The Decree also sets out minimum quality levels for existing buildings and can demand improvements. Local authorities can check the existing building stock for compliance and they also check plans and carry out checks on compliance.

For all new buildings a calculation has to be carried out to determine the energy index. There are two tools one for residential and one for non-residential. Maximum thermal transmittance values are set but the main requirement is an overall energy performance (heating, DHW, ventilation, pumps, lighting, cooling and humidification) known as the Energy Performance Coefficient (EPC). It is based on primary energy consumption and energy used from renewables is not counted. The policy is to periodically tighten the EPC standard until energy neutral buildings are obtained. It was 1.4 in 1995, 1.2 in 1998 and 1.0 in 2000). The index was introduced in 1994 in response to awareness of sustainability and there is now a consideration of introducing something similar for drinking water and for the use of materials.

There is a requirement for waste separation on building sites but it is the rising cost of disposal that is forcing change. There is an air tightness requirement that is reliant on standard details rather than testing.

A new procedure is in preparation that will calculate an energy performance value for existing buildings. This will aim to bring all buildings up to the standard of insulation required by the 1975 Dutch regulations (Uwall ~ $0.75 W/m^2K$). Compliance is not obligatory, but consideration is being given to making it a mandatory requirement when a house is sold with a rates subsidy offered as an incentive for getting the work done.

In 1994 the 'National Package' was introduced. It consists of lists of measures for sustainable building and is used on a voluntary basis in most cities and regions. In general the community initiates the use of the NP and developers agree to implement it. The measures are both compulsory and voluntary and so provide some choice to the developers and architects. It includes energy, water, materials, iaq, green space around buildings, waste management and some social aspects. The NP has now diversified and there are packages for new residential buildings, existing residential buildings, non-residential, urban design and infrastructure. Attitudes to the package vary - sustainable building consultants claim the requirements are too low and developers consider them too onerous and restrictive. It has raised issues up the agenda.

The Dutch regulations offer significant food for thought. The provision for replacement of Dutch by harmonised European Standards (NEN - EN's) in time is a useful element of future proofing. Opportunities to carry out minimum checks on compliance for existing buildings and to demand improvements is an existing element in Scottish Regulation which could be usefully extended to deal with a range of issues including hazards due to floods and energy upgrading. The use of the EPC and its continual improvement is a valuable concept that could be applied across a range of issues. The Dutch are already considering applying it to drinking water and to materials. The introduction of an energy performance for existing buildings to bring all buildings up to an agreed standard at point of sale or via subsidy would be a major contribution to meeting targets and also to reducing the burden or running costs over time. Looking to the German regulations this could be tied to an economic efficiency criterion, i.e. the value of the energy savings must recoup the cost of the measure during its normal life expectancy.

In the Netherlands there is a philosophy of shifting the tax burden from labour and capital based income towards the use of the environment. This is reflected in a range of national and regional subsidies mainly for energy saving including the current energy tax rate of 20-30% (depending on fuel); VAT at 17% is added on top of the energy tax. These subsidies change quite often.

There is a need for government and the public sector to lead the way in setting standards and a sustainability check for all public buildings would be a useful start. Communities use the 'National Package' containing a list of both compulsory and voluntary measures for sustainable building. It is also worthy of further investigation.

New Zealand

The New Zealand Building Code, like its sister code in Australia, adopts a light touch to regulations concerning the environment. Recent changes to the Code have no bearing on the promotion of sustainable construction. The NZBC is 'neutral' in regard to sustainability. It neither hinders nor facilitates its inclusion. As such does not offer opportunities for the Scottish Building Regulations to develop in relation to the promotion of sustainable construction.

None of its voluntary initiatives or incentives is worthy of special attention. It offers little guidance to the Scottish Building Regulations, other than the use of performance based requirements. The Code explicitly does not deal with resource management as this is seen as "the responsibility of the owner".

Norway

A summary of the Norwegian Regulations is available in an unauthorised English translation although some of the latest amendments are not included. The Regulations, which are functional requirements, go through an overhaul every 5 to 8 years. Guidance Documents are maintained and change more rapidly - always within the bounds of the functional requirements of the Regulations. They are used to spread new knowledge as often as possible, to suggest solutions and to give general guidance.

The Norwegian regulations represent some of the more advanced thinking in Europe today and are performance based rather than prescriptive. The following issues are highlighted in the Norwegian Regulations that should be considered for the Scottish Building Regulations to promote sustainable construction.

There are stringent regulations on space heating and distribution, and on appliance efficiency. Some generators including district heating systems, heat generators using solid fuel and condensing boilers are exempt as are electrical resistance heaters and heat pumps, which reflects the Norwegian context of cheap and clean hydro power and so concerns about electrical energy differ from elsewhere in Europe.

The environment, energy and health are considered widely during all phases of construction - execution, usage and demolition. Construction works are required to be designed and operated to avoid any unnecessary cooling demand and so that demand for power is low, little energy is consumed and little pollution is caused during the life of the works, including demolition. There is a requirement for protection of vegetation and animals in the surroundings of the construction work from effluents.

The energy demand of buildings for heating and ventilation is not allowed to exceed an upper limit. Requirements for energy and power for a building may be established in one of the three ways. In establishing the overall energy limitation the energy gain from internal heat and solar radiation as well as infiltration losses have to be considered. Embodied energy of materials is considered together with energy in use to give total energy usage of building. There is a requirement that materials and products for use in construction works are to be manufactured with justifiable use of energy and with the aim of preventing unnecessary pollution and that materials and products with a potential for re-use and recirculation should be chosen.

There is a life cycle approach to indoor air quality and the efficient operation of buildings with a number of regulations that promote both energy efficiency and good hygiene through simple and efficient maintenance and cleaning. Written instructions are required on plant operation and maintenance. Surfaces and surfacing materials are to be chosen so that dirt is not hidden or unnecessarily accumulated. Buildings have to be cleaned prior to use and designed to allow easy access for cleaning of surfaces in contact with the supply air or the air in rooms and those expected to become very dirty. Ventilation plant operation has to have adequate monitoring to allow performance assessment in use with design for hygiene and access for cleaning of supply and exhaust air. Plant has to be easily adjusted and maintained. Heating and refrigeration controls are required to allow the output to be adapted to the demand, and to be reduced or interrupted in periods of no demand, including sub-division for different areas.

Building and surface coating materials are regulated so as not emit contamination to the indoor air, in concentrations known to be harmful with respect to health hazards and irritation. They are required to be fit for normal use and be produced, handled, stored and applied in such manner that emissions of contamination and smell to the air in rooms are as low as possible.

The requirement of ventilation air in commercial and public buildings is to be determined from the choice of materials as well as the number of occupants and the activities. And there is a presumption in favour of a window or door opened towards open air unless constrained by the intended use. All rooms are required to have satisfactory lighting without creating an unpleasant heat load and rooms for permanent occupation are to be provided with daylight, windows and an outward view unless the dwelling or working situation indicates otherwise where windows may be replaced by other well arranged lighting.

Strategic links with the Planning and Building Act make it a requirement to equip buildings for connection to a district heating plant if there is an obligation in the municipal plan. Other links to planning acts determine minimum outdoor space requirements.

There is a requirement for flooding avoidance at design rainfalls. It is unclear if amendments have been considered to cope with the possible impacts of global warming.

Sweden[82]

Boverket, The National Board of Housing, Building and Planning is the Swedish government agency for planning, the management of land and water resources, urban development, building and housing. The primary legislation controlling both town planning and building regulations is the Planning and Building Act (1987:10). In 1994 the Riksdag adopted comprehensive changes in planning and building legislation and many technical requirements were later transferred to a new Act on Technical Requirements for Construction Works etc. (1994:847), This act was further amended in 1997. The overall object of the Act is to promote equal and good social living conditions and a sound and sustainable environment, whilst having due regard to the freedom of the individual.

In Sweden legislation in the fields of planning and building and the management of land and water resources has been subject to radical changes in recent years. There are a number of aspects that could have a bearing on future Scottish Regulation and Policy.

The Swedish building regulations BBR contain mandatory provisions and general recommendations. The mandatory provisions only apply when a building is constructed or to the part of a building that is altered or extended. However, if applying the Regulations would significantly extend the life of the building, then the requirements may be demanded. They also apply to earthworks and demolition works and to sites which are set aside for building development. They closely reflect the requirements of the Construction Products Directive.

A number of initiatives from other agencies are forward thinking in particular the municipal initiative on Community Sustainable Development, crime prevention through environmental design and the Environmental Code which is decidedly eco-centric aiming "*To promote sustainable development based on the understanding that nature is worthy of protection in its own right, and that man's right to exploit nature carries with it a responsibility.*"

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[82] The Swedish Council for Building Research (Byggforskningradet) 1996 The Energy Book - A review of Present Knowledge and research

Energy

New buildings are required to be designed so that the energy requirement is limited by low heat losses, efficient use of heat and efficient use of electricity. There are mandatory provisions and general requirements for limitation of heat losses which address thermal insulation, thermal transmittance, ventilation and the production & distribution of heat. An average thermal transmittance for the building envelope is required to be calculated and must not be exceed a stated value. Permissible U-values make allowance for workmanship and construction supervision, beneficial solar gain, minimum boiler efficiency (90%) and maximum design flow temperature (55°C). Local control is required in rooms and parts of multi-occupancy buildings, Each room must have its own heat emitter controlled individually and heating installations in buildings other than blocks of flats are to be designed so that the rate of flow of outside air can be reduced when the building or a part of the building is not in use.

There is a presumption against electric heating - an issue to which the Swedes are particularly sensitive because of the decision to rule out Nuclear Power generation. Electric heating is only allowed if houses have especially high thermal insulation standards.

Infiltration & Ventilation

Air tightness standards are defined, and pressure testing is one of the verification checks that the owner can call for. However, development of standardised construction methods has led to a level of construction performance that has made testing unnecessary. However if the ventilation heating requirement exceeds a certain level heat recovery is a requirement. Ventilation ducts are required to be accessible for cleaning and ducts and other components cannot be made of, or treated with, materials which may release contaminants into the indoor air. Installations for the humidification or cooling of air in ventilation systems must be designed and connected so that they do not entail a risk that harmful micro-organisms or harmful substances will be released into the indoor air.

Existing Buildings

There are many examples of refurbishment involving external insulation and overcladding. Many are now seen as ill advised as they destroyed the architectural qualities of the buildings and contained too little insulation to

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be economically justifiable. Recent energy efficiency improvements in existing buildings in Sweden are not generally a result of building legislation, but have more to do with the interest subsidies and tax incentives.

A regulation that requires installations to be kept in good working order allows for continuing control of buildings in use. There is a national programme of inspection.

Pollutants

There danger from emissions of gases and particles from structural and non-structural elements is acknowledgement and there is a presumption against products emitting high levels of pollutants.

Future Proofing

There are examples of forward-looking (future proofing) legislation designed to avoid future alteration work and bureaucracy. There are provisions designed to increase the flexibility of dwellings and places of work to changes in future heating methods. Heating systems must be designed to facilitate changing the heating fuel.

One-off subsidies for special purposes have been used in the past to stimulate the housing market, encourage renovation and provide help for radon proofing work.

Subsidies are also available for encouraging better use of electricity and for converting electrically heated buildings to other forms of heating including to district heating. Grants are also available for installing more efficient electrical equipment, provided the connected load on the grid is reduced (i.e. a smaller incoming fuse is installed). There is an energy tax of about 43%. VAT at 25% is imposed on top of this.

USA

Although the USA codes themselves are rather prescriptive and do not offer much to reflect on in terms of promoting sustainable construction when compared to the Scottish regulations, there are interesting developments taking place to promote the adoption of new standards for traditional materials and construction methods. Also the method for updating the codes, although cumbersome, is to be commended and could help to rationalise the current approach to updating the building regulations in Scotland, which is not so transparently organised.

Codes are still primarily prescriptive (which are considered to inhibit innovation) rather than performance based. They do not cover indoor air quality, toxicity, non-renewable resources and climate or traditional methods and materials

The LEED environmental assessment system for building design offers a number of pointers for items which might be considered for incorporation into the Scottish Building Regulations (e.g. water saving, recycling). It is a voluntary, consensus-based, market-driven building rating system (bronze, silver, gold, or platinum) based on existing proven technology. It evaluates environmental performance from a "whole building" perspective over a building's life cycle, providing a definitive standard for what constitutes a "green building". The subsections are a mixture of performative and prescriptive requirements.

The building codes for the USA are covered by four organisations. Each organisation publishes its own codes covering different states. These can be purchased from the individual organisations websites. In addition, each state has its own legislation concerning building codes. This creates quite a confusing situation in terms of comparison. These organisations have recently been brought together under a single evaluation programme, the International Code Council (ICC) in order to try and harmonise the codes. The ICC publish a number of codes including a harmonised building code.

The USA codes undergo a continuous process of change that is highly democratic. Public hearings are held on a regular basis throughout the country and any interested party or individual may make representations for changes to the codes. The representations are then considered by a panel of experts and advisors and the deliberations and decisions announced publicly via the web. At one such public hearing in 2002 ASHRAE proposed that "energy from renewable energy sources collected on site shall be omitted from the annual energy use of proposed design" to encourage designers to specify renewable energy products. A further proposal put forward by the U.S. Dept. of Energy, recommended the introduction of heat recovery to all fans.

The American Institute of Architects (AIA) has a comprehensive policy on sustainable design and a standing committee on the environment. Many other organisations promote sustainable. The Development Center for Appropriate Technology (DCAT) in Arizona was set up specifically by David Eisenberg to address the issue of sustainability and USA building codes. Eisenberg has coined the Hippocratic corollary: *that a building should first do no harm* in order to examine where the codes need enlarging. DCAT also promotes the development of standards for non-orthodox construction materials. DCAT hosted the first National Summit on Building Code reform in 1998 brought building code officials, environmentalists and sustainable building professionals into dialogue with each other. Since then, a number of subsequent summits have seen the development of this dialogue.

BEES (Building for Environmental and Economic Sustainability) is a technique for selecting cost-effective green building products. Version 2.0 of the Windows-based decision support software, aimed at designers, builders, and product manufacturers, includes actual environmental and economic performance data for over 65 building products. It assesses 4 environmental impacts for a handful of these products: ozone depletion, smog, ecological toxicity, and human toxicity. For all products, global warming, acid rain, eutrophication, natural resource depletion, indoor air quality, and solid waste are assessed. New software features have been added, including reporting of physical flow quantities for each environmental impact.

Scotland

The Scottish Executive is responsible for the preparing and issuing of the Technical Standards for compliance with the Building Standards (Scotland) Regulations. Before making or amending the Building Standard (Scotland) Regulations, Scottish Ministers are required to consult the Building Standards Advisory Committee (BSAC) and other bodies. The Building Standards (Scotland) Regulations are in 16 sections and are available from the web and The Stationery Office Ltd www.thestationeryoffice.com.

Recent amendments to the Building Standards (Scotland) Regulations came into force in March 2002. Specific measures of note include:-

- The introduction of tougher thermal regulation standards for all new buildings and the removal of the exemption for some conservatories from building regulation requirements.
- More stringent standards for the energy efficiency of domestic boilers and building services.
- Improvements to promote use of sustainable surface water drainage systems to reduce incidences of flooding and pollution. Part M has been expanded to introduce more sustainable options, intending to ensure safe and adequate drainage from a building and from paved surfaces within the curtilage of a building. The expansion of Part M, includes standards relating to Sustainable Urban Drainage Systems (SUDS), outfalls that will minimise the risk of environmental pollution and sets standards for infiltration systems such as reed beds and gives standards for constructed wetlands. The Building Regulations are also beginning to address conservation of water.

There are a significant number of measures that are intended to promote energy efficiency, waste management, wider environmental considerations and renewable energies including ROC's, loans, taxes, levies and design advice.

The New Bill offers opportunity for Scotland to make fundamental changes to its regulatory framework, which can reflect the aspirations of its political leadership and its professional bodies to deliver an improved quality of life.

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