



Stakeholder Workshop Scottish Executive, Edinburgh Monday 1st October 2007

Workshop 1: Previously identified needs/challenges

During the first workshop stakeholders considered the previously identified research needs/challenges from the 2001 stakeholder workshops that led to the BKCC programme of research. Stakeholders were asked whether they thought the need/challenge was still valid and asked to provide comments.

Building resilience into existing building stock – vulnerability and risk audits as a means to establishing priorities

- Understand performance in use and life cycle costing implications.
- Understand performance of materials and elements of buildings and new regional variations.
- Key issue for councils. Lack of knowledge/skills in retrofitting – need to build capacity.
- Problems of common ownership, tenants make it hard to get things done.
- Danger of roof damage in high winds.
- Desire for high density urban housing, because higher land values lead to 'cheaper'; flat-pack' Ikea housing; will the desire for fast, cheap houses repeat previous construction mistakes?
- Are rainwater goods and associated drains able to cope with enhanced rainfall events?
- Lack of understanding of embodied energy – especially when demolition is argued for.
- Some local councils after years of not building local authority housing have started ambitious social housing schemes – should we use best practice so that post-war schemes built in 60s, demolished in the 90s is not repeated in 2050.
- 'New build' knowledge and attitudes being applied to traditional building construction and performance due to lack of understanding.
- Addition of building-by-building flood protection.
- Retrofitting needs specific for Scotland.

- Not enough awareness of need for climate change adaptation among the public, industry or policy community. Let alone knowledge of how to make this happen.
- Resilience should be in all new build within 100 year.
- Implications of increased rotting and drying cycles on all building materials.
- Developers will only do what they are told to. Changes needed to planning legislation. Building control regulations will have the greatest impact on making volume house builders produce 'greener' houses that anticipate climate change issues.

Soil mechanics – subsidence risk and foundation construction and design specifications – including drying and frost damage potential

- Impact of land movement on sewer and clean water underground infrastructure – rupturing pipes, increased leakage, infiltration, water quality.
- Impact on archaeology.
- Increased moisture leading to increased rising damp and internal rot development.

Role of groundwater in flooding – associated risks

- Will upgrading of the drainage system be required?
- Local councils in former mining areas of central Scotland don't have full appreciation of the impact of rising groundwater on land use allocations – for housing or open cast coal mining.
- Gradual development industry acceptance of providing 'SUDS', still undermined by confusion of responsibilities for maintenance or ownership let alone getting the right design to anticipate future climate change.
- Transportation of contaminants.
- Increased saline intrusion into groundwater aquifers from sea level rise – impacts on clean water sources.
- UKWIR research available on groundwater.

Sustainability of existing drainage systems (SUDS) in the face of climate change – implications for design of new drainage systems

- Rainwater harvesting and grey water recycling are often not specified in buildings due to the cost. As water is so 'cheap' the payback periods are effectively infinite!
- Can SUDS be retrofitted in existing developments?
- Integrated nature of the SUDS system; capacity of existing SUDS to cope with extreme rainfall events.
- Natural solutions that can be accommodated on site and help in wet and dry conditions – low tech, low cost, low skills solutions.

Potential of grey water systems as an adaptation option

- Already know enough about grey water.
- Research needed into the mechanisms and means to make re-use of grey water in existing buildings a reality.
- The principle is valid but research to explore the feasibility of grey water on existing building use (i.e. case studies are still needed).
- Focussed on practicalities of fitting to existing buildings.

Continued viability and comparative advantages of building material and construction techniques – implications for maintenance and costs

- What are the preferred materials and techniques employed in areas similar to the conditions we will experience in 10, 20 30 etc years time?
- Need to change building techniques – is on-site construction viable or is more pre-fabrication better?
- Methods and techniques are always evolving so scope on adaptation needs to be monitored and addressed on a continuous basis.

Construction site conditions, techniques for flood risk areas, performance of traditional materials, impacts of air pollution, pests and insects

- Build on floodplains? Look elsewhere i.e. floating houses in Holland, houses on stilts. Is the trend towards air tight buildings suitable for damp Scottish climate?
- Long term life span of houses on raised platforms or stilts.
- Floodplains need to be for adaptation capacity not building on. How can we best use land for capacity and biodiversity, recreation etc?
- Effect on the economy of not building on floodplains.
- Recycling of commercial and business waste – need legislation to influence certain sectors.

Energy and telecommunications infrastructure

- Telecoms are an increasing adaptation measure particularly for changes in transport. Need to ground based elements will survive climate change in the next 10 years, and what are the changes needed for infrastructure in the future.
- Adapting existing infrastructure/urban form to supply other forms of energy e.g. hydrogen energy from waste to replace existing supplies with implications for further development.
- Do we devolve our energy infrastructure/supply to adapt to weather and mitigation needs? How are we ensuring base load supply locally? Renewable answer?
- Centralised vs. decentralised energy and the implications for the grid. What level of unpredictable microrenewables integration can the grid cope with? Storage of renewably produced energy. Best practice guidance on micro-renewables, educate the public on what they do and how they work etc.

- Investigate low tech approaches – including lesser use of energy and materials.

Coping with peak demands, performance under changed climate, viability of wind, wave and hydropower, access to offshore facilities

- Moves to sustainable transport modes that run on electricity e.g. trams, trains. Continuity of supply is important.
- Particularly if we are still having difficulty forecasting future climate.
- An important issue but already covered.
- Need better understanding of what research has been done and how would this effect policy e.g. building standards.
- Has to be seen in the wider question of long term energy sources for the UK.
- Limited to provision of on-side renewables and passive measures to central building energy demand.

Impacts on transmission lines above and below ground

- No should be an area that is already being dealt with by our existing practices
- Possibly need to look at impact of renewables on grid system.
- No, has been done to saturation.
- No, the industry worldwide has experience of climate extremes.
- Greater assessment of risk seems important. Can we learn from industrial experience?

Overheating of buildings and alternative cooling techniques

- Need to co-ordinate with mitigation/energy efficiency issues.
- Community heating/cooling schemes.
- Re-use of waste heat.
- For existing and historic buildings.
- Knowledge of alternative systems needs to be better disseminated and adopted in practice.
- On materials and techniques that best function to prevent over-heating and cooling.
- Impact of rising temperature on rail stations and depots.

Humidity and ventilation in buildings – drying and performance of building materials in the face of projected changes in climate

- Old buildings: best practice for retro-fit systems.
- On historic and existing buildings.
- For housing for those with health issues.
- More relevant case studies are required.
- Wider adoption of natural ventilation – mechanical systems are still being used.

Land-use policy and planning – guidance on flood risk, long-term efficacy of remediation measures for brown field sites, and vulnerability to wind damage

- Framework for change – what big shifts in lifestyle need to be anticipated in a world where climate is changing and mitigation means we are adapting with another objective too?
- Achieving balance between greening the city, increasing density of development without increasing development in the green belt.
- If we build on floodplains what kind of houses should we build?
- Brownfield – how good is remediation work on old mine workings – subsidence.
- Forecasting impact of different types of development into the future; broad quantitative measures to enable policy changes.
- Need to look at how much brownfield land is being remediated and for what purpose; need to know that remediation does not expose environments to adverse consequences of changes.
- How to plan out for the need for over-engineered solutions – we can't fight nature, we have to learn/research how to make/let it work for us.
- Assessment procedure for siting of buildings.
- Effects of contamination under different climate conditions – so mitigation can be sound and long term.

Changes to legislation, standards and regulations as drivers of change – regionally specific and more flexible legislation to allow for innovation

- Single database of current standards and legislation.
- Understanding what barriers to uptake exist.
- To clarify how rapidly the built environment can be transformed to a new low carbon economy.
- Need more awareness of changes predicted and cautions to be taken to address the issues. For transport it is not always clear how climate change impacts are being addressed.
- Review of impact of climate change in standards included in the design manual for roads and bridges.
- Policy makers must be convinced to move to the adaptation agenda as well as mitigation.
- Needs to be achievable and enforceable.

Lifestyle changes – implications for future use of buildings, energy demand and the efficacy of adaptation options

- Yes, this is probably an area that would benefit from more research based on improved knowledge.
- Need to define impact of adaptation of embedded energy.
- Impact of new school building programme on climate change – use of surplus buildings.
- Lifestyles are certainly changing in response to many factors operating over different timescales. So how do you separate out climate induced changes?

- Implications for land use planning.
- Particularly for people making adaptations to buildings in the name of climate change.

Effects on tourism and knock-on effects on land use and transport

Effects on transport – choice, reliability, costs of impacts and safety in light of extremes

- Adaptation to climate change is leading to shifts in public transport because of the mitigation importance and reducing CO2 emissions. However, there is not sufficient network capacity to deal with potential severe climatic events such as flooding, landslips. How would we deal with the effects of one key bridge, tunnel, intersection being 'taken out' for several months? What would be the effect on commuting patterns and economic development?
- Tourism and climate change research not well covered at the moment.
- Transport as a major contributor to emissions, need for robust public transport infrastructure going forward to > 2100 as private transport is less viable.
- There is little evidence of real adaptation to the effects of climate change in Scotland's transport infrastructure provision. Large areas of new road and rail infrastructure are still being planned in areas which will be affected by sea level rise or flooding.
- Increasing demand for support facilities (visitor centres/toilets/cafes) can create additional pressures.
- Still relevant as Scotland's tourist seasons are highly variable and focused on the summer months. There may be opportunities from warmer weather or losses to skiing in the winter. Need better understanding of variable impacts.
- Still relevant – increasing pressures from this sector on the urban/city regions.
- Continued growth of service/tourism funded economy will create even greater demands on land use planning allocations and linkages with transport planning.

Dissemination from research to professionals and practitioners – accessibility and understanding

- Clear English please.
- UKWIR research often only available for water industry – potential use for other sectors, eliminate overlap of research.
- Dissemination needs to become about training and giving professionals and practitioners the skills to act, as well as just knowledge of the issues i.e. how they can/should adapt.
- 'Translate' the material before dissemination.
- In the form of sectoral case studies.
- What type of network design best supports ongoing dissemination of information? How do we best co-ordinate research efforts?

- Levers for action.
- Greater identification of roles and responsibilities for developing adaptation responses. What role do local government, Scottish/UK governments and individuals need to play?
- Local councils hold tremendous power through decisions on vast range of inter-related activities that have climate change impact or potential impact. Local members need educated to think of climate change duplications alongside local party politics.
- Work in multi-disciplinary ways from the outset.
- Can practitioners be supported in applying new ideas? Costs, knowledge and staffing can prevent the willing people from getting onboard. More joint working needed?
- Detailed worked examples of major energy projects right down to individual developments so that policies have an evidence base.
- Need information 'moles' on interpreting how you can use research. Journal papers should be more widely available, not just to journal subscribers or those with Athens logins.
- UKCIP08 may help but need tools which can be taken to regional/local level which will assist understanding of effectiveness of proposed adaptation measures.
- Need simple, pitched information that can be zapped into the media and also investigated in depth.
- SKCC is excellent – need wider platform to relate knowledge internationally.
- Literature review of existing projects –online keyword database.
- Need clear communication strategy at start of research projects.
- Research occurs at a fast pace which practitioners find difficult to keep up with.
- Researchers need to better understand the mechanisms, levers, legislation and constraints which professional work with, then reach findings within those parameters. Then design their dissemination to fit.
- Has to be targeted at the practitioners. Too many 'usual suspects' around the table.
- Need to make research outcomes more accessible and translated into practical guidance.
- Information dissemination is vitally important, without it there is no point to research.
- Yes, otherwise might as well not bother doing the research in the first place.
- Need for 'applied science'. Implement existing research into practice.
- Researchers should visit stakeholder more often to present their findings.
- Look what works elsewhere in the world.
- 'Snap shot summary': use graphics, easy to read/understandable.

Need to draw on best practice and experience from other locations

- Identifying innovations/technologies used in other countries- reduce chance of reinventing the wheel and can build on and improve technologies.
- Obtain a fuller understanding of 'fitness for purpose' of indigenous practices.
- Translate best practice from the academics/scientists to professions/technical/lay levels of understanding.
- Best practice needs to become viable and owned by political leaders and champions who can take ownership and share this with the wider public, taking it out beyond the policy and academic elite.
- Need to generate ambitious application of new ideas then be able to replicate that to get others to follow.
- Need to see what the rest of the world is doing and if it could be usefully applied to Scotland and the rest of the UK.
- Case studies and contrasts.
- How research has successfully influenced politicians and their electorate into policy changes.
- Central source of expertise would be helpful.
- Lessons learnt from good practice and bad to highlight areas to be improved.
- Need to define 'best' practice recognising that buildings and infrastructure serve multiple interests and benefits.
- Need to modify 'best practice' in light of adaptable techniques required.
- More information required on best practice but more importantly on best process.

Assessment of the capacity of the sector (and components thereof) to respond to change – adaptive capacity and barriers to change

- Lack of skilled trade's people.
- Lack of climate change professionals to assist in building capacity to change.
- Economists, finance professionals, performance managers, accountants etc. who will have to make adaptation a reality, do not have models of carbon pricing and budgeting, nor knowledge and long-term climate forecasting to be able to adapt their business etc. How can they be trained?
- Greater communication between sectors, more integrated approach to planning to enable different stakeholders to recognise and understand the wider impacts on other stakeholders. For example, the effect of 'urban creep' on increased flooding and sewer design.
- Education on DIY – increase trend for home renovation.
- Skills shortage in the construction industry in energy to potentially construct new grid capacity for decentralised renewables whilst construction workers simultaneously needed for adaptation options such as flood defences. Where will capital come from?
- Professionals are struggling to take on board the huge and currently higher profile of mitigation. Factoring in adaptation will feel like 'too much'.

- Problem of adequate regulation of housing/building construction industry as to energy efficiency and adaptive/resilience measures in buildings: if standards increase, need stronger regulation.
- Barriers to change – cost of technologies – how much will this change as technologies advance and uptake increases? How will this then affect the demand? Human mentality – how do you persuade people to change their behaviour? How fast can technology change? How fast can regulations change and the industry keep up? (e.g. can we build zero carbon homes by 2016?)
- Skills shortages – not enough scientists and engineers! How do we encourage more people to study these courses at university?
- Barriers to change – cost and compensation; availability of skills; availability of options for demonstration; knowledge of what the benefit of adaptation will be.
- Overall capacity of transport network e.g. total capacity amount of stations/lines under flood risk etc
- Barriers – getting the right mix of operational business and knowledge; staff and ambition in order to demonstrate costs of effective adaptation.
- Human behavioural capacity – personal and group efficacy.
- Need methodologies to demonstrate the cost/benefit of adaptation proposals now for more long term changes.
- Need to define how output could be applied to policy and practice.
- Could help target future research.
- Changes have to be achievable.
- Institutional and financial barriers.
- Yes, by sector, profession, legislation, type of organisation, constituency.
- Study of existing research needed first.
- Understanding the local/regional issues – not ‘top down’ imposition of adaptive capacity.
- Assessment of transport costs i.e. accessibility
- In Scotland a limited amount of adaptation has been done on road network.
- Need assessment of costs to sector and availability of skills to implement.
- Yes, on whether planning legislation and guidance does allow for a response to climate change and whether the resources are there to achieve this.
- Estimating tools. Develop simple rules for assessing work content for certain operations made necessary by climate changes.
- Enhancing capacity to design in multiple benefits (and wider stakeholder interests) from the outset.
- To enable engineers to work within the environmental limits of the systems that they work within – so linking solutions and ecosystems – a skills issue.
- Construction industry – economic barriers – looking for low cost, short-term solution rather than long-term solutions.
- What will help people make the changes?

- More research required especially within existing housing stocks and suitable material use.

Workshop 2: Key research/knowledge gaps

During the second workshop stakeholders were divided into groups to identify additional research needs and to consider the nature of the response to address them.

Flooding

- Immediate flooding (Forth Valley and Tey Valley) – tidal?
- Becoming more frequent
- Power stations and petrol-chemical site being built on floodplain/next to the sea.
- Resilience of infrastructure – long term issue.
- Decisions to retreat are no longer viable.
- Requirement for flood defences – Glasgow pioneering studies.
- Some historical sites are protected but many are not.
- Water treatment facilities – vulnerability, implications re flooding back.
- Salt water intrusion to agriculture – link to low probability, high risk events.
- Equity issue – most vulnerable – how to change this aspect.

Policy-based research

- Economic implications
- Insurability
- Wider economic implications
- Wider socio-economic implications
- Implications of retreat or compensation, change of use- assets now worthless or devalued.
- Linked lessons learned from post-war experiences.
- Loss of valued assets
- Significant industrial areas.
- Policy to deal with vulnerability of most vulnerable (equity)

Scotland, migration and climate change

- Climate change and refugees
- Current policy to increase population
- Infrastructure, housing, planning etc
- Increase of carbon footprint
- Timeframes may mean instantaneous – implications for target
- Humanitarian aspects.
- Balance re policy and practice.

Vulnerability of hydro-electric and other renewable energy sources

- Change in snow/snowmelt
- Change in timing of available precipitation water

- Implications of meeting target for renewables
- Risk given climate change and extremes
- Implications for integrated multi-power systems – phase in and out relative reliability of renewables given extremes
- Role of nuclear
- Consider flexible energy supply systems (smaller vs. larger)

Capability and capacity of construction industry to deal with repairs and maintenance

- Losing capacity
- Inability to continue to support historical buildings
- Already a considerable draw – Olympics
- Investment in training – question of adequate skills
- Consider in the context of extremes
- Already a skills shortage without an extreme event
- Long-term investment – takes time (courses, training, facilities)
- Look at case studies
- Migration of workforce

Lessons from mitigation

- Methods of enforcing standards/regulations
- Best means of delivering the desired results: policy, regulation, local authority etc

What does adaptation cost?

- Big picture scenario
- Broad perspective
- Big statistics – budget for Scotland
- Looking at up front and life cycle management costs
- Costing timeframes
- Flesh out with practical examples
- Targeted at policy and political audiences
- To support decisions relative to effective spend

Provision of transport system

- Structuring public transport
- Incorporating climate change – cross-over issue
- Mitigation – implication for increasing/decreasing vulnerability
- Climate change not generally incorporated in transport strategies – driven by other agendas e.g. air quality
- Little direction/joined up thinking from national/regional levels

Integrated approach to adaptation – need for policy officers

- Why is this not happening?
- How to break down barriers
- Practical solutions
- Networking designs – alternatives – relative effectiveness
- Links to over-arching objectives – evaluating potential success of this approach

Building materials

- Implications of importing relative to national identity.
- Sustainability of various directions from a broad economic and social perspective
- Preservation of national identity
- Understanding full costing of various options
- Energy audits implications of implementing suggested changes

Role of behavioural change as an effective adaptation option

- Limitations and potential
- Understanding of benefits

Carbon costs

- How do we calculate it?
- Whole life carbon analysis
- Potential implications
- Carbon accounting
- No joined up thinking about future uses of new buildings e.g. Victorian buildings converted to flats

Land economics

- Land sales being used to fund other areas of Local Authority work
- Policy may impact land values – development costs increase if you insist on sustainable developments
- Land is paid for by borrowed money e.g. mortgages.
- Are the public prepared to pay more for a more sustainable home/office?
- Developers are too focussed on profit
- What lessons can we learn from abroad?
- Effects of raising standards on development especially on affordable homes.
- Value (financial and social) of public 'green spaces'
- Is policy suitably joined up with guidance?

How do we adapt older buildings?

- From what to what?

- Why adapt – too hot in summer?
- Costs – too much to heat and cool; replacing tiles; repainting.
- Basic measures via repair and maintenance
- Are we looking at dealing with future climate?
- Drainage- do we have capability to cope in 50 years time?
- Do we have capacity to adapt?
- How do you choose materials – are they suitable – are they a mal-adaptation?
- What are the impacts on different ages of housing stock? Are there different ways to adapt these?

Standards – what are current standards?

- Repairs done to a ‘standard’
- Never go beyond the standard – no money within Local Authority
- They don’t take climate change into account.
- Fashions and trends e.g. wood burning stoves– what are the implications on air quality?

Design decisions

- Architects
- Choice of materials
- Who is the client – they set the agenda; how knowledgeable are they?
Role of educating architects re climate change and giving clients more information about climate change.
- Costs
- Use of unproven technologies
- How many people can use these new technologies?
- Lack of skills increases the costs.

Should building regulations be looking forward to 2100?

Land use change to increased housing density

- Land take issue
- New builds
- Regeneration

Wind

- Characteristics and events
- Road, transport – high sided vehicles
- Locations of high incidence – topography
- Vulnerability study – current events – UKCIP

Benefits of climate change

- Increased growing season
- Tourism
- Decrease in fuel poverty
- Decrease in energy use

Freeze-thaw cycles

- More rapid change
- Pavement, road issues
- Will be presented in UKCIP08
- Weather-generator – frequency of occurrences

Flooding

- Soft and hard engineering
- Feasibility of continued defence
- Socio-economic effects
- Multi-agency
- Local drainage management

Agencies, processes and governance

- Management of integrating data to address issues in planning
- Applying planning into policy
- Relationship between research and devolved authorities.
- Local vulnerability
- Building capacity at a national scale to develop the tools
- Strategic understanding
- Research through case studies
- Need for involvement of government agencies
- Research not driven regulations
- Conflict between agencies and researchers

Local energy

- Local energy as a strategy for coping with extreme weather events as well as reduce transmission losses

Alternative technologies

- Current infrastructure changes to be made for adaptation to new technologies while adapting to climate change.
- Building adaptation capacity for future known and unknown needs.
- Need to build in forthcoming (unknown) new technologies and demand

Psychographic segmentation

- Identify groups of the population with common psychological traits/attitudes/personal efficacy/social norms/behavioural control
- Public perception of adaptation
- Occupant behaviour
- Are some people more amenable to change?

Adapting to extremes

- Infrastructure needs
- Planning for extremes
- Examine existing models
- Protecting historical buildings and areas
- Financial impact of moving to another area as opposed to repair.

Adaptation and mitigation

- Fine line between adaptation and mitigation that has not been fully explored.
- Explore basic adaptation and mitigation win-win techniques – related to cost and across all different sectors in the built environment
- Evidence based.

Computer modelling of buildings

- Predict energy demand of present and future building stock
- Need for post-occupancy audit – benchmark validation – redefine models
- Occupancy behaviour.

Waste infrastructure

- Impact of climate change
- How can we use our energy resources in the best way to re-use material and adapt to climate change.
- Use of waste as an energy source.

Workshop 3: data, knowledge and expertise required

Following workshop 2, stakeholders were issued seven votes to prioritise which knowledge gaps/research questions they deemed most important. The research issues with the most votes became the focus of workshop 3. Stakeholders were asked to identify 'who' would need to be involved in that research questions; what 'knowledge and skills' were required and what 'data and information' would be needed.

Optimising development and land use change

Who needs to be involved?

- Land owners
- Scottish Enterprise
- Local authorities
- Scottish Environment Protection Agency (SEPA)
- Developers
- Scottish Government
- Housing associations
- Community Scotland
- Communities
- Planning Aid
- Scottish Natural Heritage (SNH)
- Community Planning Partnerships
- Royal Town Planning Institute
- Town and Country Planning Association
- Scottish Water
- Land users
- Material suppliers

Knowledge and skills

- Urban planners
- GIS modellers
- Material suppliers
- Social sciences
- Land use economics
- Development appraisals
- Engineering skills
- Transport planning
- Community engagement

Data needs

- Completion data – link back to supply for densities and links to land use classes
- Heat islands and population densities
- Census data – household sizes/density
- Car ownership
- National/Scottish household survey
- Land supply information

Adapting older buildings

Who needs to be involved?

- Historic Scotland
- Local Authorities
- Housing Association
- Royal Institution of Chartered Surveyors
- Scottish Building Standards Agency
- Archaeological Data Service
- Commission for Architecture and the Built Environment
- Homes for Scotland
- Public institutions
- Training establishments
- Home owners
- Construction industry
- Tenants
- Scottish Property Federation
- Heritage bodies
- Scottish Government
- Developers
- Occupants
- Neighbourhoods

Knowledge and skills

- Structural engineers
- Training trainers for knowledge base
- Traditional materials and skills
- Mechanical and electrical engineers
- Awareness of embodied energy
- Labour mobilisation
- Town planning skills

Data needs

- Listed building registry

- What is an old building? Stock profile
- Post occupation performance – how do they perform now.
- What does performance mean?
- Flood maps and vulnerability
- Data relating to changes in use of buildings e.g. applications for cavity wall insulations
- Claims evidence re flood, wind and other climate events

Building materials

Who needs to be involved?

- Architects
- Engineers
- Building Standards
- Building industry
- Material Change for a better Environment (WRAP)
- Royal Institution of Chartered Surveyors
- Royal Institute of British Architects
- Building suppliers
- Imported materials
- Material scientists
- EU communities
- BRE

Knowledge and skills

- Understanding performance lifecycles
- Costing availability
- Materials interaction
- Transporting of materials
- Synthetics
- Substitutes for traditional
- Building sciences
- Technology processes

Data needs

- Properties of different materials that are comparable
- Having faith in the data
- Sourcing of raw material – consider adaptation concerns e.g. BSI agreement

What does adaptation cost

Who needs to be involved?

- Clients (developers and owners)

- Manufacturers of technologies
- National and local governments
- Insurers
- Funders and grant giving bodies
- Government economists
- Carbon Trust
- Electorate

Knowledge and skills

- Economists
- Energy auditors
- Opportunity costs
- Health, social, cultural costs
- Disseminators
- Environmental costs
- Definition of adaptation
- Case studies to present knowledge
- Engineering skills

Data needs

- Look for existing models e.g. flood and incorporate climate change factors
- Look for adapted designs
- Robert Green University – Index SI identified environmentally friendly house designs and layouts (Aberdeen Sustainability Research Trust)
- Data from Bed Sed?
- What are you costing?
 - Climate change factors
 - Energy efficiency
 - What other countries are doing, established technologies overseas have impacts on the cost of technology here.
- Passivhaus: Germany
- Passive house: Sweden
- Allergy free homes: Fairfield Perth
- Findhorn Foundation

Design decisions

Who needs to be involved?

- Building industry (Architects, Engineers)
- Development managers
- Local and national government
- Further education, post-graduates, under-graduates (education)
- Royal Town Planning Institute
- Royal Institution of Chartered Surveyors

- Royal Institute of British Architects
- Specialists
- Communities
- End users

Knowledge and skills

- Architects
- Financial skills
- Tyndall Centre: visualisation, 3D model
- Communicators
- Clients and funders
- Planning committees (councillors)
- Consent process
- Planning skills
- Engineering skills
- Building standard skills

Data needs

- Building materials
- Current standards
- Housing trends and population movements
- Competence in decision making process
- CPD back up from professional organisations
- Impacts of climate change
- Multi-disciplinary approach – geological, climatic etc.
- Topographic GIS data
- Engineering models
- Integrated thinking
- Better evaluation and interpretation of data
- Community values/needs
- Planning policy
- Executive guidance
- What is there already?