



Quantifying the Business Benefits of Sustainable Buildings –

Summary of existing research findings (Extracts)

DRAFT for discussion

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Executive Summary

This report has been prepared as the first stage in a project to define the business benefits arising from sustainable construction techniques through case studies. This work is part-funded by the DETR under their Partners in Innovation programme. The project team members comprise: BRE's Centre for Sustainable Construction, BIFM, BCO, RIBA, Argent, BG Properties, Friends Ivory & Sime, North British Housing Association and the Northern Ireland Housing Executive (NIHE).

This project aims to motivate building occupiers, managers and others involved in making decisions on the maintenance and procurement of buildings to adopt current best practice in their decision making through an improved understanding of the benefits that can be achieved. There is a perception amongst these groups that more sustainable solutions in maintenance and procurement inevitably result in increased capital costs and /or reduced market / staff appeal. The project will explore the benefits achieved by studying case studies across a range of sectors and issues. It will seek to map out the benefits and begin to quantify them where this can be achieved.

Much work has been carried out on the options for more sustainable buildings and a number of guidance and incentive mechanisms exist to encourage the take up of more sustainable solutions. These include the DETR's Energy Efficiency Best Practice Programme, Construction Best Practice Programme, Movement for Innovation (M4I), Design Advice Scheme (DAS), The BRE Environmental Assessment Method (BREEAM) and the BSRIA Code of Practice to name but a few. This has provided a wealth of information on how to achieve more sustainable buildings but little that allows key decision makers to assess the business case for adopting such solutions instead of well tried and tested ones. Feedback from such schemes always comes back to the same issue. The industry is ready and able to make changes but only when the case is proved.

This report is the first output of a BRE lead project to assess and attempt to quantify this case by looking at a number of case studies covering a range of sectors. The project is funded under the Partners in Innovation programme and involves a number of influential and strategic industry partners. The report summarises the current state of thinking over business benefits arising from such buildings and seeks to map these out. No attempt has been ad at this stage to quantify them except in very general terms.

The report concludes that benefits are diverse and potentially very significant. Many are hard and relatively easily quantifiable such as energy costs, construction costs etc. However, the 'softer' benefits relating to risk, image, profitability are currently unquantifiable. They are the more significant though and should be the focus of future work under this project.

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1.0 Outline of the Project

Aim

This project aims to motivate building occupiers, managers and others involved in making decisions on the maintenance and procurement of buildings to adopt current best practice in their decision making through an improved understanding of the benefits that can be achieved. There is a perception amongst these groups that more sustainable solutions in maintenance and procurement inevitably result in increased capital costs and /or reduced market / staff appeal. Whilst this does not appear to be supported by the growing evidence it presents a major barrier to greater sustainability in our building stock. There are, however, many organisations who are beginning to recognise real and quantifiable benefits including the following:

- capital cost savings
- reduced running costs
- increased investment returns
- increased productivity, staff recruitment and retention
- more efficient resource use
- major image / marketing spin-offs

Those tasked with developing proposals for procurement and maintenance of commercial accommodation are faced with justifying them to sceptical investors and high level management who tend to be and focused on short term capital costs. Whilst there is much guidance available on solutions and actions of which awareness is moderately good, there is little in the way of quantifiable data on benefits, life cycle impacts with which to build a case for their adoption. This project seeks to collect together existing data and reinforce this through studying a series of case studies to raise understanding and confidence. These will be used to provide a simple method for predicting benefits arising from the range of practicable options available to premises managers.

The study will seek to include a range of building types ranging from offices and industrial buildings to retail and leisure. These represent the significant proportion of the commercial building stock in the UK and therefore the largest potential for making real progress towards reducing impacts.

Project Methodology

Our approach is based on the need to work with those directly involved in decision making both with new and existing buildings to identify and quantify benefits actually achieved. Approximately 14 case studies will be carried out looking at a range of more sustainable buildings and technologies / techniques in a number of differing sectors.

This will allow the identification and wide dissemination of real-life data that will provide confidence required by stakeholders if they are to make investments in more sustainable solutions.

This approach supports those putting together business cases for building sustainability into their planning and decision making of future .

Outcomes and Benefits to Industry

The outputs will provide support to hard pressed premises and facilities managers both through direct information on real-life situations and the benefits that have been achieved and through the development of a simple method for predicting the potential benefits arising from the range of commonly accounted options. The benefit of this approach is that those targeted will be able to visualise where benefits have been achieved and then how to go about achieving them in their organisations. This will be largely through the efforts of managers and designers being able to demonstrate in a quantifiable way the benefits that can be expected.

The project will produce the following outputs:

1. A series of 14 Case Studies covering a range of commercial and residential building and occupant types. These will give a succinct description of the context, building, financial benefits (capital, Operating, Investment, staff productivity and retention, rental levels), other business benefits which cannot easily be quantified in terms of financial (including environmental management and corporate image) and time period of these benefits.
2. A paper based publication in the form of a self assessment guidance on predicting benefits which would use the case study experience together with other published guidance to allow decision takers to predict benefits that could be expected from the range of options available in building maintenance, management and design.
3. A series of articles and workshops aimed at disseminating the key findings to premises managers.

It is anticipated that these will lead to:

Greater understanding of the impacts of higher performance buildings on businesses.

- Greater mutual understanding between occupiers and their accommodation providers and managers.
- Better informed decision making on maintenance and refurbishment and design of commercial buildings

Better performing buildings.

Team members

The project team members comprise: BRE's Centre for Sustainable Construction, BIFM, BCO, RIBA, Argent, BG Properties, Friends Ivory & Sime, North British Housing Association, Northern Ireland Housing Executive (NIHE).

2.0 Context for Sustainable Buildings

2.1 Background to Sustainable Development

Sustainability is defined in dictionaries as the ability to carry forward or support or maintain for a prolonged period approaching perpetuity. In business terms this is something that has traditionally been aspired to in terms of economic factors as businesses strive to balance inputs and outputs to maintain a profitable enterprise.

Sustainable Development has become a widely used term that goes beyond such economic security to include issues of environmental impact and resource use together with social effects. The triple bottom line created by this approach is what is now commonly meant when the term is used and this is the definition adopted by the UK Government and in this study.

DETR has defined Sustainable Development as achieving social, economic and environmental objectives in parallel (1). Government sees this as a means of creating a more inclusive society in which the benefits of increased economic prosperity are widely shared, with less pollution and more efficient use of natural resources. The need for growth is as great as ever especially but not exclusively in the developing world. Yet the environment is struggling to cope even with the current levels of consumption. We need new ways of meeting our expectations and aspirations.

2.2 Sustainable Business

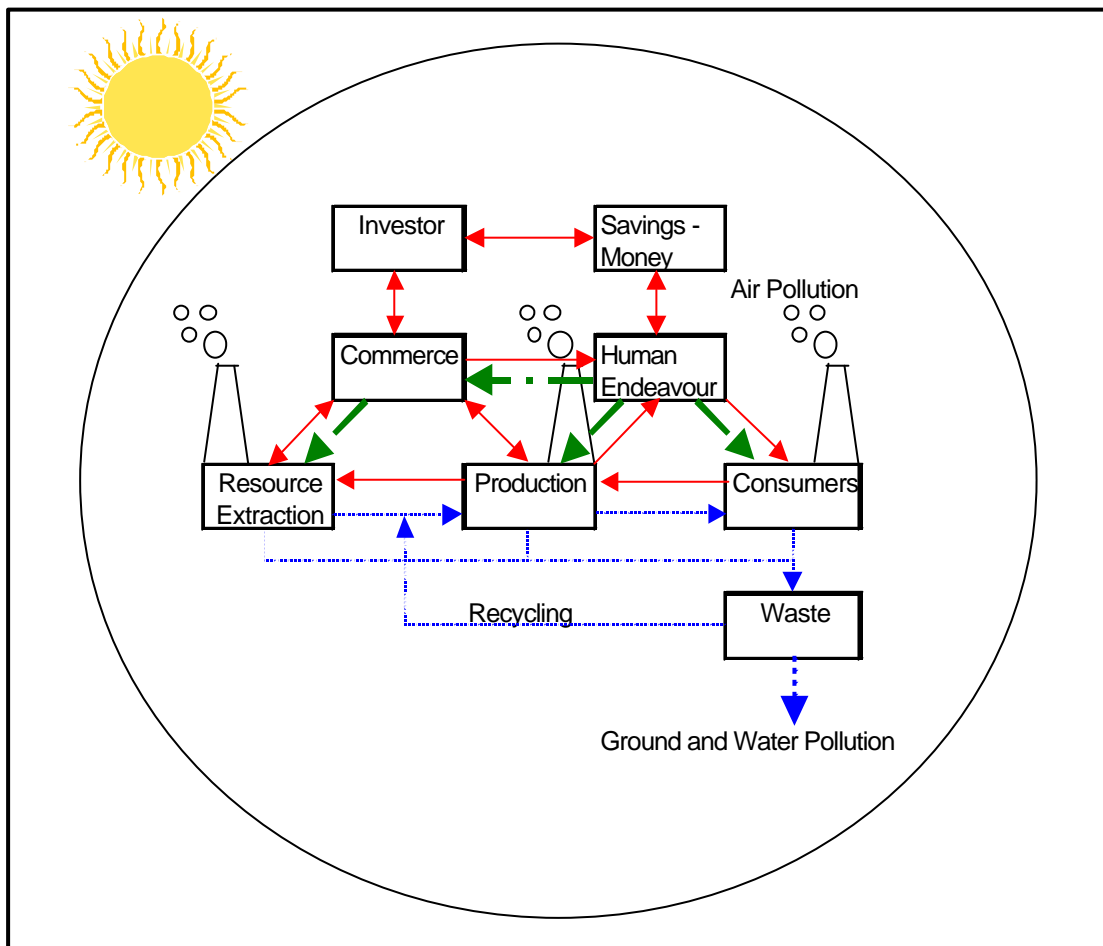
For a business to be seen as sustainable it will need to meet the criteria of balanced input and outputs in the economic, environmental and social fields. Since the invention of money the concept of sustainability in business has been understood in economic terms and is now a central feature of almost all societies. Businesses that do not succeed in meeting this criterion will not survive and the commercial marketplace acts as a self-regulating mechanism.

In the areas of environmental and social impacts such 'markets' do not exist at present and maintaining or working towards sustainability is in its infancy. However, pressures are growing rapidly to adopt such an agenda and indeed to assess performance and report against such issues. Key business decisions are being increasingly taken with environmental and social concerns alongside economic ones as crucial parts of total value. Increased legislation and consumer pressure is forcing the hand of business to change, albeit slowly.

All industries have traditionally taken raw materials and processed them into consumable goods. Human endeavour and finance are an important ingredient with the focus on economic factors such as investment, returns and savings. The construction industry is no exception. Products have been disposed of at the end of their useful life in landfill. A small degree of reclamation of valuable materials has occurred for economic reasons as in the case of metals.

Prior to the industrial revolution such processes were largely dependent on materials and to a large degree markets which were moderately local due to the limitations of transportation and manufacturing capacity. The Industrial revolution changed this. It provided mechanisation of processes and transport and increasingly reduced costs. The result has been a progressively increasing consumption of goods and the resulting increase in consumption of energy, raw materials and the emission of pollutants and wastes to water, air and land. The traditional processes of business are summarised in figure 1. The solid red arrows indicate the flows of money in this system whilst dotted blue indicates resources and dashed green, human endeavour. The system is closed with the exception of energy, which ultimately comes from the sun, and pollution.

figure 1 – sustainable business, BRE





Quantifying the business benefits of sustainable buildings

For a business, which typically occupies only a part of this cycle, to be sustainable the inputs and outputs must also be maintained over time. This includes resources such as materials and labour as well as pollution and waste.

Whilst movement is occurring towards these targets as a result of increased political and statutory and market place pressures there is a long way left to go before this balance is achieved.

3.0 Decision makers concerns

3.1 Stakeholders Costs

In understanding the costs and therefore the burdens and risks that each stakeholder considers in making decisions, we need to understand the structure of the decision making process which surrounds property and the concerns of each player. The whole life costs arising from a building are the key issue when it comes to justifying a more sustainable approach to construction and property management as these reflect the total economic sustainability of a development. The fragmented state of the UK property sector means, however, that no single stakeholder is required to consider the whole life costs in this way. We can identify the key groups as follows:

- Investors – Responsible for providing funding and concerned with investment returns, rental yields and intrinsic value only.
- Developers – Responsible for up front costs of providing the product in the first place. This places the emphasis on the attractiveness of the product and so concentrates on image issues.
- Tenant – Responsible for all operational costs. Image is also important as it effects profile
- Owner Occupier – Responsible for both the development and operating costs. They are, therefore, more likely to take life-cycle costs into consideration when making decisions on property

The relative burdens on these are indicated in figure 4 below

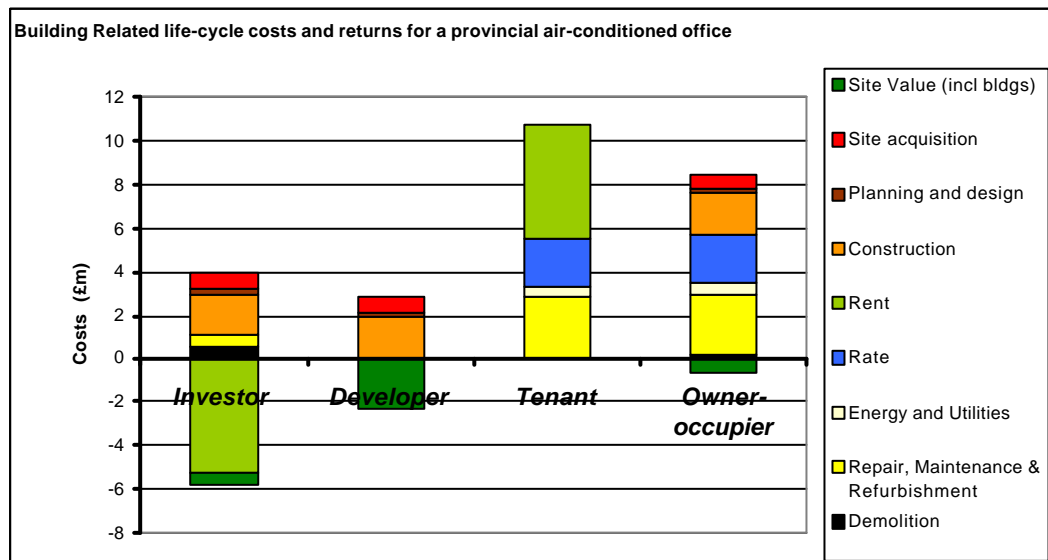


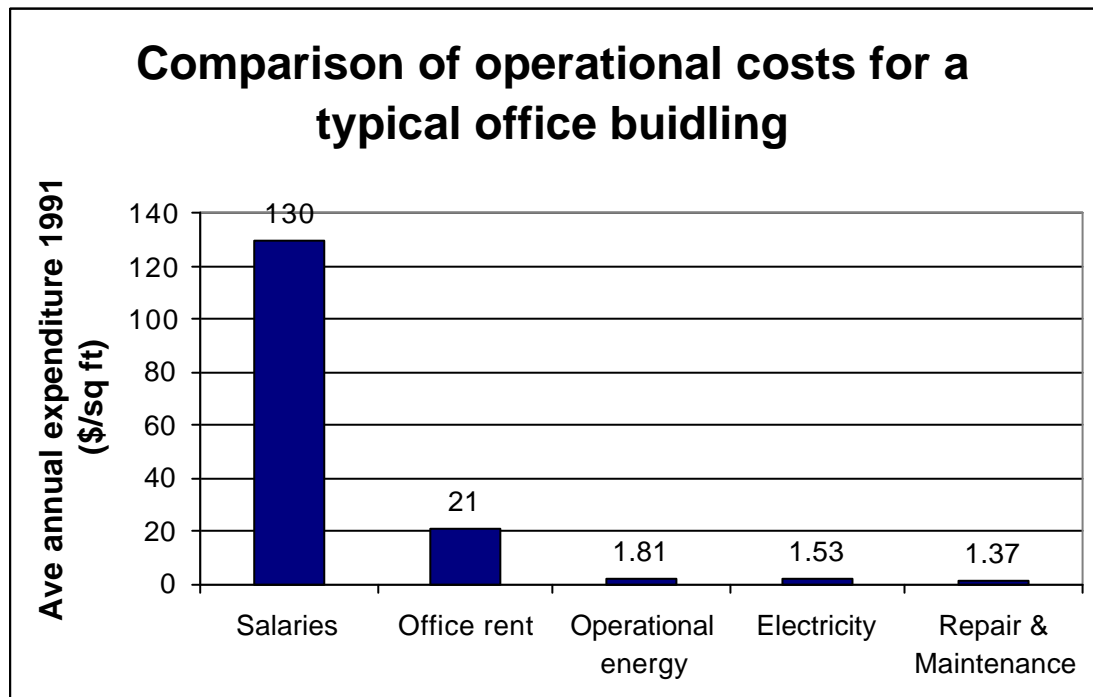
figure 4 – stakeholder burdens, BRECSU

Research by BRE has shown that the relative cost burdens resulting from a building are as follows:

Costs	Factor	Burdened Stakeholder
Construction costs	1	Developer
Operating Costs	5	Tenant
Productivity of activity	200	Tenant

Figure 5 shows the results of work by Amory Lovins, which supports this position that most operating costs are outweighed by staff costs. This shows that any tenant will be primarily concerned with the costs of staff in a commercial building. The residential sector is clearly different and here operating costs are more of an issue especially in the social sector.

Figure 5 – Amory Lovins 1999 (3)



The key influencer on the building specification is the investor. It can be seen from figure 4 that they have no interest in any of these economic burdens and so do not include these issues in their decision-making other than potentially through the assessment of investment risks.

In terms of economic burdens and probably most of the environmental and social ones as well, the tenant is the victim although they will often not realise this and are at any rate limited in their ability to overcome this. Recent changes such as the advent of Procure and Operate packages both in the public and private sectors such as PFI helps to overcome this in theory as it removes the role of manager from the tenant and combines this with those of the developer. In some cases the investor is also involved which brings all parties into the frame so allowing the consideration of whole life costs. For this reason such procurement route, although currently a minor part of the market present an opportunity to seek improvement if they can be encouraged and a greater part of the building stock included. There are clear commercial pressures that will act as a barrier to these moves and currently only the larger tenants have the clout to impose such constraints. In practice, however, Procure and Operate contractors seldom structure their decision making in a manner that allows this to happen. Most operate on the traditional procurement lines with management treated as a separate exercise. This can negate the benefits of this approach.

4.0 Industry Perceptions

Each of the players involved in the procurement of a building will have preconceptions that they bring to the table. These can often pose a significant barrier to the adoption of innovative solutions. Some will be well founded on experience or robust prediction and should not be accepted but many are demonstrably unfounded and stem from a fear of the unknown. Many of those surrounding more sustainable buildings fall into this latter category.

Of these preconceptions, 3 are highly significant barriers in the decision-making processes that could lead to improvement.

4.1 Perceived Investment Risks

The first is in terms of investment risk. Sustainable buildings are often branded alongside 'Green' buildings by investors. The image is of natural materials, green roofs, radical passive design, and technological gizmos. They are seen as a potentially short-term fashion trend with a narrow market place appeal that runs counter to longer-term investment strategies. Such buildings clearly do not appeal to long term investment planners.

To date the investment market is relatively unaware of the less radical options and the benefits that they may bring. Addressing such concerns involves education through the use of 'safer' practical examples and demonstration projects, which are demonstrably lower risk. There are an increasing number of these around and this project will identify and study in detail some of these.

It also means tackling the awareness of investors' advisors from property agents to designers about the opportunities that exist and the practicality of many of these. It also means raising understanding of benefits amongst occupiers of buildings as ultimately tenants provide the ongoing demand that make property a safe investment.

4.2 Perceived Capital Costs

It is a commonly held belief that more sustainable buildings cost significantly more in terms of their capital cost. This belief is not well founded and is based on experience with 'bolt-on' sustainable design solutions. It does also reflect a wariness of the unknown amongst construction professionals in general and Quantity Surveyors in particular.

4.2.1 Value Management in a prestige office

Research Carried out under the DETR's Energy Efficiency Best Practice Programme explored the relative capital costs benefits and disbenefits of applying a range of basic energy efficiency solutions in commercial buildings. These effects were studied both in terms of capital and annual operational costs. The studies related to a typical air-conditioned office building (ECON 19 type 3 benchmark). This building was a deep-plan atrium office with a 4-pipe fan coil system.

The study applied various efficiency solutions to this base case and showed the cost benefits that occurred through decisions made at inception, sketch design and detailed design.

It showed that significant reductions in both capital costs were obtained by making changes at inception. Lower reductions were obtained by changes at sketch design stage although they did still occur. Changes made in detailed design and specification such as lighting controls, condensing boilers, heat recovery systems and higher insulation levels resulted in savings on annual operating costs but tended to result in increase in capital costs.

It is this last part of the process that is traditionally used by QS's to predict increased costs. If the broader picture is considered, total capital costs are significantly reduced in this situation, mostly by early decisions on building form, siting and basic design parameters on indoor environment. Nothing proposed in this case had a fundamental change on the rental value of the resultant building.

The study also looked at the effects of changing from an active a/c system to a passive naturally ventilated one.

The initial decision to move to a naturally ventilated solution had a dramatic effect, both in terms of operational and capital costs. Some of the possible solutions, which might result from this decision, did significantly raise the capital costs. However, these increases did not approach the scale of the initial savings achieved

Both parts of the study indicate that addressing sustainability in design and specification of buildings does not increase capital costs as is often perceived and in fact can significantly reduce both the overall capital costs and running costs for the typical base case provided that decisions are taken early on. Resorting to 'bolt-on' kit will often increase costs and will seldom achieve an optimum solution.

4.2.2 The cost efficiency barrier

So-called sustainable solutions for buildings are often based on achieving greater efficiencies in existing technologies. This may provide the most cost effective and practicable means of achieving greater performance in many cases.

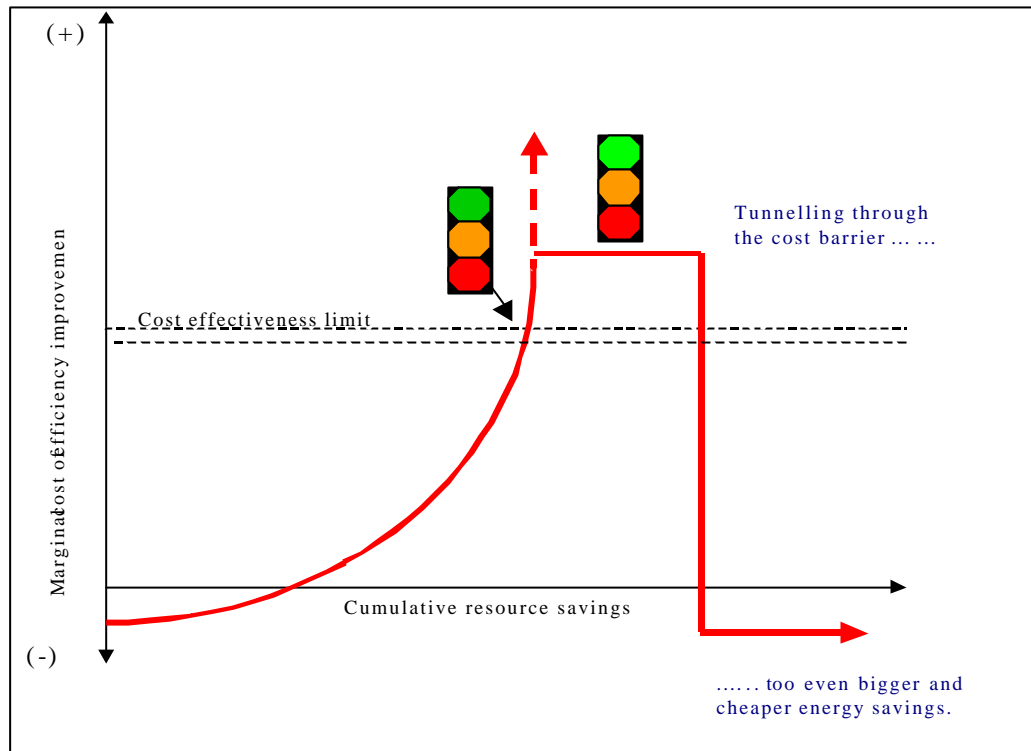


Figure 7 - Breaking the Cost Efficiency Barrier – Amory Lovins 1999

The encouragement of energy efficiency in the construction sector has been a key aspect of Government policy in respect of buildings for many years through its Energy Efficiency Best Practice Programme. This encourages better levels of performance in building fabric and systems.

Similar techniques can be used for water and resource uses generally. However, energy and other resource costs are often low in comparison with overall operating costs as we have seen and as such the drivers for greater efficiencies are limited in many cases. Whilst there is clearly much that can be done to improve efficiencies there are definable cost efficiency limits where the capital cost becomes unwarranted when the payback period is considered.

Amory Lovins has stated that this should not be seen as an absolute barrier to greater efficiencies as there are many cases where exceeding this barrier will ultimately result in very significant savings. An example of this is the case of energy efficient cooling. Savings can be achieved by specifying more efficient air-conditioning systems but going further, into borehole cooling for instance, can take a project beyond the cost efficiency barrier. Designing out the need for air conditioning through careful passive design can make major savings over the original cost.

5.0 Benefits to Businesses

5.1 Introduction

Work to establish the benefits to business in procuring more sustainable buildings is not new. Much has been written about it but very little has attempted to quantify these benefits. The Probe studies funded by DETR and Building Services Journal are an exception that looks at specific case studies of past exemplars and revisits their predicted improvements. BRE's own Environmental Building is another example that is undergoing ongoing monitoring. Unfortunately these examples are limited and tend to be exceptional in some way making it difficult to learn broader lessons from and so to apply the results to other situations. This project aims to carry this work considerably further and provide a series of case studies. It also seeks to map the benefits and their connections.

Previous published and unpublished work (outlined in Section 9) has been studied and the results used to develop a set of benefits outlined below. It should be emphasised that this research has not been exhaustive and neither is this report in any way a complete summary of work undertaken to date. The quantity of work undertaken makes this impossible. We have tended to concentrate on a number of key, well-funded research projects which have focused on the UK context. Differences between national construction industries makes it dangerous to assume that benefits recognised in one country will automatically be translatable across national boundaries. Some international work has been studied where this was felt to be relevant to the UK context.

This work has been analysed and a series of generic benefits identified. These benefits are often interconnected and the summary map in Section 6 of this report shows these connections as currently understood. It should be emphasised that this map provides a starting point for this project and will be refined as the project develops. For this reason it should be seen as a draft set of benefits. The map will be used during the case studies to identify and categorise benefits. It will also be distributed for consultation to a wider range of organisations for more general comment and feedback.

For clarity we have broken up the 3 strands of sustainability further. Connections have been predicted which results in a hierarchy of benefits with the top level indicated by bold type below:

The following pages include a brief outline of the potential benefits of sustainable buildings identified by previous work in this area.

5.2 Economic benefits

5.2.1 Financial

- a. **Capital costs** – The capital costs of a project can be affected substantially by the decisions taken at inception, feasibility, outline and detailed design stages, during construction and commissioning.
 - In general more highly serviced buildings cost more to build and use more energy, materials etc.
 - Bolt on 'green' features such as controls, shading, water-recycling systems etc will result in higher capital costs. These might be considerable increases for those elements
 - Increased capital costs may be incurred in specific areas but can be offset by benefits elsewhere. The new Wessex Water HQ in Bath used prefabricated wall panels that resulted in an increase in the capital cost of that element of approximately 10% over conventional block and render solutions. Savings in on-site construction costs through reduced time and defects outweighed this by almost 2 times so making the solution cost-effective.
 - Decisions made early on in a project are likely to result in less of an increase in capital costs than those made at a late stage and may result in significant savings.

- b. **Operational costs** – Operational costs are diverse ranging from utilities such as energy water and waste; staff costs; rents; maintenance; management costs and transport, both business and personal commuting.
 - Operational resource use costs account for approximately 5 times constructional costs over the typical 60 year life of a building.
 - Typical staff costs account for approximately 200 times the construction costs over the same period.
 - Basic planning and fabric related issues can make considerable savings in these through careful design, orientation etc.
 - Greater efficiencies through systems can result in significantly reduced costs for energy and water.

- c. **Investment** – Investment appeal can be influenced through the attractiveness of a building project or company. This is a factor of value, yield and flexibility both now and in the future. It is influenced by the issue of risk below
 - Investments values can be improved where increased income levels are achievable through rents or resale.
 - Investment appeal will also be increased through a quicker realisation of those income levels through reduced procurement times. This will make an investment more appealing even where the final income levels are the same.
 - Greater flexibility in building design will increased the investment appeal through an increase in the potential market size and through a reduction in the longer term risks of redundancy.
 - Increased flexibility in design often results in significant over specification that has a negative effect on resource use leading to some conflict in sustainability terms.

- d. **Profitability** – Profitability is a key issue for businesses. It is affected by productivity, sales, market profile, competitiveness or reduced competition.
- Profitability is central to Egan thinking on Rethinking Construction outlined in section 2.3 above.
 - The drive for profitability in the design and procurement process often results in less innovations being used. This is as a result of the need to minimise unforeseen risks arising from untried / tested solutions. Recycling of effort between projects will also tend to encourage this stagnation in the design and procurement process.
 - A more sustainable solution can achieve the same performance / appeal or more for less effort so increasing the profitability of the development. This is a key issue for this project to explore.

5.2.2 Risk

- a. **Legislation – Compliance with legislation is a key driver for the construction industry as with any others.**
- Issues of compliance with current statutory requirements / obligations are well understood in the building procurement process. Indeed the processes tend to revolve around these requirements in the way that the process is structured. The Planning and buildings control processes become the major milestones for many projects.
 - Industry and investors are increasingly concerned about future proofing their business / investments against future changes in legislation. In a political atmosphere that places environmental concerns high on the agenda with strong international commitments to back these up, this increased level of wariness is likely to remain and intensify. With the average life of a procurement programme lasting several years the current rapid rate of change in legislative requirements makes this a significant issues even in the procurement stages let alone the longer term where health and Safety and environmental protection requirements come into play.
- b. **Liability** – All stakeholders have liabilities to staff, occupiers, third parties, businesses and investors that can have significant bottom line implications. Liabilities are resulting in larger and larger compensation awards and greater degrees of criminality so providing increased incentives to minimise these at the outset.
- In an increasingly litigious society, concerns over liabilities are increasing and can provide an incentive to move away from traditional solutions.
 - Conversely the same pressures are likely to cause designers and their clients to avoid of innovation where this is not well tried and tested.
 - Employers / landlords responsibilities increase with more complex systems. Although there are many basic liabilities that all need to take on board. The provision of highly serviced accommodation, such as air-conditioned offices, requires more stringent regimes to ensure that they are working properly.
 - Greater autonomy from mains services also places a greater degree of responsibility and a duty of care on the building owner / employer. This

would be true for systems such as grey water systems and other systems that replace conventional utility providers who are normally responsible for such liabilities.

- c. Investment – Investment risks are significant and long term in nature especially where property is concerned.
 - Much of the above can affect future investment potential through limiting buildings attractiveness at some point in the future.
 - Flexibility is often considered a useful safeguard against changes in the market demands and more sustainable buildings can help to increase this by making them less dependent on particular modes of operation and maintenance requirements.
 - Conversely, innovation can have a negative effect on the market appeal and therefore, on the short term performance of investments. This is a major issue in the UK as the property market is driven to a large degree by a speculative or quasi-speculative market place. Longer term investment performance is unlikely to be influenced by this provided that the building performs well in use as the reluctance stems from a fear of the unknown.
- d. Defects – Defects are a key ‘Egan’ issue that can be limited by having a simpler building solution.
 - Avoiding complex systems in servicing and construction will help to limit defects resulting from defective products and poor workmanship.
 - Greater use of off site construction techniques such as prefabrication will also have a beneficial effect on build quality and therefore on defects levels. The Peabody Trust’s affordable rental housing scheme at Murray Grove demonstrated this benefit.
 - Improved education, both in construction and operational use, will lessen the impacts of defects on the construction industry and are particularly relevant where less conventional solutions are adopted.
- e. Predictability – One of the problems that arises from a lack of detailed feedback from buildings in use is the lack of experience to base predictions of likely performance on.
 - Predictions of costs and time in design, construction, occupation and maintenance can be extremely helpful in increasing the efficiency of the procurement process.
 - The need for predictability and the pressure for shorter procurement periods both act against greater innovation.
 - This project seeks to boost this through increasing understanding of the issues involved

5.2.3 Management / auditability –

Management process benefits are less tangible and do not in themselves provide direct environmental economic or social benefits to any individual stakeholder. They do however result in all players being in a better position to manage direct impacts and therefore benefits arising from the other issues covered in this report. For this reason

they can be vital to the successful achievement of more sustainable objectives in a project.

- a. Design process – Much of the impact of a building is decided during the design process with key influences being at the early stages.
 - Effective briefing, specification, target setting and benchmarking is important at the design stage to minimise risks of unforeseen problems.
 - Sound integration of design and construction processes will result in less wastage of time and resources.
- b. Management process - In the management of buildings targeting and monitoring, environmental management and reporting are all affected by the ability to collect information on performance and make comparisons.
 - Establishing sound monitoring and targeting procedures are often critical to achieving the benefits that are achievable.
 - Widespread awareness and feedback have also been shown to be critical to achieving targets.
- c. Construction process – The traditional split between design and construction can act as a barrier to innovation as a result of the need to educate.
 - The construction process is a relatively low profit sector and as a result the pressure is always there to reduce financial costs as much as practicably possible.
 - Briefing, specification, monitoring, target setting, buildability and the ability to properly commission a system are all crucial issues to consider. They can have a dramatic effect on business performance for those involved.

5.3 Environmental Benefits

Environmental benefits do not tend to be directly felt by the stakeholders in a particular project. They are, therefore, the focus for Government and other NGOs / strategic industry bodies but are often removed from the decisions of the commercially minded stakeholders directly involved in individual building projects.

This has made the 'selling' of environmental benefits difficult and limited in its success to date. For this reason we have not gone into great detail in this report in analysing the environmental benefits arising from sustainable buildings. These are well documented and there is a wealth of guidance from DETR, BRE, CIRIA, BSRIA, CIBSE, RIBA and many others on these. The BRE Environmental Assessment Method (BREEAM) also provides a useful tool in recognising these benefits in a credible way, which is widely used by clients and designers wishing to seek environmental recognition. The existence of such tools and guidance is insufficient in its own right to persuade a greater adoption of sustainable solutions and this project seeks to identify the commercial benefits that arise and demonstrate. Environmental benefits are, therefore, beyond the basic scope of this project to define in detail. The key benefits are, however, outlined briefly below and environmental benefits will be clearly identified and quantified where practicable in the case study projects.

5.3.1 Controlling Climate Change

- Climate change occurs as a result of changes in the chemical makeup of the atmosphere. This is affected by the makeup and in particular the proportion of 'greenhouse gases' and the consequent ability of the atmosphere to absorb heat predominately that emitted from the planet's surface.
- Emissions of gases such as CO₂, SO_x, methane and others contribute to the atmosphere's ability to absorb and therefore store heat. A rise in global atmospheric temperatures has a significant effect on air movements and so on levels of humidity, pressures.
- This means that there is significant potential for major climatic changes to occur as a result of fairly minor changes in global temperatures. Recent climatic events have been blamed in these factors and business is becoming more concerned about the future risks. This is particularly true of the insurance market where increased adverse weather is likely to result in greater claims and therefore, in higher insurance premiums.

5.3.3 Reduced ozone depletion

- The release of ozone depleting substances such as CFCs, HCFCs and Halons into the upper atmosphere causes significant breakdown of the ozone in the stratosphere. Whilst this effect is occurring across the earth it is particularly evident above Antarctica and the arctic where the so-called Ozone Holes are being carefully monitored and continue to grow. This layer protects earth's surface from harmful solar radiation in the UV spectrum. Excessive UV can be harmful to humans, other animals and plant life.
- The Montreal Protocol started a process which controls the emissions of these substances and seeks to reduce our dependency on them. The use of such substances is being phased out as a result of this. As a result the use of CFCs is already prohibited and HCFCs are becoming increasingly tightly controlled. They will be phased out as refrigerants in the UK by 2006 resulting in major problems for systems that rely on them as refrigerants.

5.3.4 Reduced resource depletion

- Resource exploitation causes significant environmental and social disturbance locally. This can be limited by reducing resource consumption. It also avoids depletion of the earth's resources.
- In reality most construction resources, whilst not limitless, are not at risk. Costs of exploitation could increase considerably as current resources are depleted. This is also true of energy that is potentially available from many sources. The exploitation of these would significantly increase energy costs however and as a result there are sound long-term economic reasons for reducing consumption.

5.3.5 Pollution

- Pollution to air water and land causes significant environmental and healthy problems across the world. This is not entirely a local problem although much pollution is predominately local in its effect. Emissions of SO_x, NO_x, particulates, water runoff, dust etc can cause significant problems and harm external image
- Waste from the construction industry largely goes to landfill at present. This causes potential problems from pollution and the lack of suitable landfill sites. The Government has introduced Landfill taxes to provide an incentive to minimise waste and this has significantly increased the costs of waste disposal in the UK.

5.3.6 Biodiversity

- The range of life species on Earth is large but under extreme pressures in many areas. Degradation in one part of the food chain can have catastrophic effects through the whole ecosystem so causing unforeseen effects that could affect our ability to produce food as well as result in a decrease in amenity.

5.4 Social benefits

5.4.1 Health & Well-being

- a. Health & Safety – Health and safety is a major concern for all businesses. Legal obligations are stringent and liabilities high.

- Compliance with COSHE regulations includes issues relating to the quality of the internal environment and is a major cost on business but necessary to ensure safety.
 - More complex services and greater autonomy from statutory utilities impose greater degrees of duty of care on building owners and employers.
- b. Occupant well-being – Beyond safety issues, much can be done to ensure the wellbeing of occupants. This has spin-offs in productivity, loyalty, and attractiveness as an employer. Issues such as comfort, controllability, influence and hassle are all important factors.
- Although much has been written and debated about the effects of indoor environments on occupant well-being evidence is limited and mostly circumstantial in nature.
 - Occupant satisfaction surveys by BRE, the University of Wales (Cardiff) and others have indicated that less highly serviced buildings tend to score more highly in such surveys than conventionally serviced space. This appears to run contrary to expectations and indicates that occupants prefer a degree of variation in environment and a degree of control.
- c. Neighbour well-being – External image can be substantially effected by a buildings effect on its neighbours, visitors etc.
- Issues such as Noise, congestion, pollution can have a detrimental effect on neighbours. Steps taken to address these contribute significantly to reducing the social impact of a development

5.4.2 Image

- a. **Customers / Clients** – Attraction, loyalty, respect and satisfaction are all critical issues for businesses. This is affected by the external image of the organisation.
- Buildings provide a very public face to an organisation where clients and customers visit the premises.
- b. **Occupants** – most businesses are dependent on the individuals that work for it. Staff loyalty, and retention is important, as is attractiveness to new potential recruits.
- This issue has been addressed in several sections above.
- c. **External image** – External Image is important to most businesses as it effects the perception of clients, public, media, politicians and regulators.

5.4.3 Community - These issues affect the external image of a business.

- a. Neighbourliness – Being seen to be operating in its every day business in a manner, which is sensitive to neighbours, is likely to improve the feeling that a business is behaving in tune with the community.

- b. Community – A greater degree of community awareness can be demonstrated through undertaking activities that go beyond the normal business activities of an organisation. Opening facilities on site to outside organisations is an example of such an activity. This can reap significant benefits in loyalty and image although the value of this is highly dependant on the organisation in question.
- c. Aesthetics – In many cases, objections to a development and a feeling that the community has been adversely affected, comes from the aesthetics of the building in question. This is a difficult area to apply guidelines. Research carried out by the University of Surrey for BRE into the assessment of aesthetics showed the difficulty of achieving a consensus in some key areas.
 - A fair degree of consensus into the relevant criteria can be achieved.
 - There is a significant concern that overly prescriptive guidelines on aesthetics could result in a lack of interest in developments by making all buildings conform to a consensus view. The resulting development could be overly mundane and the overall effect bland which would be seen as negative.
 - Aesthetics are also governed to some extent by fashion. Like most fashions, architectural aesthetics vary over time and following an over fashionable style could be seen as being negative in terms of the longer term durability of a design and, therefore, to its value over time.

5.4.4 Respect for People - These issues effect the external image of a business

- a. Clients – Demonstrating respect for clients has a significant effect on their willingness to return. There is, therefore, a direct marketing benefit to be achieved in showing respect for clients.
- b. Suppliers – Most businesses are dependent to varying degrees on their suppliers in achieving their own performance targets. A good working relationship with suppliers is a critical factor in maintaining this.
- c. Staff. – As has been stated before, staff costs are a factor of 40 times higher than operating costs. It follows that staff contentment is vital in achieving productivity, image and bottom line financial benefits,
- d. Neighbours – See community above
- e. Education – A willingness to provide for the ongoing education of employees, both during procurement and operation of a building are very beneficial to the smooth operation of the building itself. It is also a good way of demonstrating respect for people that reaps benefits for all parties. Quality management, environmental management, Investors in People and similar schemes all place significant emphasis on education.

6.0 Quantification

To date quantification has been attempted on some of the above benefits. Considerable work has been undertaken under the DETR's Best Practice Programme and elsewhere on the effects of energy efficiency on both capital and operating costs. Some additional work has been carried out on water efficiency although this is very piecemeal.

In addition BRE has studied the capital costs of achieving certain standards under our BREEAM and EcoHomes methods for English Partnerships and others. This unpublished work has shown that improvement can be achieved against those methodologies without any significant additional costs provided that basic decisions are taken early on. BRECSU research has indicated that early stage decisions have the biggest effect on efficiency and the smallest effect on costs. They will often result in significant savings. 'Bolt-on' features tend to be more expensive and result in considerably less improvement for increasingly greater costs.

At present we have not attempted to go any further in quantifying any of the above. The case studies outlined in section 1 will present an opportunity to do this. The next stage of this project will seek to identify these benefits in particular, as they are the key to encouraging a sea-change in the industry.