ENVIRONMENT

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INTRODUCTION

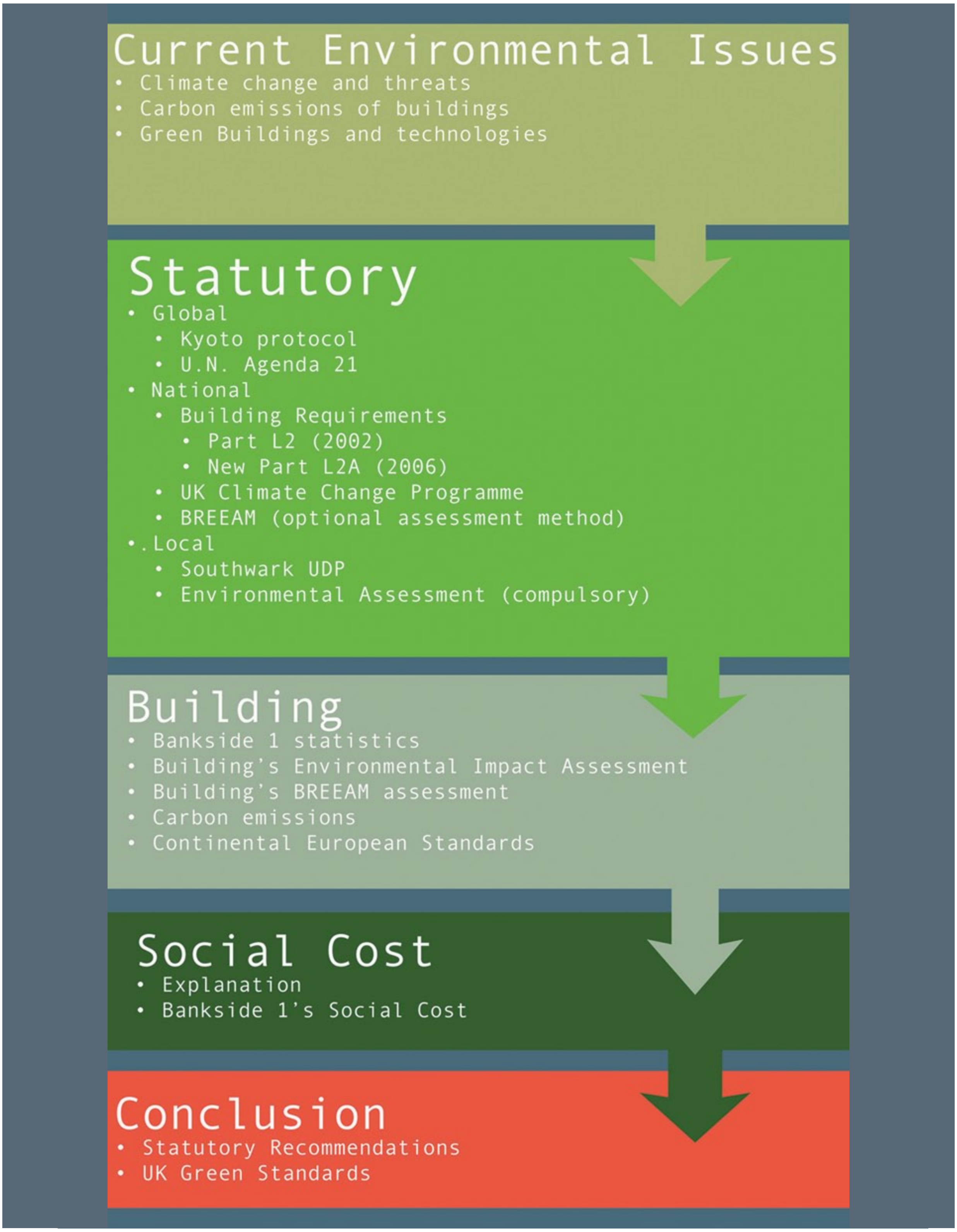
Bankside 1, the “Blue Fin Building.”

Today, the world faces a growing threat of climate change caused by the emissions of greenhouse gasses into the atmosphere. Many world governments have pledged to lower emission through agreements such as the Kyoto Protocol. However as scientists warn almost daily that this threat is worse than previously thought, the way we live and work comes into question.

This chapter will discuss the environmental impact of Bankside 123 in the context of the global environmental threat. We will present an overview of the current threat that faces our planet and discuss international, national, and local legislation that aim to reduce our environmental impact. We will examine Bankside 123 and its evaluation from the Building Research Establishment Environmental Assessment Method (BREEAM). Finally, we will introduce the concept of a social cost for carbon emissions, which allows us to quantify the degradation of the environment.

Overall, we aim to put into context how developments like Bankside 123 effect the environment. The research presented in this chapter will illustrate that the growing threat to the environment is not ameliorated through our current process of developing the built environment. Current and new laws and building standards are improvements, but more needs to be done. The statutory enforcement of the concept of a social cost for carbon emissions could force major changes in the way we build and the way we think about our planet.

The diagram on the following two pages describe the chapters outline and how the subjects relate to one another.



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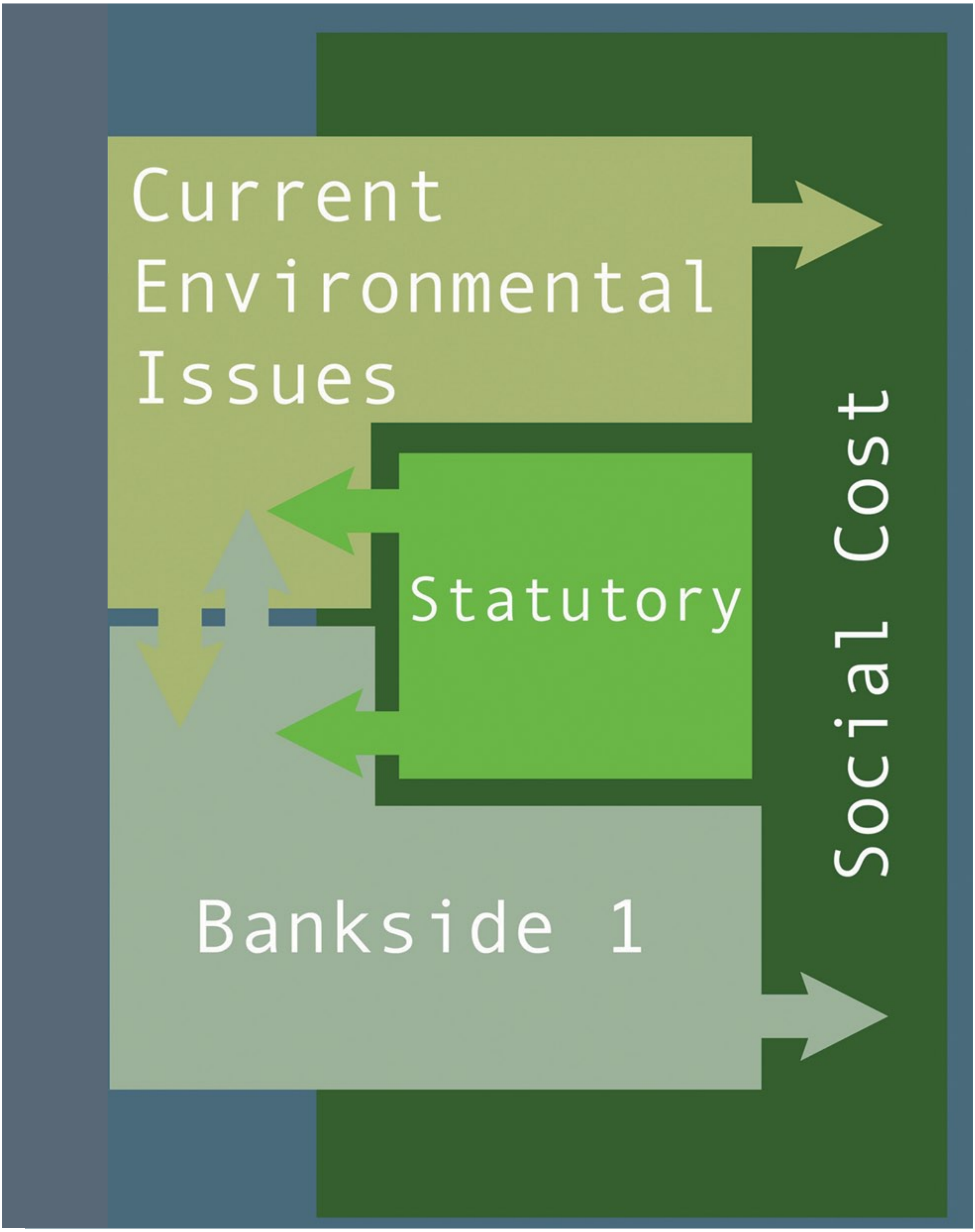
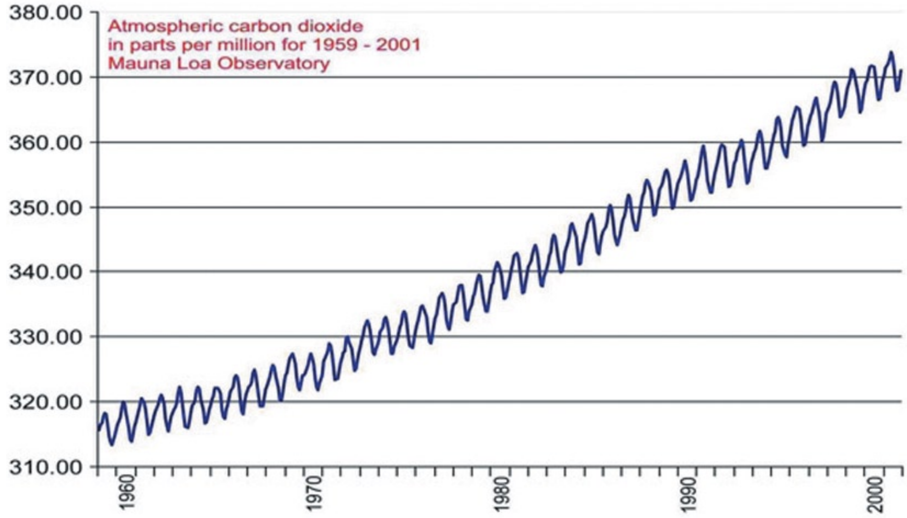


Relationship Diagram

CURRENT ENVIRONMENTAL ISSUES



Atmospheric carbon dioxide observed at Mauna Loa Observatory, Hawaii, 1959-2001

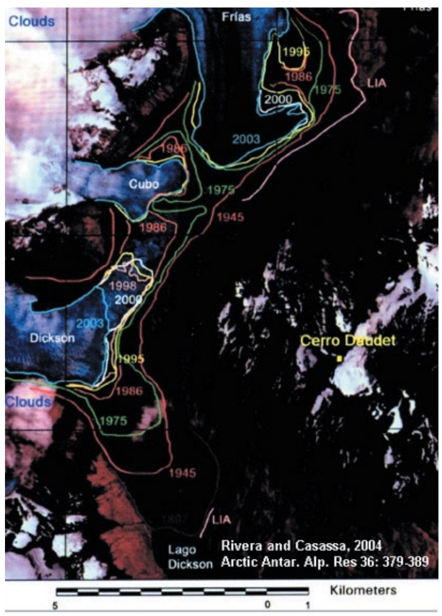
THE GREENHOUSE EFFECT AND GLOBAL WARMING
The greenhouse effect is the warming of the Earth's surface and atmosphere that tends to intensify with an increase in atmospheric carbon dioxide. The rays from the Sun reach the Earth's surface and heat it. A part of this energy is reradiated by the Earth's surface in the form of long-wave infrared radiation, much of which is absorbed by molecules of carbon dioxide and water vapor in the atmosphere and which is reflected back to the surface as heat. This is similar to the effect produced by the glass panes of a greenhouse, which transmit sunlight in the visible range but hold in heat. The trapping of this infrared radiation causes the Earth's surface and lower atmospheric layers to warm to a higher temperature than would otherwise be the case.

The Earth's climate has changed continually over time. In the past it has been altered because of natural occurrences such as volcano eruptions. Currently, however, the term climate change is generally used when referring to changes in our climate which have been identified since the early part of the 1900's. The changes we've seen over recent years and those, which are predicted over the next 80 years, are thought to be mainly as a result of human behavior rather than due to natural changes in the atmosphere. The greenhouse effect is very important when we talk about climate change as it relates to the gases which keep the Earth warm. It is the extra greenhouse gases which humans have released which are thought to pose the strongest threat.

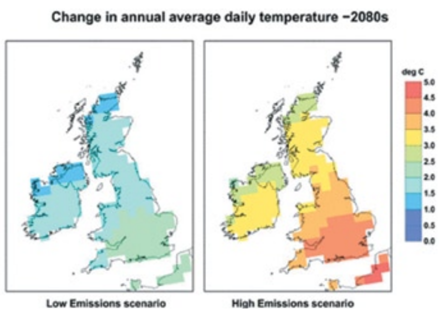
According to The Intergovernmental Panel on Climate Change (2001), the warming effect due to increases of greenhouse gases in the atmosphere is estimated to be more than 8 times greater than the effect of solar irradiance changes. Carbon dioxide emissions are the most dangerous threat to the Earth and the most significant creator of climate change.

The Mauna Loa Observatory in Hawaii recorded a 19.4% increase in the mean annual concentration of carbon dioxide, from 315.98 parts per million by volume (ppmv) of dry air in 1959 to 377.38 ppmv in 2004. The 1997-1998 increase in the annual growth rate of 2.87 ppmv represets the largest single yearly jump since the Mauna Loa record began in 1958. This represents an average annual increase of 1.4 ppmv per year. (http://cdiac.esd.ornl.gov/trends/co2/sio-mlo.htm)

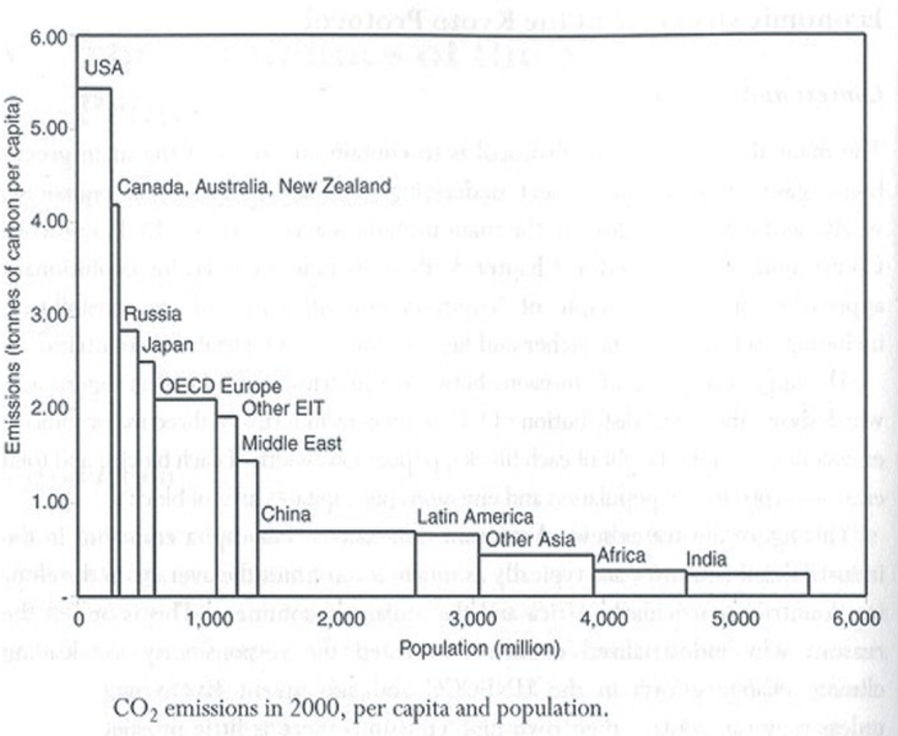
Carbon dioxide emissions have caused significant increases in global temperatures. According to DEFRA (Department for Environment, Food, and Rural Affiars, UK), average global surface temperatures have increased by 0.4 to 0.8° C since the late 19th century and current climate models predict that global temperatures will rise by a further 1.4 to 5.8° C by the end of the 21st century. During the 20th century, the annual mean central England temperature warmed by about 1°C. The 1990s were exceptionally warm in central England



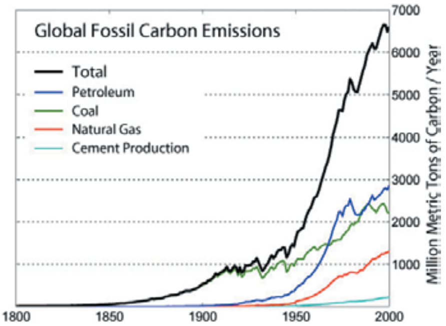
Argentine glaciers melting, source: http://www.geo.arizona.edu/Antevs/nats104/00lect27sealevl.html



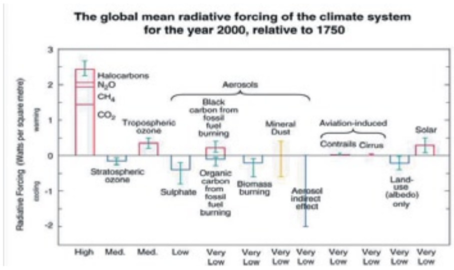
Source: DEFRA



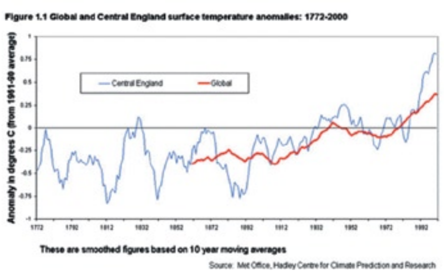
The world's leaders in CO2 emissions relative to population. Source: Grubb (2004).



Global fossil emissions from 1800-2000, Source: Wikipedia



Carbon Dioxide is the leading force of climate change, Source: IPCC (2001)



The amount of C02 in the atmosphere in Central England. Source: Hadley Centre for Climate Prediction and Research

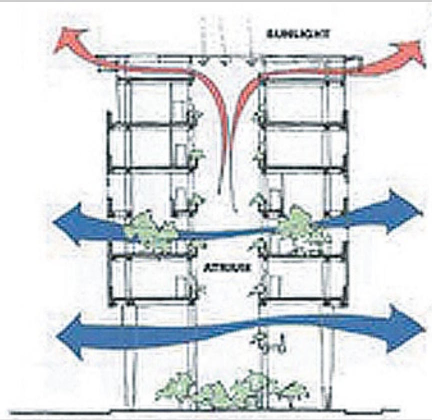
by historical standards, about 0.6°C warmer than the 1961-1990 average. (http://www.statistics.gov.uk/STATBASE/Expodata/Spreadsheets/D7279.xls)

The amount of carbon dioxide emissions differs significantly between countries. The emissions of Africa and India are much lower than more industrialized countries. Wealthier industrialized countries are more responsible for the climate change than developing or underdevelopment countries. Additionally, among the industrialized countries, there are differences in carbon emissions. Grubb (2004) shows carbon emissions per capita of EU and Japan are about half the levels of United States and Australia.

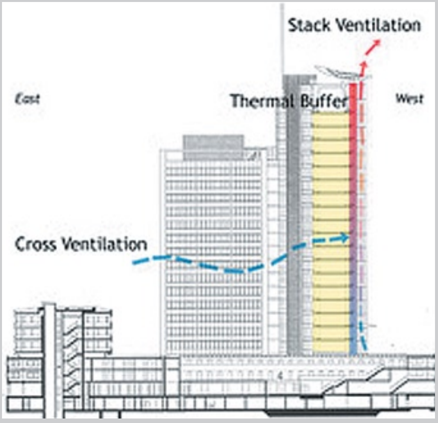
Global warming leads to the melting of glaciers. This melting causes sea level rise. According to The Guardian ('Warming doubles glacier melt', October 17, 2003), from 1995 to 2000, glaciers in Argentina and Chile are melting amount of 0.105mm of global sea level rise annually. Ice loss rates 1975-2000 is more than doubled compared to 1968-1975.

Carbon itself is not poisonous to humans, but its impact is critical to the destiny of human beings and other creatures that inhabit our planet. Climate change can cause significant damage to the Earth, directly and indirectly. Many economists and environmental experts have tried to establish and quantify the damage caused by carbon emissions. The damage seen with rising sea levels is one of the most obvious examples. According to DEFRA's Climate Change homepage, sea levels are expected to rise by 40 centimeters by the 2080s because of thermal expansion of the oceans and because of melting of land ice. In Southeast England, sea levels could rise between 26 and 86 cm above the current level by the 2080s. This will threaten the existence of some small island states and put millions of people at risk. The effects to various sectors such as agriculture, energy, timber, and water and the indirect impact, such as human life, migration, species loss, or urban infrastructure, are also considered. Because of the complexity and uncertainty, there are many different projections of the damage.

SELECTED GREEN TECHNOLOGIES



Natural ventilation can occur when air is allowed to pass through openings in the building. This is most effective on buildings with narrow floor plates.



Double-skin facades create a thermal buffer, which allows heat to rise and exit the building via an opening at the top. They also help insulate the building.


Sun Shades can reduce solar gain in buildings by shading certain building facades. They can be designed to block sun in the summer and allow it in the winter.

BUILDING GREEN
Green Development integrates environmental responsiveness, resource efficiency, and sensitivity to the existing culture and environment. Many of these qualities also describe green buildings, which use environmentally friendly technology such as passive heating and cooling, sunshades, and natural ventilation to reduce building energy consumption and environmental degradation. While green technologies have allowed many buildings to improve their environmental impact, very few green buildings have little or no environmental impact.

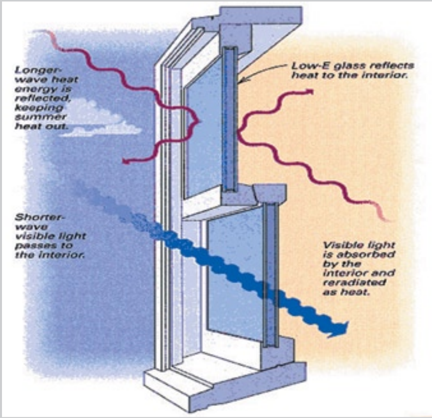
The negative effect of buildings on the environment can be understood in several ways. One of the newest and most controversial methods is the concept of embodied energy. Embodied energy is understood as the “cumulative energy demand,” which includes the extraction, processing, transport, manufacturing, and installation of building materials. It may also include capital equipment and services supplied to the product system included in the building. Because of the relatively new research associated with this method, the concept of embodied energy is not highly regarded as the most accurate way of interpreting the environmental impact of a building.

Energy demand and loss is a more common way of understanding the adverse impact of a building on the environment. Factors for this evaluation method include electricity and heating demand and the total heat loss through the building façade which is known as the u value. Some building also produce large amounts of carbon dioxide which is the number one greenhouse gas contributing to the degradation of the ozone and planetary climate change. A case study into the amount of carbon produced by Bankside 1 will appear later in this chapter.

GREEN BUILDING TECHNOLOGIES
Green building technologies help reduce the environmental impacts of building on the environment. These technologies use both passive methods and more advanced and efficient mechanical systems to ventilate buildings and reduce energy use.

Many developers question the economic benefits of adding green technologies to their buildings. But because energy can be one of the highest costs for businesses after

Daylighting buildings can be more energy efficient because less artificial lighting is used. This is best practiced in buildings with a narrow floor plate.



High Efficiency Glazing acts as insulation on glazed surfaces. This type of glass keeps the building warm in winter by preventing heat from escaping and keeps the building cool in the summer by preventing too much solar heat gain.

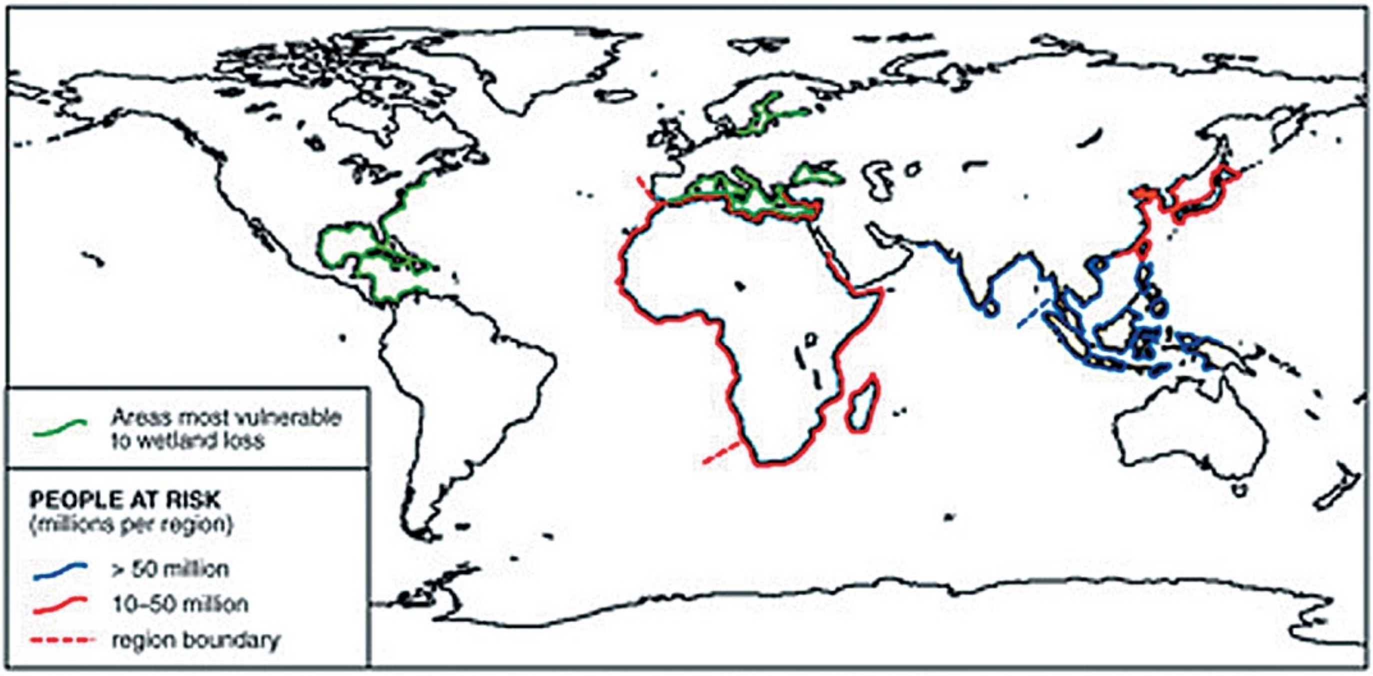
Green Roofs, roofs covered in a sustainable and easily maintained plant material, help insulate buildings and control storm water run-off.

employee salaries, the long-term economic benefits of having energy saving buildings can save money for companies who occupy buildings over a long period of time. Overall, green office buildings are ideal for owner occupied buildings, which can see energy costs reduced over time. However, in today's office market, large multinational companies tend to choose speculative office developments instead of constructing their own building. While developers may choose to include some green elements in their building, unless they plan to hold onto their building for a long time, the added upfront costs of installing more sustainable technology in speculative buildings may not make economic sense.

There are many advantages to building "green." Green buildings can be an excellent marketing and public relations tool for companies and can paint a positive public image of a business's commitment to sustainability. Buildings with green technologies can lower energy costs over 25 years and may lead to a better working environment from higher level of daylighting and better ventilation. Better working environments may also improve worker productivity, which in turn, can increase profitability. For small and medium enterprises (SME's) define size, 20% energy savings from more efficient buildings can equate to a 5% sales increase. In addition, Energy Efficient Loans are available to SME's for upgrading office space to more efficient green technologies.

The conservative nature of the office real estate market makes it economically difficult to include green technologies in speculative office developments. Even with many of the advantages listed above, developers are hesitant to put in the added cost of including green technologies. Developers may have to stray from the tried and true methods of development to build green which may be a challenge to the contractors/architects the developer prefers to work with. There is also no guarantee of energy savings with green technologies, as buildings may perform differently from predicted. In addition to the added construction costs, green building standards do not always comply with market needs. In the UK, large companies prefer the flexibility of deep floor plates, which require more lighting and heating and cooling. Businesses may request or require air conditioning (i.e. in the city, dust or noise can be a problem for offices with natural ventilation).

STATUTORY



Source: Hadley Centre prediction of the effects of sea-level rise by 2080

There are many statutory measures set aside to stop the degradation of the Earth. As shown in the chart on the following page, provisions exist on the international, national, and local levels. While the aim of many of these measures is to help the environment, many, including some on the local level, are only recommendations. In this section, we will discuss several major provisions that will directly and indirectly impact Bankside 123.

THE KYOTO PROTOCOL

The Kyoto Protocol is designed to address the climate change issue. It was agreed upon in December 1997 and came into effect on the 16th February 2005. It is the first international action with binding targets and timetables for reduction of greenhouse gas emissions. 150 countries, including the UK, have ratified the agreement. The Kyoto Protocol addresses several greenhouse gases but concentrates primarily on carbon dioxide. The first goal is 5.2% carbon emission reduction to below 1990 levels over the period 2008-2012. But the world's largest emitter – the US – and a number of other countries have not agreed to the Kyoto Protocol. According to Grubb (2004), UK should cut carbon emission 12.5% to below 1990 levels as a bubble of EU 15 countries under Kyoto Protocol. EU 15 countries should cut 8% collectively.

UK CLIMATE CHANGE MEASURES

Several measures have been put in place to reach the goals set by the Kyoto Protocol. The UK Climate Change Programme (2000) will focus improving business' use of energy, stimulate investment and cut costs, stimulating new, more efficient sources of power generation, cutting emissions from the transport sector, promoting better energy efficiency in the domestic sector, saving households money, and improving the energy efficiency requirements of the Building Regulations. In addition the programme will focus on continuing to cut emissions from agriculture and ensuring the public sector takes a leading role in this process. Their goal is reducing carbon dioxide -8.4% from 1990 levels in 2010.

The Climate Change Levy (CCL) is a tax on the use of energy in industry. The levy was introduced on 1st April 2001 . It was announced in the March 1999 Budget to give businesses a full two years time to adjust. Rates of levy are 0.15p/kWh for gas, 1 .17p/kg (equivalent to 0.15p/kWh) for coal, 0.96p/kg (equivalent to 0.07p/kWh) for liquefied petroleum gas (LPG), and 0.43p/kWh for electricity. (http://www.defra.gov.uk/environment/ccl/)

Country	*Tax*	*Tax rate (in €/kWh, except where indicated otherwise)*
Austria	Energy tax	0.015
Belgium	Energy fee (low frequency electricity)	0.0013641
Denmark	Duty on CO_2	0.0134
Denmark	Duty on electricity (heating)	0.0673
Denmark	Duty on electricity (other purposes)	0.076
Finland	Excise on fuels (manufacturing sector)	0.0042073
Finland	Excise on fuels (rest of the economy)	0.0069
Finland	Strategic stockpile fee	0.0001262
Germany	Duty on electricity	0.0128
Italy	Additional tax on electricity, towns/ provinces (private dwellings)	Varies
Italy	Additional tax on electricity, towns/ provinces (industry)	Varies
Italy	Tax on electrical energy, state	0.003
Italy	Tax on electrical energy, state	0.0021
Japan	Promotion of power resource development tax	0.0041
The Netherlands	Regulatory energy tax (up to 10,000 kWh/year)	0.0601
The Netherlands	Regulatory energy tax (10,000–50,000 kWh/year)	0.02
The Netherlands	Regulatory energy tax (50,000–10 million kWh/year)	0.0061
Norway	Tax on consumption of electricity	0.0128
Spain	Tax on electricity	4.864%
Sweden	Energy tax on electricity (households)	0.0214
Sweden	Energy tax on electricity (manufacturing and commercial greenhouses)	0
Sweden	Energy tax on electricity (other sectors)	0.0151
Sweden	Energy tax on electricity (material permitted for abstraction > 200,000 tonnes)	0.0015
United Kingdom	Climate change levy (ordinary rate)	0.0069
United Kingdom	Climate change levy (reduced rate)	0.0014
United States	Delaware: Public utilities tax	4.25% of gross receipts

Source: OECD (2003).

Taxes in OECD member countries levied on electricity , sconsumption, source: Grubb(2004)

Kyoto Protocol 1997
Montreal Protocol on Substances that Deplete the Ozone Layer 1992
International Tropical Timber Agreement 1994
Protocol on Energy Efficiency and Related Environmental Aspects 1998
Convention Concerning Safety in the Use of Chemicals at Work, 1990
Convention Concerning Safety and Health in Construction 1988
Convention Concerning Safety in the Use of Asbestos 1986
Protocol on Strategic Environmental Assessment 2003
European Landscape Convention 2000
ISO 14001 Series of Environmental Standards for Business
UN Commission on Sustainable Development's Agenda 21, 1992
Rio Declaration on Environment and Development 1992
International Energy Agency's Energy Efficiency Policy 2000
International Council for Research and Innovation in Building and Construction

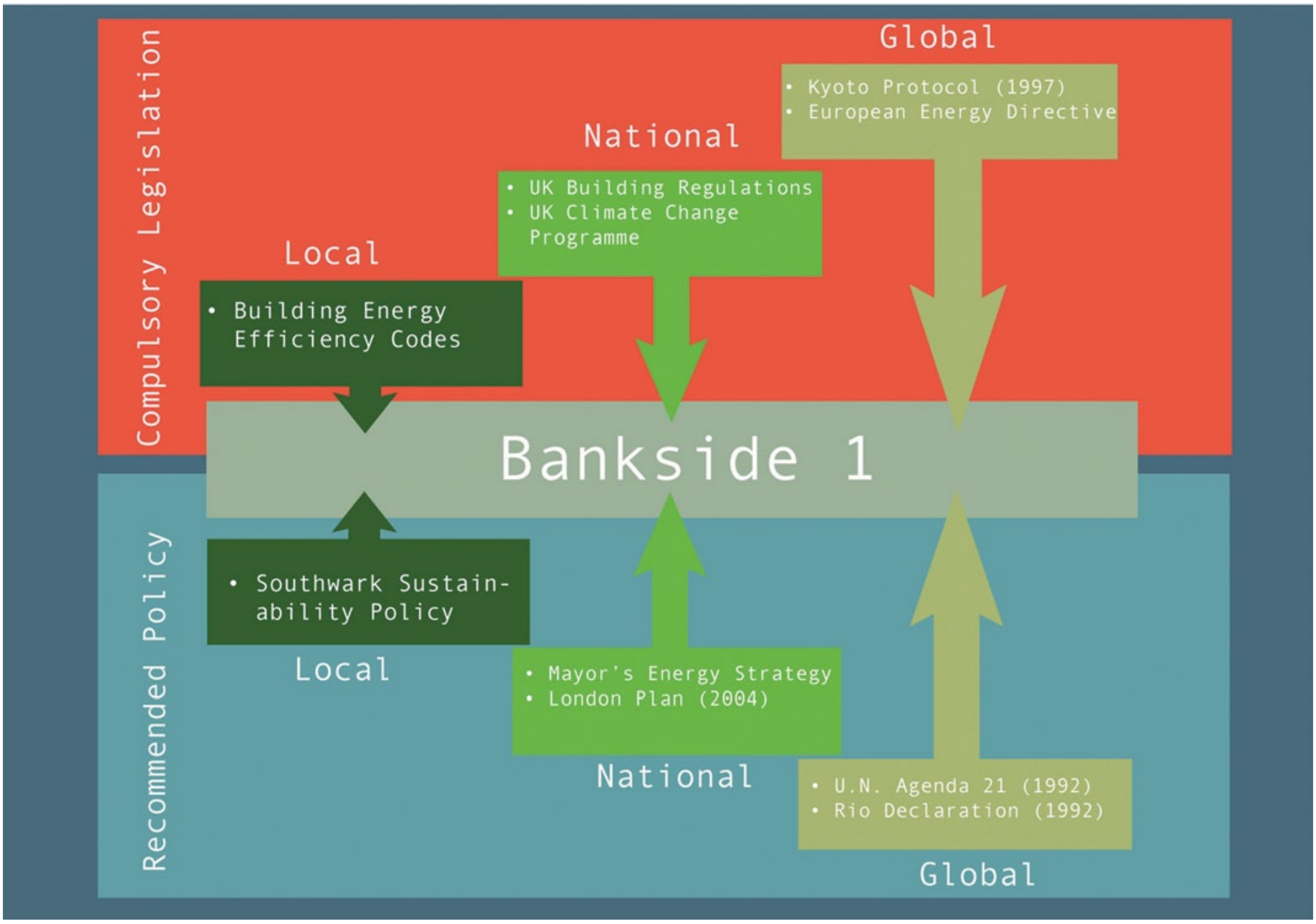
UK Climate Change Programme 2000
The Clean Neighbourhoods and Environment Act 2005
The Environment Act 1995
BS 8207: 1985 Code for Practice for Energy Efficiency in Buildings
UK Government's Sustainable Development Strategy, Securing the Future 2005
Department of Trade and Industry's Sustainable Development Strategy 2000
DTI's White Paper on Energy Efficiency 2003
Government's Strategy for Combined Heat and Power 2002
Chartered Institution of Building Services Engineers (CIBSE)
CIBSE Building Energy Code 1: Energy Demands and Targets for H & V Buildings 1999
CIBSE Building Energy Code 2: Energy Demands for Air Conditioned Buildings 1999
CIBSE Energy Efficiency in Buildings 1998
CIBS Building Energy Code 1977

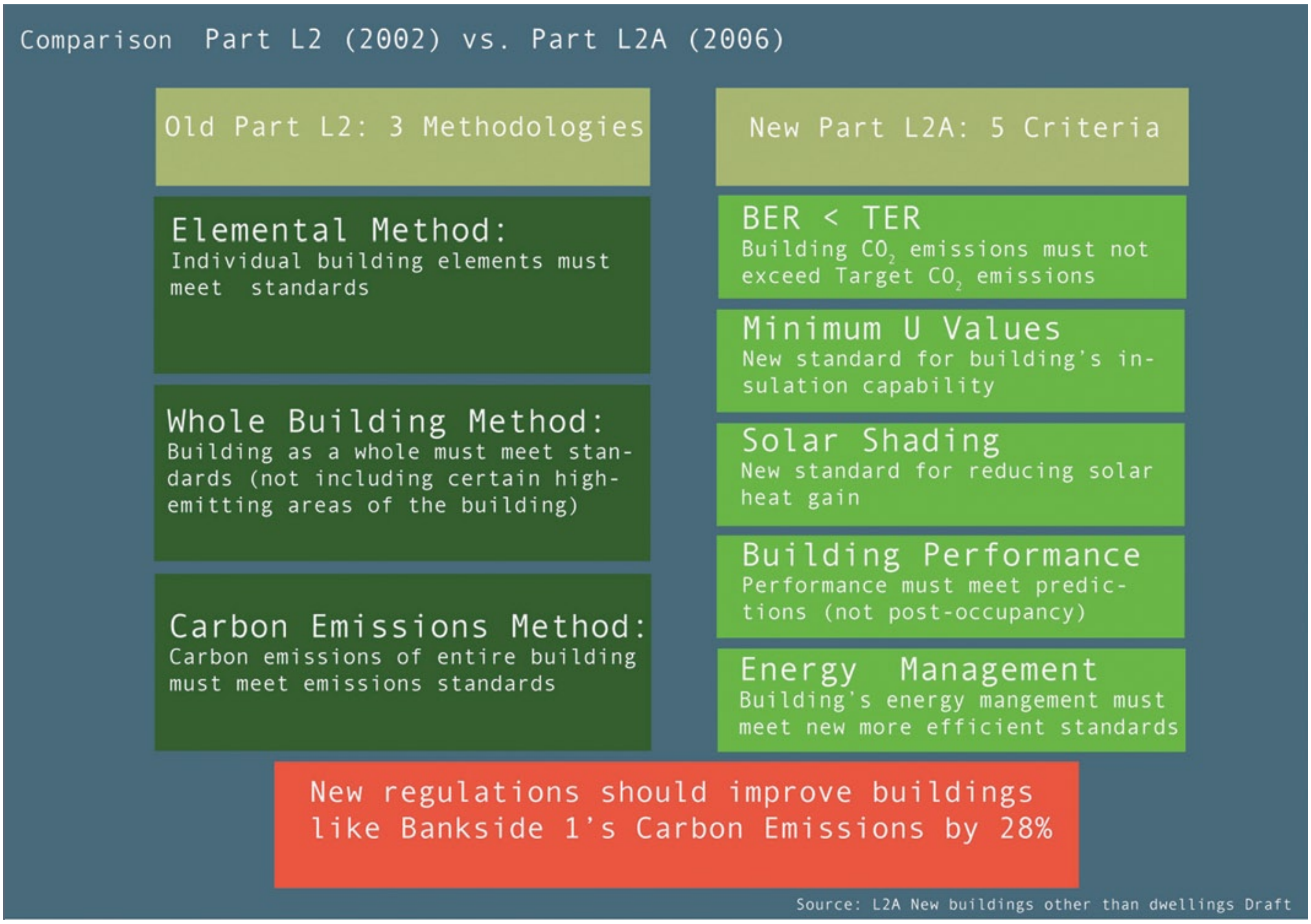
Mayor's Energy Strategy 'Green Light to Clean Power' 2004
London Sustainable Development Commission 2002
London Climate Change Partnership 2005
London Climate Change Agency 2005
London Plan 2004

Borough of Southwark Sustainability Policy 2004
Environmental Code of Construction Practice (soon to be available online)
Building Energy Efficiency Codes to be introduced in the Sustainability Assessment in new Southwark Plan

Building Research Establishment Environmental Assessment Method: "Very Good" required for Bankside 123 by developers

In the UK, because electricity generation is mainly based on fossil fuels rather than nuclear or hydro-electric energy, carbon emissions from generating electricity are much higher than any other fossil fuel. According to Nick Baker's lecture in Urban Environment course, LSE, electricity emits 0.83 kg CO2 per useful kWh. However, gas emits 0.24 kg CO2 per useful kWh, oil generates 0.37 kg CO2 per useful kWh, and coal makes 0.44 kg CO2 per useful kWh. Social cost of 1kWh electricity is, therefore, 1.5p. It can be compared to CCL's 0.43p/kWh. The market price of electricity in UK is around 5p in August, 2005.





CHANGES TO THE UK BUILDING REGULATIONS

The new UK building regulations Part L2A will go into effect on April 6, 2006. The new regulations strive to lower carbon emissions from office buildings and make it more difficult to construct fully glazed office buildings without high efficiency glass. The new regulations differ from the existing Part L2 regulations in several ways. The old regulations were based around three methodologies for evaluating a building's energy performance compliance: the elemental method, the whole building method, and the carbon emissions method. The elemental method evaluated the building on the specifications of individual elements of the building such as windows or certain spaces. The whole building method evaluated the entire building's energy performance based on carbon performance, air leakage and U Values, but to allow for more flexibility, ignored the use of space within the building. This method was used to evaluate Bankside 123. The carbon emissions method evaluated the proposed building's carbon emission compared with a notional building designed to the elemental method.

The new Part L2A for non-dwellings energy evaluation is based on the carbon emissions method but is evaluated by five criteria: the building's emissions rating (BER)<target emissions rating (TER), minimum U values, solar shading, building performance, and energy management.

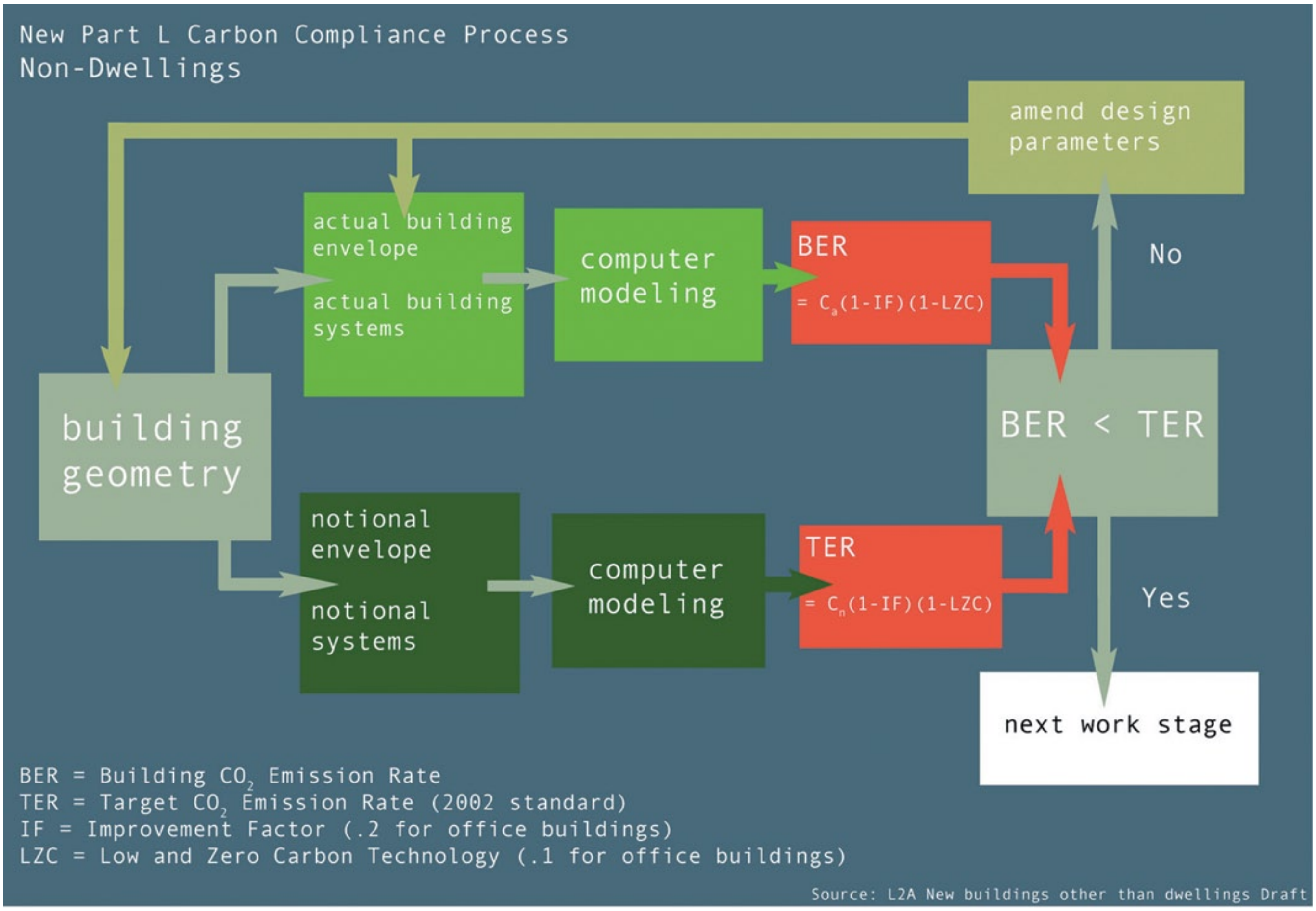
The first category is an expansion of the former carbon emissions method and compares the buildings projected emissions rating with one of notional building. If the BER>TER, the building's design must be amended and a new comparison must be evaluated until the building is in compliance. The new regulations also have stricter standards for the minimum U

values, which is understood as the amount of heat lost through the building skin or roof. The new standards will make it tougher to build all glazed buildings such as Bankside 1 without high efficiency glass. The new criteria also require the building to have some form of solar shading to reduce heat gain from the sun.

The last two criteria refer to building performance and energy management. The building performance criteria evaluate the building's energy performance and air-tightness post-construction and pre-occupancy to see if the values predicted have been met. Higher standards for energy management from the previous building regulations are required post-occupancy.

The new building regulations also effect existing buildings under new Part L2B. However, existing buildings must be in compliance with the new standards only if major renovation/ extending work is being done or if the use of the building is being changed. Existing buildings that fall under those categories are subject to a test to determine whether or not they must be in compliance (i.e. installing a door vs. renovating a factory for housing). If the building must comply, up to 15% of the cost of the intended works must be dedicated to improvements.

All new projects approved after April 6, 2006 must comply with the new regulations. Because the EU is pressuring the UK to implement the new regulations, which are already 4 months late, at that time, there will be no honeymoon period for developers and contractors to update plans. As a result, developers and builders are scrambling to get their documents completed before the April 6 deadline.



THE BUILDING

BANKSIDE 1
In order to analyze Bankside 1 from an environmental perspective, we have looked at the building itself as a whole and summarized both the Environmental Assessment Report of the building that was completed for planning approval and the BREEAM (Building Research Establishment Environmental Assessment Method) report that was voluntarily produced by the developers prior to construction. It is through these studies and through a later analysis of Bankside 1's COs emissions that we present our environmental analysis of the building.

BUILDING ELEMENTS
Bankside 1 is a 46,000m2 office building located in Southwark Borough, London. The building has a deep floor-plate (21m deep at some points) with an atrium in the centre. Deep floor plate buildings are typically not energy efficient for several reasons. Daylighting offices with natural light to reduce electric lighting needs and energy demand, is difficult to achieve because natural sunlight doesn't reach deep into the office core. The atrium helps with this effort however, as we will discuss later in the report, it doesn't provide as much daylighting as it could. Deep floor plate buildings also require large HVAC plants to heat and cool the building. Because of the deep floor plate, natural ventilation is difficult to achieve. Bankside 1 has a large HVAC plant on the roof of the building which provides air conditioning in the summer and heat in the winter. The building also has non-operable windows, making it reliant on its HVAC system, which in turn can produce a lot of carbon dioxide.

The building's most distinctive feature is its blue "fins" features on the façade. The placement of the fins have a somewhat arbitrary position: each fin's position is determined by a sequence of positions that was chosen through a literal roll of the dice. The angle of the fins is set to the maximum shading angle each particular façade would need. However, the proximity of each fin to eachother (determined by the roll of the dice) also determines the fins angle. The closer two fins are to eachother, the less shade it provides through its angle. This was also determined through a sequence associated with random dice rolls. The number of fins on each façade depends on the façade's orientation, with the fewest fins on the North façade. According to one architect at Allies and Morrison, the fins would reduce solar heat gain on the building by 25%. However, another architect reasoned that figure was incorrect and guessed closer to 10-15%.

Solar heat gain is also reduced through fritting, a type of etching, on the upper and lower sections of the office glazing. There is also a small sun shade and an interior window shade which help reduce the impact of the sun.

ENVIRONMENTAL ASSESSMENT REPORT
In September 2001, Land Securities submitted the Environmental Assessment Report (EAR) completed by Environ Inc. to Southwark Borough for a development, which was then known as "St. Christopher's House Development. The submission of the EAR along with other crucial planning documents was part of the steps taken to get planning permission for the development. Today, the EAR tells us that Land Securities was committed to developing, in their minds, an environmentally friendly building. The report serves as a summary of the measures the developer, architect, and contractors will take to ensure that the building will comply with government regulations and standards set by the Borough and the developer.

Below is a summary of the key findings from the EAR:
Planning Policies (from PPG 1):
• Be encouraged in or alongside existing town centres, rather than out of town, in order to sustain their viability
• Concentrate development for uses which generate a large number of trips to places well served by public transport, especially town centres, rather than out of centre locations and
• Prefer the development of land within urban areas, particularly on previous developed sites, provided that this creates or maintains a good living environment, before considering the development of Greenfield sites.

Public Transport and use of the Car:
• Public transportation is easily accessible from the site.
• The building will provide facilities to benefit cyclists including secure bicycle parking and 100 bicycle and motorcycle places throughout the site.
• The building car parking provision is 60, which is lower than the standard set by the Borough (1 per 1,115m^2). The parking will be available for a limited number of office users and none will be provided for the general public.

Building Design and Materials:

• Embodied Energy reduction by the following measures
  - Flexibility and adaptability
  - Ensure that less durable materials can be easily replaced
  - Minimise transport of materials to the site
  - Search for local supplies of recycled materials
  - Minimise the use of materials with high embodied energy
• Materials will be selected using the following criteria:
  - Low embodied energy
  - High embodied energy but materials are recyclable
  - Recycled content of the material
  - Material maintainability
  - Sourcing of materials
  - Total exclusion of deleterious and hazardous materials

• Proposed Design Life for the Building Materials:
  - Structure: 75 years
  - Envelope: 50-75 years
  - Services: 15 years
  - Space Planning: 5 years
  - Work Setting: constantly changing

• BREEAM Assessment Criteria and Considerations:
  - Proposed development is design for maximum flexibility so that the building can be adapted to different uses in the future without redevelopment required. For example. The vertical dimensions, floor plate sizes and plant provision have been optimised for future change
  - An excellent working environment is to be provided to encourage continued use of the building.
  - The building has been designed to maximise water efficiency, incorporating water efficient bathroom facilities.
  - Careful consideration is being given towards avoiding issues related to "sick building syndrome."
  - Plant has been selected to minimise emissions of oxides of nitrogen (a contributor of acid rain) as well as carbon dioxide (the main "greenhouse gas"). Exhaust monitoring systems will be installed to help minimise emissions.
  - Efficient waste management systems will be used, both for storage and collection. Waste material that is to be recycled will be stored separately from general refuse and in addition, office and retail recyclable material will also be stored in unique containers.
  - Development will most likely achieve a 'very good' rating.


Blue fins on Bankside 1's facade.
Source: Modified Allies and Morrison drawing.

• Façade has been designed in order to combine high internal environmental quality with low-energy consumption.
    - The façade will ensure solar heat gain in winter months (reducing the need for heating)
    - The façade will exclude the summer sun with solar gains to be reduced to 7.5 W/m^2 at the perimeter office area (reducing summer cooling capacity).

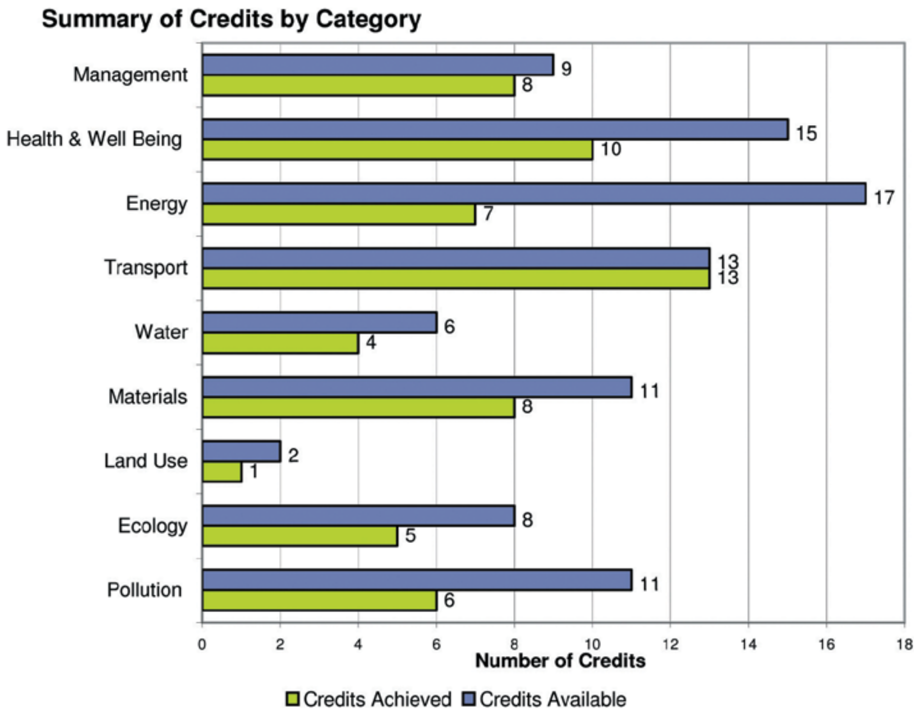
• Material Recycling will be informed by CIRA guidance and government waste policy.
    - Appropriate quality material will be retained on site for re-use
    - Material excess to site requirements will be sent off-site for re-use or recycling at the nearest appropriate site, taking account of local demand patterns to avoid stockpiling
    - Where appropriate recycled material cannot be generated at the site, recycled material should be imported in preference to newly produced materials
    - Any special or hazardous materials identified prior to construction are to be identified and will be separated, appropriately contained and transferred by registered haulers to an appropriately licensed site.

• Energy Management
    - Energy use will be controlled by a Building Management System, which will match demand for energy use with internal environmental conditions and use of floor space.
    - The Building has been designed with the aim of maximising the use of daylight so to reduce the requirements for artificial lighting.

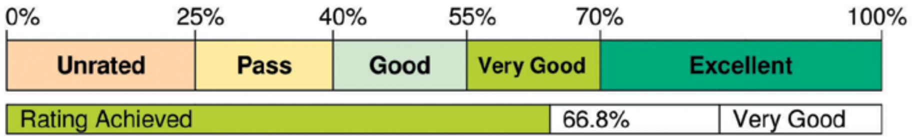
• Each building's atrium will allow natural light into the core
    - High performance glazing with external frit to the upper parts and insulated panels below will be used.
    - Peak cooling loads can be reduced in all three buildings through the optimisation of façade shading devices, which will reduce the plant size by approximately 200-300 kW.

Overall, the aims of the developer was to build a building that would be considerate of the surrounding environment, with low embodied energy and a target BREEAM building rating of very good. Many of standards that were met by the developer were set by either the national or local governments. With the report filed, after planning review, the development was granted planning permission. For further understanding of how the final design of the building fared, we will look at the BREEAM report for building 1.

BREEAM Rating
The Building Research Establishment Environmental Assessment Rating (BREEAM) is a voluntary rating system, which summarises a building's environmental performance in seven categories: health, energy, water, materials, land use, ecology, and pollution. The rating system for offices, "seeks to minimise the adverse effects of new buildings on the environment at global and local scales, whilst promoting healthy indoor conditions for the occupants." The rating system rates the building through a certain number of points available for each of the above categories. The points are multiplied by the environmental rating and given an overall rating of Pass, Good, Very Good, or Excellent. Bankside buildings One, Two, and Three all received Very Good ratings. Below is a summary of how Bankside 1 performed according to the BREEAM standards:



Bankside 1's BREEAM rating breakdown.
Source: BREEAM Report for
Bankside 1, 2003.



Bankside 1's BREEAM rating achieved.
Source: BREEAM Report for
Bankside 1, 2003.

The overall rating is derived from the percentage of credits achieved under each heading, multiplied by the Environmental Weighting Factor:

CATEGORY	Number of credits available	Weighting factor
Management	9	15
Health and wellbeing	15	15
Energy Transport	17 13	25
Water consumption	6	5
Materials	11	10
Land use Ecology	2 8	15
Pollution	11	15

The total of all these scores is the overall rating and a rating is awarded according to the following scale:

Pass	Good	Very Good	Excellent
25–40	40–55	55–70	70–100

The Environmental Performance Index is based on the percentage of core credits achieved, multiplied by the Environmental Weighting Factor. The final score is derived from the following scale:

BREEAM rating system weighting.
Source: BREEAM Report for
Bankside 1, 2003.

CREDIT SUMMARY
Bankside 1 received a 66.8% rating based on the amount of credits its received multiplied by the environmental weighting. The Categories where it received little or no credit are the following:

HEALTH:
Operable Windows (0/1)
Internal Air Pollution (0/1)
Daylighting (0/1)
Electric Lighting Design (0/1)
Lighting Zones (0/1)
View Out (0/1)

ENERGY:
Fabric and Form (1/5)
Energy CO_2 Emissions (4/10)

WATER:
Mains Leak Detection (0/1)

MATERIALS:
Reuse of Façade (0/1)
Reuse of Structure (0/1)
Recycled Aggregates (0/1)

LAND USE:
Reclaimed Contaminated Land (0/1)

ECOLOGY:
Change in Ecological Value (2/5)
POLLUTION:
Water Runoff (0/1)
Refrigerant GWP (0/1)

The following is a summary of some of the building's shortfalls:

Operable Windows: 1 Credit is awarded where the external façade to the office area, equivalent to at least of 5% of the gross internal floor area of the building, is operable. There should be an even distribution around the office area to enable adequate cross-ventilation.
•The building has a sealed façade and does not qualify for this credit.

Daylighting: 1 Credit is awarded where 80% of the net lettable office area is adequately daylit. Use of the British Standard requirements for daylight factors will demonstrate compliance.
•The building's deep plan will make it "unlikely" that this credit will be achieved.

View Out: 1 Credit is awarded where all workstations are within 7m of a window enabling a view to the outside (which can reduce eyestrain and related health problems).
•Workplaces for a typical floor would not be less than 7m from a window.

Fabric and Form: Up to 5 credits are awarded, based on the predicted total losses minus total gains in kWh/m2/year (based on heating season).
•Calculations using data provided by Roberts and Partners indicate that total losses – total gains of losses is equal to 46.09kWh/m2/year garnering one credit (+/- 45.01 to +/-70)

Energy CO2 Emissions: Up to 10 Credits are awarded based on the predicted CO2 emission rate. Total net emissions of CO2 are predicted using the Carbon Performance Rating for offices or other AM11 compliant technology.
•Part L calculations for the whole building would be 18.33kgC/m2/year which equates to 67kg CO2/m2/year garnering 4 credits out of 10 (<75 CO2/m2/year)

Reuse of Façade: 1 Credit is awarded where there is reuse of >50% of existing facades by area and where less than 20% of the total mass of the materials are new.
•Because this is a new development, this credit cannot be achieved.

Reuse of Structure: 1 Credit is awarded where there is reuse of >80% of existing major structure by building structure volume and where the reused structure comprises at least 50% of the total final structure by building volume.
•Because this is a new development, this credit cannot be achieved.

Recycled Aggregates: 1 Credit is awarded when at least 25% of high-grade crushed aggregate or masonry is specified for use in the building structure, ground slabs, roads etc. The specification should show that aggregate would be procured from a source no greater than 30km from the site.
•Some aggregate was used from the White City site for enabling works but not enough to be 25% of the used material. No recycled aggregate was used for roads or landscaping.

Reclaimed Contaminated Land: 1 Credit is awarded where land is defined as contaminated and where adequate remedial steps have been taken to contain or decontaminate the site prior to construction. Recommendations of a land contamination report must have been carried out.
•The site did not require remediation.

Change in Ecological Value: Up to 5 Credits are awarded where the ecological value of a development site is either not sustainably harmed or enhanced.
•The building is being constructed on land previously built on and the building has been knocked down therefore the change in ecological value is zero and two credits are achieved.

Refrigerant Global Warming Potential: 1 Credit is awarded where any refrigerants used have zero Global Warming Potential OR no refrigerants.
•The refrigerants used in the building do not have a global warming potential of less than 10.

Even though the building received a “very good” BREEAM rating, it still only received 7 out of 17 possible points in the energy category. The building’s CO2 emissions fall just under maximum levels set by the government. With all of the building’s shortfalls, the building’s rating comes into question. Is the BREEAM rating system an appropriate measure of a building’s sustainability? Does a 66.8% rating equate to “very good?”

Obsidian Office Building, facade and interior. Source: Baumschlager and Eberle, Architects

EUROPEAN OFFICES
Buildings like Bankside 1 are closely related to the types of office buildings commonly found in North America. These buildings have deep floor plates and rely heavily on HVAC systems. The increase of this building type in London indicates that the UK has subscribed to this standard of office buildings.

In certain European countries such as Germany, the Netherlands, and Switzerland, however, office standards are very different. In Sweden, for example, laws such as the “Work Environment Act” (1977) and the existence of office workers unions give more power to employees to control the design of their workplace. According to James S. Russell in his article “Form follows Fad,” work environments, “work environment shall be satisfactory taking into account the nature of the work as well as the technological and social development in society. Work conditions shall be adapted to people’s differing physical and mental capabilities.” The result is a different type of working environment, which tend to be more sustainable, with operable windows and more natural lighting.

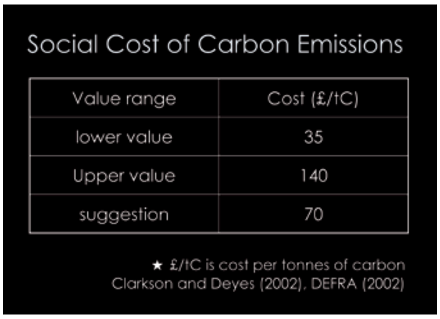
Building regulations in northern Europe tend to be much stricter than the current standards that exist in the UK. The Netherlands has one of the most progressive environmental building regulations in Europe. For example, regulations allow for heavily glazed buildings only on the condition that they provide “smart ways to cool the building,” including solar shades and high efficiency glass (Koudijs, Johan, “Transparent Energy? Intelligent Dutch Energy Performance Regulation allows for Highly Transparent Architecture,” Glass Processing Days, 2005.) Dutch building regulations have also inspired many of the new regulations that are in the new EU building standards.

The result of the northern European culture and stricter environmental building regulations are office buildings that respond to the environment while providing pleasant work environments. Buildings such as the Obsidian Building in Zurich designed by Baumschlager and Eberle illustrate how fully glazed office buildings can be naturally ventilated. The architecture firm has designed several large glazed office buildings in Austria, Germany, and Switzerland that comply with strict European environmental building regulations.

THE SOCIAL COST OF CARBON

Damage from carbon emissions is not paid by those who emit it but by society as climate change is a global phenomenon. Therefore, this damage can be called a social cost. The social cost of carbon is the cost to society for the damage caused by carbon emissions. Because of the complexity of the issue, there are different opinions about and projections for the social cost of carbon emissions.

According to Dawning et al. (2005) in “The Social Cost of Carbon: A Closer Look at Uncertainty,” there has been a lack of proper “sectoral” studies (i.e. specific fields such as agriculture) and understanding of local to regional interactions. These are important for estimating the social cost of carbon. According to the book, net damages should be calculated for a long period of time, however, because climate change is essentially unpredictable along with changes in human behavior, the exact calculation of the social costs of carbon is still uncertain. Decision variables such as the discount rate and equity weighting also are extremely important. Many have written on the subject including: Ayres, R. U. and J. Walter (1991), Azar, C. (1994), Cline, W.R. (1992), Dames & Moore et al.(1999), Eyre. N et al. (1999), Fankhauser, S. (1994), Fankhauser, S. (1995), Fankhauser, S., R.S.J.Tol and D.W.Pearce (1997), Mckenzie-Hedger, M. et al. (2000), Maddison, D.J. (1994). In the UK, DEFRA (2002) has suggested £70/tonne of carbon as the social cost. This falls in the centre of a study which suggests £35/tonne of carbon as a lower value and £140/tonne of carbon as an upper value.

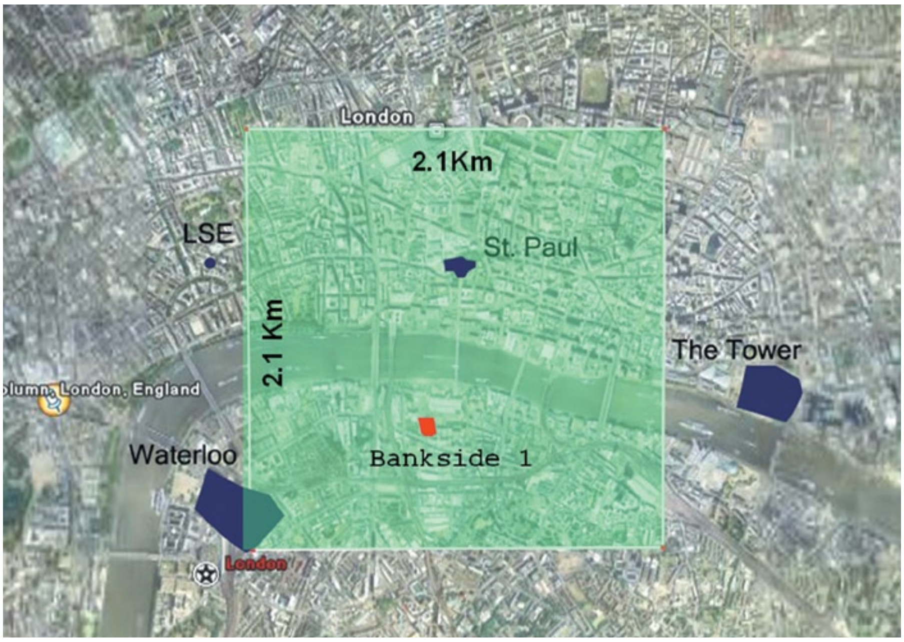

Social Cost of Carbon Emissions

Value range	Cost (£/tC)
lower value	35
Upper value	140
suggestion	70

★ £/tC is cost per tonnes of carbon
Clarkson and Deyes (2002), DEFRA (2002)

The social cost of carbon emissions. Source: Clarkson and Deyes (2002), DEFRA (2002).

One plane tree, 10~15 years old, can absorb can absorb an average of 6.9 kg of CO_2 per year and occupies an approximate area of 10m². Source: South Korean Ministry of Environment (1998).



451,493 plane trees are needed to absorb Bankside 1’s 3,115,299kgCO_2 per year, occupying an area of approximately 451 hectares. Source: Modified Google Map.

The 451 hectares of Plane trees is larger than Regent Park's 197 hectares and Hyde Park's 140 hectares. Source: Modified Google Map.

By using the mean value of £70/tonne of carbon and using the data from the BREEAM assessment of Bankside 1, the social cost of the building's carbon emission is £569,660 per year. Dawning et al. (2005) suggested "reasonable" social cost of £35 as an evaluation of the former DEFRA report. Even is this suggestion is applied, the social cost of carbon emissions from Bankside 1 is still £284,830.

Bankside 1's social cost of carbon emission equation:
•$V_{sc} \cdot C_{b1} \cdot A_{b1}$
= 70x18.33x46,497
= £ 569,660.30/year
(V_{sc}: suggested value of social cost by DEFRA, C_{b1}: Carbon Emission of Bankside 1, A_{b1}: Gross Area of Bankside 1 in m^2)

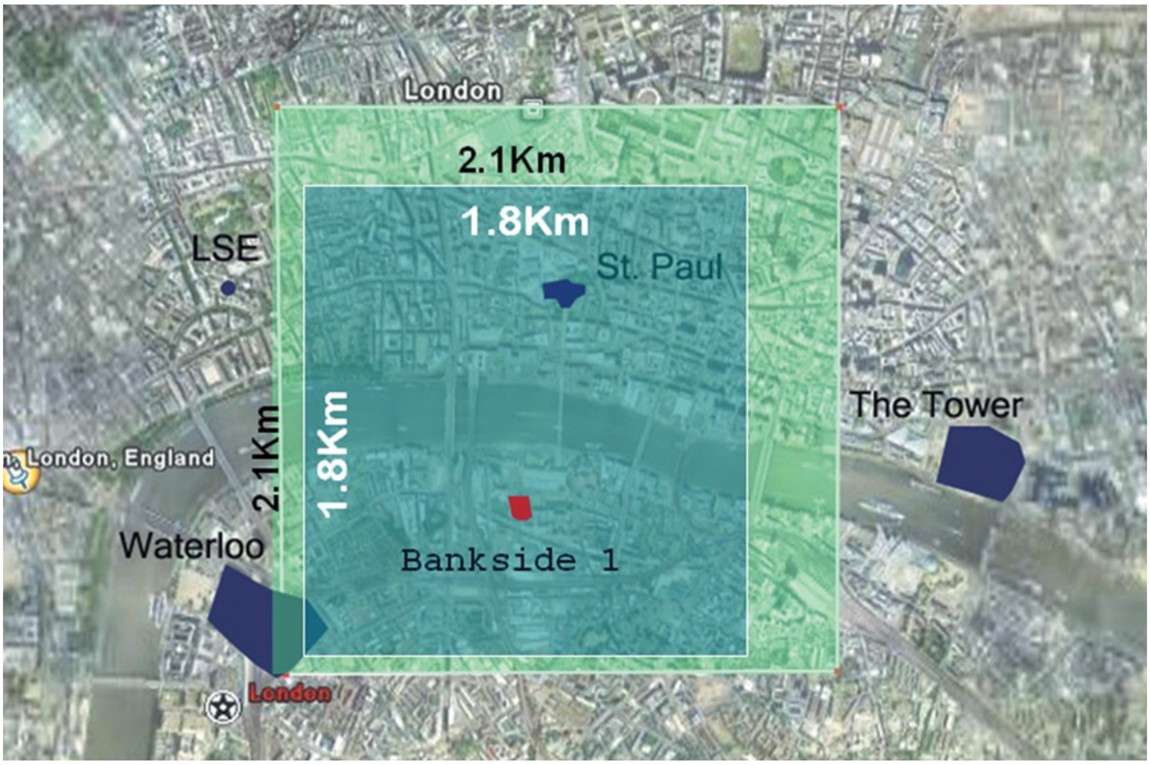
The total amount of carbon emissions of Bankside 1 is 852,290kg per year. Converting this figure to carbon dioxide gives us 3,115,299 kg CO_2. To put this figure in perspective, consider the following analogy. A tree absorbs carbon dioxide through photosynthesis process. This equation is:

6 CO2 + 12 H2O + light energy x C6H12O6 + 6 O2 + 6 H2O

Carbon dioxide in the atmosphere can be absorbed by this process. Plane trees, 10 ~ 15 years old, can absorb an average of 6.9 kg of CO_2 per year (Ministry of Environment, South Korea, 1998). Therefore, in order to absorb the yearly carbon dioxide emissions from Bankside 1, 451,493 plane trees are needed. If it is assumed that a plane tree occupies a $10m^2$, $4,514,930m^2$ or 451 hectares might be full of these trees. This area is bigger than Regent Park's 197 hectares or Hyde Park's 140 hectares. It is even wider than the 300-hectare area of Disneyland in California. Under the new part L2A building regulations which would improve the building's CO2 emissions by about 28%, 325 hectares of plane trees are needed to absorb carbon emissions from Bankside 1 . 325,074 2,243,015kgCO_2

The 451 hectares needed to absorb Bankside 1's carbon emissions is bigger than the 300 hectares of Disneyland n Anaheim, California. Source: Modified Google Map.

The 451 hectares needed to absorb Bankside 1's carbon emissions is bigger than the 44 hectares of a small country, Vatican City. Source: Modified Google Map.



If Bankside 1 complied with the new Part L2A Building Regulations, 325,074 plane trees would be needed to absorb the 2,243,015kgCO_2 emitted every year, occupying 325 hectares. Source: Modified Google Map

CONCLUSION

SUMMARY

Global climate change is currently being observed due to a rising global surface temperature, which has increased by 0.4 to 0.8° C since the late 19th century. The emission of carbon dioxide into the atmosphere, mostly from human behavior, is the main cause of global warming. As a result of the climate change, artic glaciers are melting causing the sea level to rise at an unprecedented speed.

Because building's produce 50% of the UK's carbon emissions, green building can help slow or stop the degradation of the Earth by using environmentally friendly techniques to reduce a building's energy output. Green buildings use techniques such as natural ventilation, passive heating and cooling, and sun shades to reduce energy needs. Though green office buildings have many advantages such as low energy costs, market attraction, and improvements to worker productivity, developers tend to avoid building green because of high upfront costs, which may not necessarily be retrieved through energy savings.

There are multiple levels of the legislation relevant to climate change, some specifically focusing on buildings. On the global level, the Kyoto Protocol is in action to reduce greenhouse gas emissions. Nationally, the UK's Climate Change Programme is working to cut carbon emission in several industries. The New Part L2A will soon require new and renovated buildings to comply with stricter environmental practices.

Our case study, Bankside 123 represents North American office standards, featuring deep floor plates and a large HVAC plant. The building has several green elements: daylighting through the atrium, solar shading fins, and proximity to public transport. Additionally, it received a "Very Good" rating from BREEAM, a voluntary building environmental assessment method. However, in terms of CO_2 emission, Bankside 1, one of three building of this development, received only 4 credits out of 10 in the BREEAM assessment.

Bankside 1 emits 18.33kg carbon per square metre a year, which we estimate would equate to 852,290kg carbon a year as a whole building. Applying the social cost suggested by DEFRA (2002), the social cost of the building's carbon emissions is £569,660.30 a year. This could be compared to 451,493 plane trees and these trees may need planting area of 451 hectares, which is much bigger than the Hyde Park or the Regent Park in London.

CONCLUSION

From our research, we have come to the following conclusions. First, both global and local interventions are important in the climate change issue. Although the phenomenon is effective on a global scale, solutions can be implemented in the local scale, such as building greener buildings. Even small measures within a building's management system can make a difference. According to "Your Home Technical Manual" (http://www.greenhouse.gov.au/yourhome/about/index.htm), each degree of extra heating in the winter or cooling in the summer will increase energy consumption by about 5 to 10 percent. Bankside 1 has average set temperature of 22°C. If the building's thermostat was set to 20°C in summer and 24°C in winter, carbon emissions from heating and cooling could be reduced up to 20%.

Secondly, the BREEAM rating standards are not as high as they could be. Considering Bankside 1's "Very Good" rating in relation to its energy and pollution scores is surprising. We understand that these standards are updated every year. However, when establishing standards or measurements for the environmental effects, more appropriate categorization and category weighting are needed.

Thirdly, stricter government regulations and legislation is needed to really make a difference. Developers tend to build to the minimum standard required. For example, Bankside 1's carbon emissions of 18.33kgC/m2/year fall just below the then government maximum of 18.5 kgC/m2/year. Stricter building regulations could force developers to act more sustainable. And through economies of scale, building green could become less costly. Developers and investors tend to find the best way of making money whether the regulations are strong or not. They would adapt their business to the new environment. The concept of social cost for carbon emissions could also be considered as part of stricter statutory regulations. Because the damage to the environment itself is not always visible, calculating and implementing legislation that could offset this cost could begin to bring massive change.