Beddington Zero (Fossil) Energy Development

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Construction Materials Report

Toolkit for Carbon Neutral Developments – Part 1

by Nicole Lazarus
BioRegional Development Group

Funded by Biffaward and dti Partners in Innovation

BioRegional

dti

Biffaward Programme on Sustainable Resource Use

BedZED village square

BioRegional Development Group

BioRegional Development Group is an independent environmental organisation working with industry, retail and public sectors to bring sustainable practice into the mainstream. Established in 1994, BioRegional work in housing, construction, forestry, paper, textiles, energy and food industries to create sustainable living solutions that are easy, attractive and affordable. By using local resources wisely, we can increase our quality of life whilst leaving space for wildlife and wilderness.

This report is intended to be of practical use in reducing the environmental impacts of construction. Nicole Lazarus will be glad to hear from any readers with feedback and examples of its application.

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Acknowledgements

This report has been written with the essential input of the BedZED Project Team:

Peabody Trust

Bill Dunster Architects
www.zedfactory.com

Ellis & Moore, Consulting Engineers

Ove Arup, Consulting Engineers

Gardiner & Theobald, Quantity Surveyors
Gardiner & Theobald, Construction Management

Biffaward Programme on Sustainable Resource Use

Objectives

This report forms part of the Biffaward Programme on Sustainable Resource Use. The aim of this programme is to provide accessible, well-researched information about the flows of different resources through the UK economy based either singly, or on a combination of regions, material streams or industry sectors.

Background

Information about material resource flows through the UK economy is of fundamental importance to the cost-effective management of resource flows, especially at the stage when the resources become 'waste'.

In order to maximise the Programmes full potential, data will be generated and classified in ways that are both consistent with each other, and with the methodologies of the other generators of resource flow/ waste management data.

In addition to the projects having their own means of dissemination to their own constituencies, their data and information will be gathered together in a common format to facilitate policy making at corporate, regional and national levels.

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1 Introduction

The Beddington Zero (Fossil) Energy Development (BedZED) is a mixed-use scheme in South London initiated by BioRegional Development Group and Bill Dunster Architects. BedZED has been developed by London's largest housing association, the Peabody Trust. The scheme comprises 82 homes and 3,000m^2 of commercial or live/work space. The first units were complete in March 2002 with total completion and occupation in September 2002.

The scheme enables people to live sustainably, within their share of the earth's renewable resources, without sacrificing a modern, urban and mobile lifestyle. It aims to achieve this within the cost restraints of a social housing budget. BedZED makes a sustainable lifestyle easy, attractive and affordable.

BedZED challenges conventional approaches to housing by tackling sustainability in every area from the outset. It slashes heat, electricity and water demand, eliminating the need for space heating and reducing water consumption by a third. It has designed facilities and services that make it easy to reduce waste to landfill, recycle waste and reduce car use. BedZED achieves the high densities recommended in the Urban Task Force report whilst still providing a healthy internal environment with unprecedented access to green space and sunlight.

In addition to the sustainability of the finished BedZED product, every aspect of construction was considered in terms of its environmental impact. Materials used in construction were carefully selected for low environmental impact, sourcing locally where possible and sourcing reclaimed and recycled materials where possible.

This report describes the choices of construction materials made on BedZED, it quantifies the environmental benefits of these choices and describes how the materials were sourced, specified and used. The report provides case studies for individual materials and cost comparisons with alternatives.

This report is funded by Biffaward. It also forms part of the Tool Kit for Carbon-Neutral Developments project funded by the DTI's Partners In Innovation programme. Data from this project will also feed into a national mass balance study of the flow of materials around the UK, funded by Biffaward, and it will inform an eco-footprinting analysis, funded by WWF-International.

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2 Summary

Materials in construction make up over half of our resource use by weight. They account for 30% of all road freight in the UK. The construction and demolition industries produce over 4 times more waste than the domestic sector, over a tonne per person living in the UK. The environmental impacts of extracting, processing and transporting these materials and then dealing with their waste are major contributors to greenhouse gas emissions, toxic emissions, habitat destruction and resource depletion.

Looking more specifically at the housing industry, the environmental impacts of the materials in a house are less significant than the actual performance of the house over its lifetime. Domestic household energy consumption accounts for 29% of the UK's CO_2 emissions. By comparison, the materials used in a house's construction account for just 2-3%. Consequently, the BedZED scheme has been designed primarily for long term energy efficiency during use. It then goes further by minimising the embodied impacts of the construction materials used to achieve that design.

BedZED employs state of the art energy efficiency, with super-insulation, double and triple glazing and high levels of thermal mass. BedZED meets all its energy demands from renewable, carbon-neutral sources, generated on site, and so eliminates the 29% contribution to CO_2 emissions and global warming. In achieving this energy efficient carbon-neutral design, BedZED invests in more construction materials than standard houses. However, as this report shows, the embodied environmental impacts of BedZED's construction materials are within the same range as standard UK housing. The total embodied CO_2 of BedZED is 675kg/m^2, whilst typical volume house builders build to 600-800kg/m^2. Despite the increased quantities of construction materials, the procurement of local, low impact materials has reduced the embodied impact of the scheme by 20-30%.

The BedZED project has shown that in selecting construction materials, major environmental savings can be made without any additional cost. In many cases, the environmental option is cheaper than the more conventional material. For example, highly durable timber framed windows are cheaper than uPVC and saved some 6% of the total environmental impact of the BedZED scheme and 12.5% of the total embodied CO_2. Recycled aggregate and sand are cheaper than virgin equivalents and are available as off-the-shelf products. Pre-stressed concrete floor slabs save time and costs on site and by using less materials saved some 7% of the BedZED's environmental impact compared with concrete cast in-situ. New FSC softwood from certified, sustainably managed woodlands is available at no cost premium, while local FSC green oak weatherboarding is cheaper than brick and shows a life cycle cost saving over imported preserved softwood. Reclaimed structural steel and timber are available cheaper than new and offer 96% and 83% savings in environmental impact.

BedZED sourced 3,404 tonnes of reclaimed and recycled materials, 15% of the total materials. All of the recycled and reclaimed materials used were either cheaper than the conventional option or the same price, even after additional staff time was spent on sourcing the material. High grade reclaimed materials such as doors or structural steel are not off-the-shelf products and there needs to be a willingness to work at securing a reliable supply of materials. Long lead times and storage space are particularly helpful in making reclaimed and recycled materials possible.

BedZED's local sourcing policy was able to source 52% of the materials from within the target 35 mile radius. The average sourcing distance was 66.5 miles. Compared with national average haulage distances, this was 40 miles less and saved 120 tonnes of CO_2 emissions, some 2% of the scheme's embodied CO_2. The local sourcing policy cost nothing and required no specialist expertise.

3 Materials in Construction

This chapter sets the context for the use of materials in construction. It relates the environmental impacts of construction materials to the total impacts of human activity in the UK.

420 million tonnes of materials are used in construction in the UK each year. This equates to 7 tonnes per person. The total consumption of all materials in the UK amounts to some 678 million tonnes or 11.3 tonnes per person[1]. So construction accounts for over half of our resource use by weight! By selecting construction materials wisely, we can really reduce our environmental impact.

Aggregates

Aggregates make up over 50% of construction materials by weight, some 240 million tonnes/year. Virgin aggregates are a finite resource. Extraction of aggregates results in loss of land, disturbance to neighbours, ecological damage both on land and in water courses and effects the landscape.

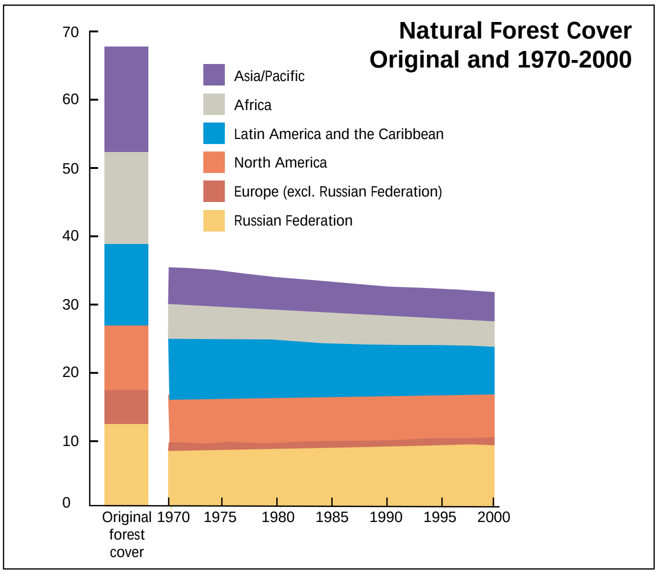
The new aggregates tax (April 2002) has incentivised the use of recycled aggregate products by adding £1.60/tonne to virgin aggregate.

Timber

In the last 30 years, natural forest cover has reduced by 11%[2] .

Logging for timber is one of the two main activities responsible for this deforestation, the other being clearance for agriculture. There are two critical implications of deforestation. One is the loss of biodiversity in the world, the loss of habitats and species forever. The other is a reduction in the earth's capacity to absorb CO_2. This drop of absorption capacity is proving critical at a time of increased CO_2 emissions, leading to global warming and worldwide climatic instability.

Although timber is theoretically a renewable resource, it can only be considered as such if it comes from sustainably managed woodland. The use of certified sustainable timber is a very positive mechanism for moving towards sustainability creating an economy that fosters the conservation of forest resources. The highest accreditation for timber is the internationally certified scheme by the Forest Stewardship Council (FSC).



Reclaimed materials

70 million tonnes of waste is produced from construction and demolition every year in the UK. A large proportion (75%) of this is recycled with only 25% going to landfill[1]. But the recycling is generally as very low grade products. The potential for high grade re-use of waste materials is enormous. Where a waste material is re-used in its existing state without significant processing or alteration, it is generally refered to as a reclaimed material as opposed to a recycled material.

There is a flourishing reclaimed material economy in the small scale reclamation and salvage yards around the country but these cater for the individual DIY enthusiasts or deal in high value architectural salvage. The thousands of tonnes of bricks, timber and steel sections, doors and paving slabs could be re-used directly and provide a local sustainable material resource to the construction industry. The supply chain for such low value, bulk materials is very dependent on efficient handling and transport systems. BedZED has pioneered a number of reclaimed material supply chains and proved that in some cases it can be done economically. *(see chapters 6,7 and 10)*

1 Office of National Statistics
2 Living Planet Report 2000

Recycled materials

Recycling of construction and demolition waste, as opposed to reclaiming, involves altering the material in some way to produce another material. It introduces extra processing stages and extra journeys compared with reclaimed and therefore can be more environmentally damaging. It does, however, supplant the use of virgin materials. It also diverts those waste materials from landfill.

The introduction of the landfill tax and the new aggregates tax has made recycled sand and aggregate replacements significantly cheaper than new.

Haulage

UK transport of construction materials produces 28 million tonnes of CO_2 per year

The movement of construction materials around the UK accounts for about 30% of all road freight.

Every 100 tonnes of material transported 10 miles produces 91kg of CO_2 equivalent emissions. If the average distance of transportation of all the materials on a construction project the size of BedZED (22,000 tonnes) is reduced by just 10 miles, then 30 tonnes of CO_2 equivalent emissions are saved – 100kg/BedZED resident. BedZED set out to source its materials as locally as possible with a target sourcing radius of 35 miles. The results of this policy are reported in chapter 8.

Housing Construction in Context

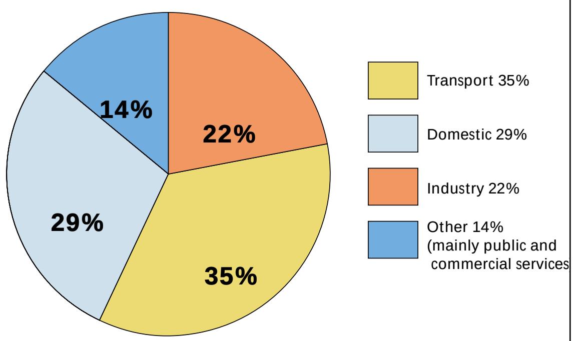
The materials used to build homes require energy consumption during their extraction, production and transportation. This energy consumption has associated CO_2 emissions known as the embodied CO_2 of the materials (see chapter 4). Table 1 shows the embodied CO_2 of a typical home and relates that to the total CO_2 emissions in the UK. It shows that the construction of our homes accounts for some 3% of our annual CO_2 burden.

Embodied CO_2 in construction for domestic dwellings	300 – 1,000 kg/m^2[2]
Embodied CO_2 for volume house builders	600 – 800 kg/m^2[1]
Average 3-bedroom semi-detached house:	
Floor area	100m^2
Occupants	3.5!
Life-span	60 years
Embodied CO_2 / person/year	286 – 381 kg
UK Total CO_2 equivalent emissions/person/year	12,300 kg[1]
Embodied CO_2 of volume domestic dwellings as % of total CO_2 emissions	2.3 – 3.1%

Table 1

The embodied CO_2 of homes is less significant than the energy consumption and CO_2 emissions during their life times. Domestic dwellings account for 29% of UK energy consumption (see Fig.1). BedZED was therefore designed primarily for exceptional energy efficiency during use. Construction materials and products were selected to meet the thermal design criteria. Choices in low impact, low embodied energy materials were considered after thermal requirements had been met. Chapter 9 reports on the embodied CO_2 of BedZED.

Figure 1: UK Energy Consumption[3]



1 Building Research Establishment
2 Movement for Innovation, best to worst case data
3 Royal Commission on Environmental Pollution

BEDZED

4 Measuring Environmental Impacts of Materials

Most material choices on BedZED have been made on the basis of clear environmental benefits. Reclaimed steel is much better than new. UK grown FSC certified timber is better than imported non-FSC timber. When such choices can be made cost-neutrally, there is no need for sophisticated analysis. When there is a cost premium or a life cycle implication, it can be helpful to have some method of quantifying the comparative environmental benefits of the alternatives in order to put the issue in context and make an informed decision.

In this report, three different assessment methods have been used to quantify environmental benefits.

Embodied energy and embodied CO_2

The embodied energy of a material is the energy required the abstract, process, manufacture and deliver it, measured in GU/tonne.

The embodied energy of a material needs to be considered over the lifespan of the material, for example aluminium is a highly durable material with a long lifespan of 60 years and is therefore an appropriate solution in some cases, despite its high embodied energy.

Energy consumption itself does not constitute an environmental burden. It is often more useful to consider a material in terms of its embodied CO_2 rather than embodied energy. As it is the CO_2 emissions that contribute to greenhouse gases and lead to global warming.

Embodied CO_2 is not directly proportional to embodied energy. It depends on the specific energy sources of a process. Processes that require high grade electrical energy will result in higher CO_2 emissions than those that run on low grade heat energy. It also depends on the energy source for that particular process. In Scandinavia, most of the power used in the aluminium industry comes from hydro-electric schemes and therefore has no embodied CO_2 in its manufacture[a].

The embodied energy and CO_2 data used in this report are supplied by the BRE[3] and are based on UK national averages.

+ This method quantifies the specific impact of CO_2 emissions, widely considered to be the most urgent current environmental issue.

− This method takes no account of toxic emissions, habitat loss or any other environmental issues.

BRE Environmental Profiling

BRE Environmental Profiling uses Life Cycle Assessment methodology and complies with an internationally established approach for analysing impacts of products and processes. It measures environmental performance throughout a product's life, through manufacture, operational use in a building and in demolition. The system has been developed by the BRE and it measures a material's impacts in 12 areas:

1. **climate change**
2. **fossil fuel depletion**
3. **ozone depletion**
4. **human toxicity to air**
5. **human toxicity to water**
6. **waste disposal**
7. **water extraction**
8. **acid deposition**
9. **ecotoxicity**
10. **eutrophication**
11. **summer smog**
12. **minerals extraction**

The impact of the material in each area is compared with the average impact of each UK citizen and given a "score" known as an Ecopoint score.

+ This method provides a comprehensive method for comparing materials and combinations of materials. It usefully combines a wide range of environmental issues and brings them together into one figure.

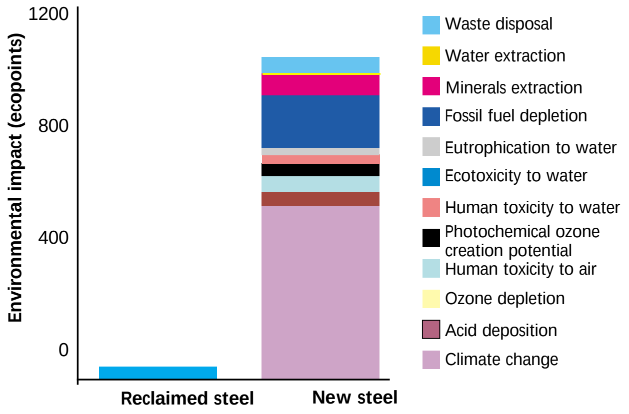
− The relative weightings of the 12 impact areas are subjective and only represent perceived importance.

This method makes no reference to what ecopoint score is actually sustainable given the earth's finite capacity.

Despite a significant weighting in the BRE's consultation exercise, wildlife and habitat loss has not been incorporated into this system due to difficulties in measuring impacts.

[a] although hydro-electric schemes have other significant environmental impacts on, for example, river ecology)
[3] Building Research Establishment

Example of Environmental Profiling for structural steel

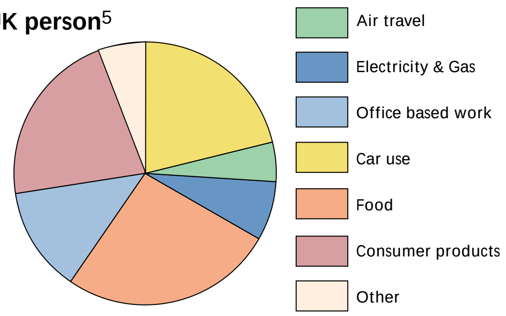


Eco-footprinting

Ecological Footprint analysis is an accounting tool that represents the environmental impacts of a process or a person's lifestyle as an area of land[6]. It measures the area of biologically productive land that is required to meet the needs of a given product or population. It compares this area with the actual available area on earth and informs as to whether we are living within the earth's capacity.

A person's ecological footprint is made up of the footprints of all their activities, products consumed and waste produced. It includes the area of forest required to absorb the CO_2 emissions attributable to that person. It includes a share of the area taken up by infrastructure, food and timber growing and fishing. A person's energy consumption has an eco-footprint, as does their food consumption, transport, work activities and leisure activities. Each consumer product has an eco-footprint as does each construction material.

Eco footprint of a typical UK person[5]



+ This method relates what we do to the actual sustainable carrying capacity of the earth.

Eco-footprinting does not rely on any subjective weightings.

– This is a relatively new tool and there is not always data available on the impacts of a product.

Eco-footprinting has not yet been developed sufficiently to take toxic pollution impacts into account.

5 BioRegional Solutions 2002
6 Sharing Nature's Interest by Chambers, Simmons & Wackernagel

5 Example Case Studies

This chapter describes the main components that make up a ZED building and the reason for each material choice. Numbers in boxed brackets indicate a case study number, eg [6]. More details on that material can be found in its case study in chapter 6.

Chapter 5 gave an overview of all the materials used at BedZED. This chapter 6 provides details of some of the more unusual materials. It compares the BedZED material with conventional alternatives and describes design, quality and sourcing issues, contractual arrangements and cost implications. Each of the 15 case studies quantifies the environmental impact of the material and compares with the conventional choice. The case studies are graded according to:

How easy it was to achieve

Cost-effectiveness

The significance of the environmental benefits

All gradings are relative to the conventional material choice for that purpose.

The Case Studies included in the complete report are:

1 LOCAL TIMBER
- **Oak weatherboarding**
- **Ash floor boards**

2 RECLAIMED TIMBER
- **Internal studwork**
- **External studwork**
- **Bollards**
- **Floor boards**

3 FSC CERTIFIED TIMBER

4 PLYWOOD

5 WINDOW FRAMES

6 KITCHEN FITTINGS

7 RECLAIMED DOORS

8 RECLAIMED STEEL

9 RECLAIMED PAVING SLABS

10 CONCRETE FLOOR SLABS

11 RECYCLED AGGREGATE

12 RECYCLED SAND

13 LOCAL CONCRETE BLOCKS

14 LOCAL BRICKS

15 INSULATION

BEDZED

VS	uPVC
Timber	Easy
	Saving
	High

VS	Aluminium
Timber	Easy
	Neutral
	High

CASE STUDY 5 : WINDOW FRAMES

The BedZED Design Team sought to avoid high impact materials such as uPVC and aluminium. So when it came to selecting window frames, timber was the obvious choice.

With triple height conservatories and 3,500m^2 of glazing, the windows package makes up 3% of the total construction costs and a much higher percentage of the material costs. The specification of these significant items is key to the buildings thermal performance and the quality of the internal environment.

Options explored

The Design Team explored the best environmental option - frames made from locally sourced hardwood. This long life and low maintenance material has lower life cycle costs than softwood alternatives which would require a £14,000/year maintenance programme and more frequent replacement. Using a locally distinctive product adds character to a development; whilst creating a demand for locally grown timber products brings neglected UK woodlands into economically viable management.

However, local joinery companies were reluctant to work with local chestnut, when their experience lay in producing softwood frames. There was little local expertise in manufacturing high performance, triple glazed, airtight windows. Also, the scale of the contract was too large for the companies operating locally. These factors led to prohibitively high quotes.

The geographical net had to be spread wider. Danish window specialist Rationel were able to meet both stringent performance demands and cost criteria. Rationel source 40% of their timber from FSC certified sources.

Design considerations

A key element of the design was keeping the windows as large as practically possible. Even with wooden frames, the metal spacers between the glass panes act as cold bridges. Large panes have less perimeter length than lots of smaller panes.

It is important for designers and suppliers to use "overall" U-values and not the typically quoted "mid-pane" U-values. Overall U-values will be worse but will more truly reflect the window's thermal performance.

Cost comparison

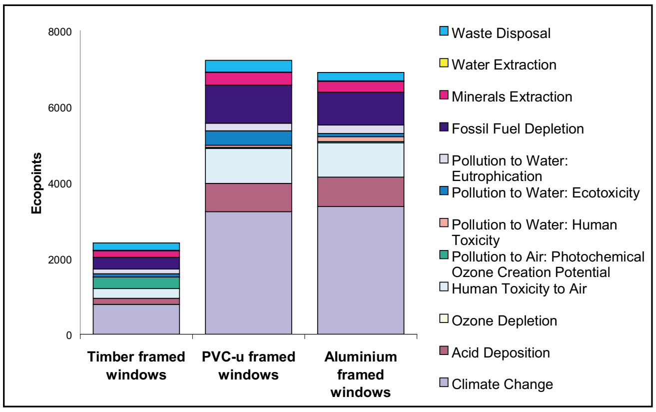
Timber windows are typically cheaper than aluminium or uPVC but can attract higher maintenance costs. The Rationel windows on BedZED are high specification in terms of air tightness, thermal performance and also durability. Their costs are higher than most timber windows but maintenance costs are lower.

The supply cost of Rationel windows on BedZED (excluding installation) for double and triple glazed ranged between £130/m^2 and £300/m^2. Equivalent aluminium frame windows from Alcoplan ranged from £185/m^2 to £275/m^2. uPVC windows from Ankers & Sons in the same price range only achieved U-values of 1.9W/m^2, as compared with 1.0-1.6W/m^2 for Rationel's timber windows.

Quantified environmental benefits

BRE have compared the BedZED softwood timber framed windows from Denmark with the conventional choice of uPVC windows manufactured in the UK and with aluminium framed windows (all double glazed).

BRE are aware that better quality LCA data on uPVC is now available and they are hoping to work with the British Plastics Federation in the near future to update this data.



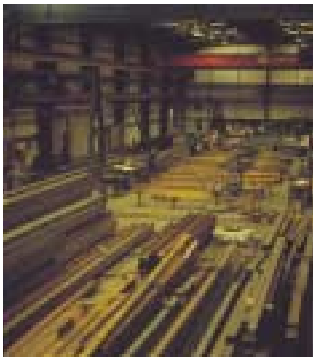
Saving from using BedZED Specification	uPVC windows	Aluminium windows
Ecopoints	4,800	4500
Embodied CO_2 (kgCO_2 eq$^{(100\ years)}$)	793,900	838,000
Embodied Energy (GJ)	12,000	9,750
Eco-footprint (ha years)	176[1]	186[1]

Reclaimed Steel VS New steel

- Fairly easy
- Neutral
- High

CASE STUDY 8 : RECLAIMED STRUCTURAL STEEL

98 tonnes of reclaimed structural steel has been used on BedZED. This amounts to 95% of the structural steel on the scheme and is mainly used in the steel frames in the workspaces. The sections are retrieved from demolition sites within the 35 mile radius.



Reclaimed steel

Design

The engineers specified a range of section sizes that could be used for each piece. Connection details were designed to accommodate this range of sizes. This approach, at an early design stage, allowed for flexibility in sourcing the reclaimed sections.

Steel framed workspace

Once reclaimed steel sections had been identified, The Historic Sections Book was used to obtain allowable stresses.

Quality

Prior to ordering any reclaimed steel, the structural engineers carried out a visual inspection of the material, checking:

- Date of manufacture
- Condition ie. Rust or scaling
- Number of existing connections either bolted or welded
- Suitability for fabrication

Reclamation process

Sand blasting, fabrication and painting of all new and reclaimed structural steel took place in the steelwork contractor's workshop. The reclaimed steel required an extra pass through the sand blaster and treatment with a zinc-rich coating.

Curved steel sections

It was not possible to use reclaimed steel for the curved sections on BedZED. The local section bender was unwilling to pass reclaimed steel through their machine. Due to time and programme pressures, the contractors proceeded with new steel for these pieces rather than finding an alternative company. There is no technical reason why reclaimed steel should not be curved on future projects.

Cost comparison

On BedZED, using reclaimed steel was 4% cheaper than using new. The cost average was £300/tonne, although this price varied considerably according to the source. The comparative tender price for new steel was £313/tonne.

The cost of additional staff time in sourcing reclaimed steel and the visual inspection has been estimated at £1,000, making the use of reclaimed steel effectively cost neutral.

Construction contract

The steelwork package was tendered competitively on the basis of new steel. Tenderers were then asked for a rate reduction for the free issue of reclaimed steel. Cut off dates for the placements of orders for new steel were agreed and responsibility for sourcing and delivering the reclaimed steel was with the construction managers.

Sourcing/Availability

Reclaimed steel

There are not vast quantities of good quality reclaimed structural steel stored in reclamation yards. It requires active searching and probably some luck to find the right materials. For this reason, it is important to build in as much flexibility as possible and to allow for long lead times.

In the absence of sourcing from a yard, the ideal situation is to identify a steel source in a building that is about to be demolished and to have it extracted carefully.

Risk allocation

The Construction Manager purchased the reclaimed steel on behalf of the Client. There was a risk to the Client as with any free-issue materials. The structural engineer, Ellis & Moore held the risk associated with the structural integrity of the steel.

Quantified environmental benefits

BRE have compared the impacts of the recalaimed steel with new. They have allowed for one additional grit blasting prior to use. Overspecification of the reclaimed beams was very small (<0.5%), as most of the reclaimed beams were in good condition, and were standard sizes.

The environmental impacts of new steel are based on the typical mix of steel sections manufactured from virgin (BOF) and recycled (EAF) steel consumed in the UK.

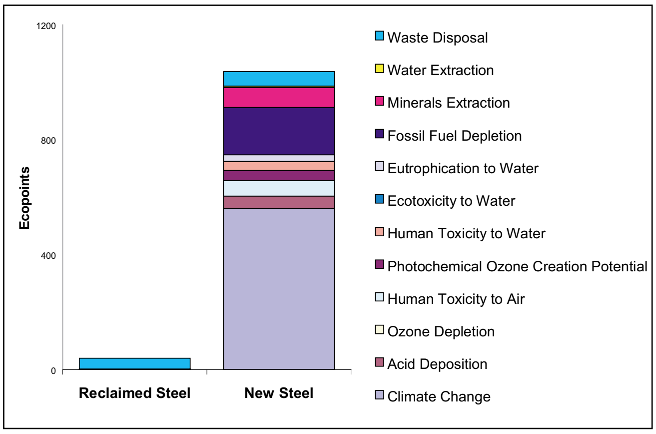
BEDZED

Saving from using BedZED Specification	
Ecopoints	1000
Embodied CO_2 (kgCO_2 eq$^{(100\ years)}$)	81,580
Embodied Energy (GJ)	2,580
Eco-footprint (ha years)	137

These savings reduce BedZED's total eco-footprint by approximately 3.8%.

In addition

As a spin off from BedZED, 11.5 tonnes of reclaimed structural steel was also used on the entrance building to the Earth Centre, resulting in 303GJ embodied energy savings, 21 tonnes of CO_2 saved and an eco-footprint reduction of 12.6 hectares.



Contacts

Ellis & Moore Consulting Engineers: 0207 281 4821
Joy Steel Contractors: 020 7474 0550
Reclaimed steel suppliers:
SGB Major Projects - 01342 835555
Civil Steel Services Ltd - 01322 337766

VS	Virgin sand
Recycled sand	Easy
	Saving
	Modest

CASE STUDY 12 : RECYCLED SAND

BedZED used 279 tonnes of recycled crushed green glass. It was used in the hard landscaping as bedding for paving slabs and replaced the same quantity of virgin sand.

Procurement

The recycled product was bought direct from Day Aggregates by the groundworks contractor, Edenway Contractors Ltd. It is an off-the-shelf product. Product Datasheets are available from Day Aggregates.

Edenway is now suggesting this product to other Clients and using it whenever possible. They experienced no difficulties in obtaining or using this product and it brings them a cost saving. Day Aggregates say that sales have increased since the introduction of the Aggregates Tax in April 2002.

Safety

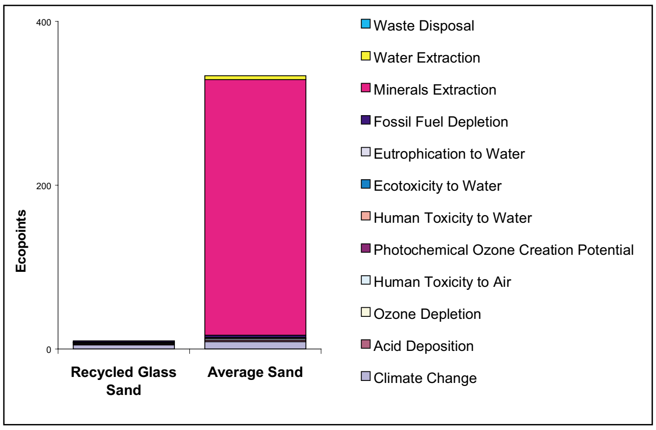
Risk assessments and COSSH statements were prepared by the suppliers. The finely ground glass is similar to sand in consistency but may be slightly sharper to touch. Gloves can be worn while handling. No safety issues arose on site at BedZED.

Cost comparison

Recycled crushed glass sand cost £10.75/tonne from Day Aggregates. This was approximately £2/tonne cheaper than virgin material, saving the project £558 (~ 15% of the material cost). The aggregates tax implemented in April 2002 (since BedZED construction) has increased the price of virgin aggregate by a further £1.60/tonne, making potential cost savings even greater.

Quantified environmental benefits

The environmental impact of the recycled glass sand used on BedZED has been compared with virgin sand typically sourced in the UK.



Saving from using BedZED Specification	
Ecopoints	320
Embodied CO_2 (kgCO_2 eq(100 years))	1,330
Embodied Energy (GJ)	17
Eco-footprint (ha years)	1

Contacts

Edenway Contractors Ltd - 020 8450 8474
Day Aggregates Ltd - 020 8380 9600

11 What you can do

1. Specify high quality timber window frames in preference to uPVC or aluminium
2. For any structural concrete, consider using a pre-stressed option
3. Introduce a local sourcing policy
4. For polystyrene based insulation, specify HCFC- and HFC-free products
5. Specify recycled aggregates
6. Insist on FSC certified timber
7. Look into reclaimed materials. Always build in extra lead times and, if possible, extra storage space for these.