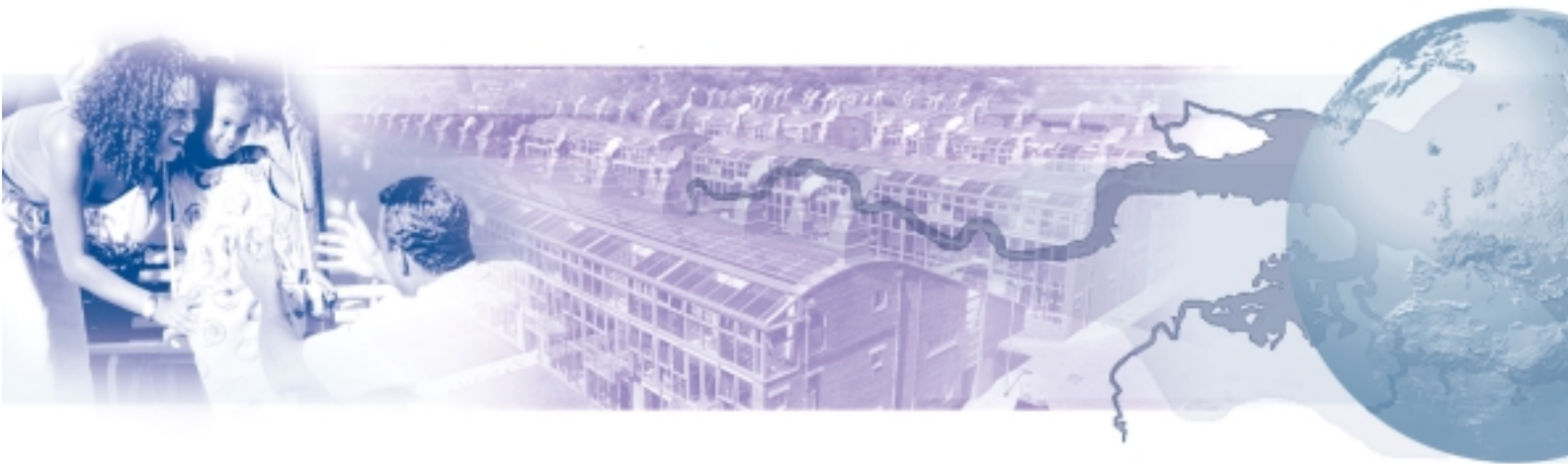


# One Planet Living in the Thames Gateway



A WWF-UK One Million Sustainable Homes Campaign Report

Nick James and Pooran Desai  
BioRegional Development Group

June 2003

**BioRegional**

**SEI** ENVIRONMENTAL  
RESEARCH CENTER  
SUSTAINABLE DEVELOPMENT



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### BioRegional

BioRegional Development Group is an independent environmental organisation working with industry partners to implement real-life, commercially viable solutions for sustainable living – *bringing local sustainability into the mainstream*.

The Group has recently been involved in initiating, designing and constructing an urban eco-village in South London, Beddington Zero (fossil) Energy Development, or BedZED. The project was designed with architect Bill Dunster and developed in partnership with the Peabody Trust.

BioRegional is currently engaged in further projects relating to our experience at BedZED and the monitoring of the development in use. BioRegional also provide consultancy services to Local Authorities, building professionals and other parties with an interest in sustainable living.

[www.bioregional.com](http://www.bioregional.com)



The Stockholm Environment Institute is an independent, international research institute specialising in sustainable development and environment issues. It works at local, national, regional and global policy levels. The SEI research programmes aim to clarify the requirements, strategies and policies for a transition to sustainability. These goals are linked to the principles advocated in Agenda 21 and the Conventions such as Climate Change, Ozone Layer Protection and Biological Diversity.

SEI's mission is to support decision-making and induce change towards sustainable development around the world by providing integrative knowledge that bridges science and policy in the field of environment and development.

[www.seiy.org](http://www.seiy.org)



WWF, the global environment network, works to conserve endangered species, protect endangered spaces, and address global threats to the planet by seeking sustainable solutions for the benefit of people and nature.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by:

- conserving the world's biological diversity
- ensuring that the use of renewable resources is sustainable
- promoting the reduction of pollution and wasteful consumption

[www.wwf.org.uk](http://www.wwf.org.uk)

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### Dr Robin Stott

Robin Stott is a recently retired Consultant Physician who has worked all his life in an inner city community based teaching hospital. He has had a longstanding interest in the wider aspects of health. He is presently vice chair of *Medact*, a health professional organisation dedicated to promoting health through the development of economic, environmental and social justice.

He has written extensively about the similarities of the antecedents of sustainability and health, including a Schumacher briefing on the subject. He is presently the sustainability advisor to the mayor of Lewisham, and is a Sustainable Development Commissioner for London.

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## Executive Summary

If everyone on the planet were to consume natural resources and pollute the environment as we currently do in the UK, we would need three planets to support us.<sup>1</sup> Reducing the environmental impact of homes in the UK is crucial in pursuing sustainable development on a broader scale.

In February 2003, the UK government released its Sustainable Communities Plan, highlighting the need for development in four 'growth areas', including the Thames Gateway region. WWF accepts that there is a need for new and refurbished housing in some parts of the UK. However, decisions about where and how housing is developed must be taken in the context of sustainability – minimising negative environmental impacts while maximising social and economic benefits. Major developments in the Thames Gateway will be seen as a blueprint for the government's approach to housing over the next 15-20 years. This is especially true given that key decisions will have to be taken before forthcoming revisions to planning guidance and building regulations have come into effect.

For this reason, the report focuses on the Thames Gateway region as a case study and investigates the implications of building 200,000 new homes to different environmental standards:

- |            |  |
|------------|--|
| Scenario 1 | Current Building Regulations with 'average' UK residents;  |
| Scenario 2 | Building Research Establishment's (BRE) EcoHomes 'Very Good' standard with 'average' UK residents; |
| Scenario 3 | BRE's EcoHomes 'Very Good' standard with environmentally aware residents;                          |
| Scenario 4 | 'Z <sup>2</sup> ' standard (Zero fossil Energy, Zero Waste) with environmentally aware residents.  |

The environmental impacts of the various scenarios have been measured in terms of specific issues such as carbon dioxide emissions, water use and waste as well as in terms of overall ecological footprint. The study has also assessed the contributions to the government's sustainable development targets, as well as the impacts on the costs of house building and associated infrastructure and household expenditure of the four different scenarios.

Sustainable homes offer the opportunity for the government to anchor the idea of sustainability in people's everyday lives. Global threats, such as climate change, often appear to be intangible concepts about which individuals feel they can do little. Addressing sustainability effectively therefore requires not only education and explanation, but the provision of relevant, inspiring and practical solutions with which people can engage in a meaningful and positive way.

### **Key findings**

The study demonstrates that by developing 200,000 new homes in the Thames Gateway to a minimum of EcoHomes 'Very Good' standard, the following significant environmental savings could be made per home/per year when compared with homes built to current Building Regulations:

- 32 per cent reduction in carbon dioxide (CO<sub>2</sub>) emissions from energy use in the home, (this saving of 0.993 tonnes of CO<sub>2</sub>/home/year equates to 198,840 tonnes of CO<sub>2</sub> or 54,220 tonnes of carbon for the 200,000 homes each year);
- 39 per cent reduction in water use;
- 4 per cent reduction in the amount of household waste sent to landfill for an 'average' UK resident living in Scenario 2; and

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<sup>1</sup> The Living Planet Report, [www.panda.org/downloads/general/LPR\\_2002.pdf](http://www.panda.org/downloads/general/LPR_2002.pdf)

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- 25 per cent reduction in the amount of household waste sent to landfill for an environmentally aware resident living in Scenario 3.

The study shows that even greater savings could be made per home per year by developing all homes in the Thames Gateway to Z<sup>2</sup> standards:

- 99 per cent reduction in CO<sub>2</sub> emissions from energy use in the home (this saving of 3.052 tonnes of CO<sub>2</sub>/home/year, equates to 610,640 tonnes of CO<sub>2</sub> or 166,540 tonnes of carbon for the 200,000 homes each year);
- 65 per cent reduction in water use; and
- 76 per cent reduction in the amount of household waste sent to landfill.

### ***Cost of Homes and Infrastructure***

The study demonstrates that in terms of capital costs and personal expenditure related to the purchase and running of a home, the cost of developing 200,000 homes to EcoHomes 'Very Good' standard and to 'Z<sup>2</sup>' standards would be comparable to, or even cheaper than, the cost of developing to current Building Regulations. This is because the additional build costs (estimated to be 2 per cent for EcoHomes and 10 per cent for Z<sup>2</sup>) could be offset partly by planning gain (a mechanism whereby developers can increase development in exchange for meeting environmental targets, saving 50 per cent of the extra cost), and partly by residents paying slightly more for their homes. The study shows that these increased mortgage repayments would be compensated for by the savings from reduced energy and water bills. In fact if all household expenditure is considered, including transport and waste, the report findings suggest that sustainable living in the Thames Gateway would result in lower household expenditure for residents in addition to the environmental benefits.

The study suggests that the infrastructure costs for all four scenarios would be comparable. The government already recognises that it must provide the necessary investment to facilitate the development of the Thames Gateway. Taking into account private sector expenditure, this study estimates that public sector investment of approximately £1.2 billion a year for 20 years will be necessary for the development of 200,000 homes in the Thames Gateway, including infrastructure costs such as transport and flood prevention. Based on the estimated reduced infrastructure materials needed for Scenarios 2, 3 and 4, this study suggests that the infrastructure costs could in fact be less than for current Building Regulations (2 per cent, 5 per cent and 10 per cent reduction respectively).

Therefore, the study shows that in terms of both personal expenditure and capital costs, developing homes to a minimum of EcoHomes 'Very Good' standard, and to Z<sup>2</sup> standards, could indeed be cheaper than building to current regulations.

### ***Ecological Footprint***

This study demonstrates that even with significant savings in terms of carbon dioxide, water use and waste in Scenarios 2 and 3, the overall savings in terms of an individual's total ecological footprint when compared to Scenario 1 are limited:

- 4 per cent for Scenario 2 (8 per cent compared to UK average); and
- 11 per cent for Scenario 3 (15 per cent compared with the UK average).

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This is because a considerable component of an individual's ecological footprint is attributable to their share of infrastructure and services which are beyond the scope of the EcoHomes standard.

The figures in Scenario 4 show that individuals can reduce their footprint by 38 per cent (or 40 per cent compared with the UK average). This is because Scenario 4 facilitates more sustainable lifestyle decisions (e.g. by providing car clubs to minimise personal car use and by enabling deliveries of locally produced organic food). This study shows that residents living in Scenario 4 can go a long way in reducing their ecological footprint, but it would still not be enough to enable an individual to live a truly 'one planet' lifestyle.

### **Conclusions and recommendations**

It is evident that construction standards play a significant role in reducing environmental impacts, and that people can make very significant contributions to reducing their impact through the lifestyle choices they make. However, the study also demonstrates the vital importance of shared infrastructure and services. The ecological footprinting analysis suggests that UK residents could reduce their *'three planet lifestyle'* by approximately one planet through living in a Z<sup>2</sup> home and through their lifestyle choices. To save the second planet and live within our fair share of the Earth's resources, we must also reduce the impact of our shared infrastructure and services.

1. New communities should be developed to Z<sup>2</sup> standards to enable residents to live sustainably and achieve *'one planet living'*. As an absolute minimum, the UK government should require that homes be built to the highest BRE EcoHomes standards of 'Very Good' or 'Excellent'.
2. Provision of the new and upgraded levels of infrastructure to facilitate development in the Thames Gateway will require substantial investment. The government must spend this money in a way that achieves significant environmental savings for the same costs. For example, investing in public transport, cycle networks and car clubs will reduce the reliance on private fossil fuel miles and result in fewer roads being required.
3. Key decisions about the Thames Gateway and the other growth areas will be made before the forthcoming reforms of the planning and building regulatory processes are implemented. WWF believes the government must intervene to ensure that development throughout the Thames Gateway and the other growth areas meets the highest possible sustainable development standards.

If the government is to meet its own sustainable development targets and realise the aspirations set out in the Sustainable Communities Plan, it must set minimum sustainable construction standards and create the necessary infrastructure and services to enable people to live within their fair share of the Earth's resources.

## **WWF's One Million Sustainable Homes Campaign**

In December 2001, WWF-UK invited the UK government and devolved administrations to make a public commitment to develop a million 'sustainable homes' in the UK (including new and refurbished homes). WWF recognised that the government and devolved administrations could not deliver such a commitment alone. They would need the support of a wide range of stakeholders, including the house building industry, the investment community, local authorities, consumers and non-governmental organisations (NGOs).

WWF has secured commitments from a wide range of organisations including house builders, developers, investors, industry trade associations and research organisations. WWF has convened a Sustainable Homes Task Force comprising key partners from these sectors to oversee the different strategies needed to overcome the 'barriers' to sustainable homes identified during the consultation process.

### ***Recommendations***

WWF is urging the government to build on its expressions of support and commit to action. The Sustainable Communities Plan set out a number of policy directions intended to create 'thriving sustainable communities', although WWF was disappointed that the government did not go further in specifying minimum sustainable construction standards for all new and refurbished homes.

Similarly, WWF was disappointed that despite the government's aspirations to reduce carbon emissions by 60 per cent by 2050, as set out in the recent Energy White Paper, the government failed to outline how it intended to deliver real emissions reductions and long-term investment in low carbon technologies. In order to meet sustainability targets such as those for CO<sub>2</sub>, WWF believes that the government must support the development of sustainable homes in the following ways:

#### **1 *Through leadership and vision***

The government should set a minimum sustainable construction standard for homes. The Sustainable Communities Plan outlined plans for the creation of four priority growth areas (namely Milton Keynes, Stansted, Ashford and the Thames Gateway) to help meet the shortfall in housing supply in the south-east. According to the Deputy Prime Minister, 'each of these offers an exciting opportunity for new design led sustainable communities – like the Greenwich Millennium Village'. To achieve these sentiments, WWF believes that new communities should be developed to Z<sup>2</sup> standards to enable residents to live sustainably and achieve '*one planet living*'. As an absolute minimum, the government should require that homes be built to the highest BRE EcoHomes standards of 'Very Good' or 'Excellent'.

#### **2 *As a construction client***

The government has already demonstrated leadership through the Millennium Communities exemplar schemes, and through English Partnerships and the Housing Corporation (the latter now requiring an EcoHomes 'Pass' standard). WWF believes the government should insist that all new and refurbished homes it is responsible for must meet a minimum standard of EcoHomes 'Very Good' (in line with English Partnerships' current position). The government already requires all new non-residential buildings that it funds to meet BREEAM 'Excellent' standard, so why not housing?

### **3 Through Regulatory Reform**

The government should provide fiscal incentives for the development of sustainable homes, as proposed in the WWF/ERM discussion document, *Fiscal Incentives for Sustainable Homes*, May 2002 ([www.wwf.org.uk/filelibrary/pdf/sustainablehomes.pdf](http://www.wwf.org.uk/filelibrary/pdf/sustainablehomes.pdf)).

The government should ensure that sustainability lies at the heart of all planning decisions. This could be achieved by providing clear planning policy guidance in favour of sustainable communities based on Z<sup>2</sup> standards, with all homes built to a minimum of EcoHomes 'Very Good' or 'Excellent' standards.

WWF believes that the government must undertake a fundamental review of building regulations to ensure they help deliver its sustainable development targets in relation to energy efficiency/fuel poverty, use of sustainable energy, reducing waste and pollution, and promoting responsible use of natural resources such as water and timber.

More details of WWF's sustainable homes campaign can be found in <i>One Million Sustainable Homes – Turning Words into Action</i> or via <a href="http://www.wwf.org.uk">www.wwf.org.uk</a> .
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## **The Thames Gateway**

### **Background**

The planned development of the Thames Gateway is the largest and most ambitious regeneration initiative in Europe. The area is one of the four priority growth areas set out by the UK government to meet housing demands in the South-east. In early summer 2003 the government will announce targets for the number of homes to be built in the area.

The Thames Gateway area of London and South-east England covers over 700 km<sup>2</sup> including more than 1,000 hectares of previously-used developable land, making it the UK's largest brownfield site. The Thames Gateway extends from Tower Bridge eastwards to Thurrock and out to Shoeburyness and the Isle of Sheppey. Its boundaries cross 15 local authority areas: Newham, Tower Hamlets, Lewisham, Greenwich, Bexley, Havering, Barking and Dagenham, Dartford, Gravesham, Medway, Swale, Southend-on-Sea, Castle Point, Basildon and Thurrock. The total area is a powerful strategic location offering development opportunities for new jobs and homes, in addition to environmental improvements. In the past, large areas to the east of London have missed out on the economic development, investment and employment growth which can be seen in many parts of west London.

Government predictions suggest that the population of London is going to expand considerably. Over the next 15 years, it is anticipated that London will gain 700,000 new residents, 440,000 of whom will come from growth within the existing population. The Deputy Prime Minister, John Prescott, has called for a second generation of new and expanded towns in the South-east capable of providing 200,000 homes. Much of this planned growth will occur in the Thames Gateway region.

The Thames Gateway Strategic Partnership, headed by the housing and regeneration minister, Lord Rooker, indicates that the area has the potential for 179,060 homes and 324,800 jobs. The Mayor of London has indicated in his draft London Plan projections of employment growth at a net 636,000 jobs and the need for 345,000 additional homes over the period 2002-2016. A Cabinet Committee, chaired by the Prime Minister, will consider how far and to what timescale the government should seek to develop the Thames Gateway. The government will set out its

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conclusions in June 2003. Until they have been announced, and for the purposes of this study, a figure of 200,000 new homes in the Thames Gateway over the next 20 years will be assumed.

The founding document on Thames Gateway London, RPG9a, stressed the importance of raising design standards and the quality of the environment radically, if the area was to turn its potential for development into a reality. It identified that to create a vibrant and sustainable pattern of communities, the developments must provide a mix of employment, housing and the activities needed for thriving communities, minimising the need for travel, and taking full account of the existing pattern of development.

### ***The 'Heroic Change' report***

*Heroic Change: Securing Environmental Quality in Thames Gateway* was published by the Thames Gateway London Partnership and Arup in 2001. The document includes a collection of best practice case studies in environmental quality and design from around the Thames Gateway, the United Kingdom and Europe.

The document was prepared with a 'bottom up' approach, in consultation with local authorities, statutory organisations, developers and community groups. It was launched by Lord Falconer with the aim of complementing existing planning guidance to be used by planners, developers and local communities to make improvements in terms of sustainable development and design quality. The 12 key objectives of the publication are to:

- create a dramatic change in image;
- focus on town centres for renovation;
- make the most of major development sites;
- create sustainable new communities;
- improve the sustainability of buildings;
- revive existing neighbourhoods;
- facilitate regeneration of employment areas;
- encourage housing innovation;
- make vacant properties contribute to their environment;
- conceive streets as places;
- build sustainable streets; and
- sustain a prime role for the rivers.

## **Government targets**

The UK government has made commitments on a range of environmental, social and economic targets. Its aims of achieving a sustainable future have most recently been highlighted in the Energy White Paper, the Sustainable Communities plan and through its commitment to its Headline Sustainable Development Indicators. However, it is unclear how the government will meet these targets when it appears to lack coherent vision of what a sustainable future might look like – where social, environmental and economic factors are actually integrated, rather than traded off against each other.

Government projections for the numbers of new homes required in England over the next 20-50 years have the potential to conflict with these targets. WWF believes that committing to and implementing a sustainable homes programme reconciles this conflict, while providing a powerful vehicle for delivering and integrating sustainability targets, and demonstrating 'joined-up' thinking on sustainable development.

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Sustainable homes offer the opportunity for the government to anchor the idea of sustainability in people's everyday lives. Global threats, such as climate change, often appear to be intangible concepts about which individuals feel they can do little. Addressing sustainability effectively therefore requires not only education and explanation, but the provision of relevant, inspiring and practical solutions with which people can engage in a meaningful and positive way. The opportunity to live in a sustainable home will offer just this – an affordable, attractive living space through which people can make a concrete and quantifiable contribution to sustainable development. A sustainable home will also lay the foundation for sustainable purchasing decisions in relation to food, household goods, and everyday activities such as transport and leisure.

Sustainable homes could also offer significant health benefits to residents and contribute to government targets on health. Dr Robin Stott (see Appendix 1) confirms the link between sustainability and wellbeing for both individuals and the planet, and that the quality of our buildings and environment has an important effect on our health. Dr Stott notes that a compact, eco-friendly city, as defined in scenario 4, can be of:

- **Direct benefit to individual inhabitants:** Reduced traffic levels would result in better air quality, lower noise levels and decreased accident rates, as well as increasing a sense of community through minimising community dislocation commonly associated with traffic. The alternatives of cycling and walking would boost health through increased exercise. The benefits of having access to healthy, local, organic food are also mentioned.
- **Indirect benefit to individual inhabitants:** Reduced traffic congestion and air pollution would reduce asthma and respiratory problems. The availability of affordable warmth would help reduce fuel poverty and the associated health implications. The local cycles of production and consumption can have societal, environmental and economic benefits. In addition, residents may benefit from an enhanced sense of trust and control in their neighbourhood.
- **Benefit to the wider and global community:** There will be global benefits in terms of reducing carbon dioxide (CO<sub>2</sub>) emissions and climate change.

### ***Energy White Paper***

On 24 February 2003, the government published its long-awaited White Paper on energy, *Our energy future – creating a low carbon economy*, which acknowledges that current energy strategy will be unable to meet future challenges and outlines changes in energy policy. In a speech to mark the publication of the Paper, the Prime Minister warned that extreme climatic events will cause £150 billion of destruction each year across the world in a decade.

The government has identified an aspirational target of achieving a 60 per cent reduction in carbon dioxide emissions by 2050 (a target recommended by the International Panel on Climate Change), this is to be primarily met through reducing consumption and boosting the use of renewable energy sources. In achieving this long-term target and an intermediate reduction target of 15-25 million tonnes of carbon (MtC) by 2020, energy efficiency is identified as delivering half of the necessary improvements.

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As the CO<sub>2</sub> emissions attributable to the construction and occupation of our homes equates to approximately 27 per cent of all CO<sub>2</sub> emissions in the UK<sup>2</sup>, it is clear that the sustainability of our homes will play a pivotal role in achieving our sustainable future. In the White Paper, the government expressed its aims for improving the energy performance of homes in the UK by bringing forward the next revision of the Building Regulations to 2005, and stating its aim to ensure that every home is adequately and affordably heated with nobody living in fuel poverty by 2016-18<sup>3</sup>. The White Paper indicates that 4-6 MtC of the total 15-25 MtC reductions by 2020, could be achieved through energy efficiency in households.

The London Sustainable Development Commission (LSDC) has recommended the reduction of CO<sub>2</sub> emissions in London of 20 per cent from 1990 levels by 2010. This target would be a first step in a process that would lead to a minimum target of 60 per cent reduction in CO<sub>2</sub> emissions by 2050. To meet these reductions, challenging targets will have to be set for new buildings. It has been calculated by the LSDC that to help achieve the 2050 target, all new developments in London from now on should be CO<sub>2</sub> neutral, and that a 40 per cent saving in current fuel use is also required for all existing developments. These figures were calculated using current domestic fabric renewal rates and predicted housing stock numbers for London over the next 50 years. As the homes built today will still be in use in 60+ years, the 2050 target was viewed as the most important for the construction sector to address now.

Despite the predicted decline in CO<sub>2</sub> emissions after 2005, Cambridge Econometrics<sup>4</sup> reports that the attainment of the government's domestic goal of a 20 per cent reduction in the 1990 level of CO<sub>2</sub> emissions by 2010 appears to be unattainable without significant new policy measures. By 2010, household carbon emissions are expected to be 26 per cent above the 1990 level and they, along with road transport, remain formidable barriers to progress towards the government's 20 per cent domestic carbon reduction target.

An aim of this study is to help illustrate that by developing the Thames Gateway using sustainable design and community principles, significant progress towards meeting the government CO<sub>2</sub> targets could be achieved.

### **Communities Plan**

*Sustainable Communities: Building for the future* was published in February 2003. The document reports on the government's planned programme of action to tackle the pressing problems related to communities in England. These are primarily issues of affordability and abandonment, the provision of decent homes and a good quality local environment for all.

The programme aims to demonstrate a step change in the government's approach. The document acknowledges that a wider vision of sustainable communities is required to underpin the government's plan which aims to show its commitment to sustainable design. The document identifies that the way our communities develop economically, socially and environmentally must respect the needs of future generations as well as succeeding now. The need for providing access to decent affordable housing in decent surroundings is established.

The framework document sets out priorities for investment over the next three years, but recognises that 15-20 years of action will be required to facilitate change. One of the aims of this study is to help demonstrate that designing and building sustainable communities today in

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<sup>2</sup> Urban Task Force (1999), *Towards an Urban Renaissance*, E & FN Spon, London

<sup>3</sup> In the UK, an estimated 2.5 million households spend over 10 per cent of their income on heating their homes, this has fallen from 5.5 million in 1996, but this is primarily due to reductions in energy costs rather than increased energy efficiency

<sup>4</sup> [www.camecon.co.uk](http://www.camecon.co.uk)

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the Thames Gateway is an ideal opportunity to implement the aspirations of ideas in the sustainable communities plan and achieve our sustainable future.

### ***Headline Sustainable Development Indicators***

In May 1999, the government published *A better quality of life*, the strategy document (and subsequent annual progress reports) aimed to demonstrate commitment to sustainable development throughout the UK.

The strategy included headline indicators to both raise awareness and help focus public attention on what sustainable development is. The 15 indicators represent a 'quality of life barometer' which measure performance against the three pillars of sustainable development – social progress, environmental protection and economic growth. The strategy also outlined a wider set of 147 indicators that focus on specific issues which cover people's everyday quality of life concerns.

Of the 147 indicators used to measure progress towards achieving government sustainable development objectives, 70 can be linked to housing and community issues, this is an illustration of the importance of housing in achieving our sustainable future.

<b>Factor</b>	<b>UK Government Targets / Commitments / Projections</b>	<b>Sustainable Homes contributions to Targets</b>
<b>Housing</b>	<ul style="list-style-type: none"> <li>• 4m new homes (projection)</li> <li>• land use targets (60% of homes on previously developed land by 2008)</li> </ul>	<ul style="list-style-type: none"> <li>• Sustainable homes will make a positive rather than a negative impact on environment and provide social and economic benefits.</li> </ul>
<b>Climate Change</b>	<ul style="list-style-type: none"> <li>• 20% CO<sub>2</sub> emission reduction by 2010</li> <li>• 60% CO<sub>2</sub> emission reduction by 2050</li> <li>• 10% renewables by 2010</li> <li>• 10 GW CHP by 2010</li> </ul>	<ul style="list-style-type: none"> <li>• Energy efficiency improvement reducing energy use, cost and emissions.</li> <li>• Each sustainable home will save between 0.993 and 3.052 tonnes of CO<sub>2</sub> per annum.</li> <li>• Mainstreaming cutting edge sustainable energy technologies (e.g., solar and biomass fired CHP) will contribute significantly to both renewables and CHP targets.</li> <li>• Drive innovation in energy sector - technology and systems, development and demonstration of new generation technology, integration of small scale plant onto grid, development of innovative energy services.</li> </ul>
<b>Fuel Poverty</b>	<ul style="list-style-type: none"> <li>• End fuel poverty in vulnerable households by 2010</li> <li>• Eliminate fuel poverty in Britain by 2016-18</li> </ul>	<ul style="list-style-type: none"> <li>• Dramatic improvement in building fabric and integrated sustainable energy supply provides adequate warmth, light, at low prices and low/zero emissions.</li> </ul>
<b>Waste</b>	<ul style="list-style-type: none"> <li>• By 2005, to reduce the landfill of industrial and commercial waste to 85% of 1998 levels</li> <li>• By 2020, to reduce the landfill of biodegradable municipal waste to only 35% of its 1995 level</li> <li>• By 2010, to recover value from 45% of municipal waste (at least 30% by recycling or composting)</li> </ul>	<ul style="list-style-type: none"> <li>• Sustainable building material will significantly reduce the 20% of UK waste produced by construction.</li> <li>• Mainstreaming community-based recycling and composting schemes will significantly reduce municipal waste.</li> </ul>
<b>Timber</b>	<ul style="list-style-type: none"> <li>• Support and promote purchasing of timber from credible, independently certified, well managed sources</li> </ul>	<ul style="list-style-type: none"> <li>• The construction industry uses between 50-70% of all timber consumed in the UK, most of it sourced from other countries around the world - timber from credible, independently certified, well managed sources will be used widely as an environmentally responsible building material.</li> <li>• Source timber from credible, independently certified, well managed sources for on-site biomass energy production demonstrating best practice (and increasing amount of timber from credible, independently certified, well managed sources).</li> </ul>
<b>Transport</b>	<ul style="list-style-type: none"> <li>• Reduce congestion on the inter-urban trunk road network and in large urban areas in England below 2000 levels by 2010</li> <li>• Reduce the number of people killed or seriously injured in GB in road accidents by 40% by 2010 and the number of children killed or seriously injured by 50% compared to average for 1994-98</li> </ul>	<ul style="list-style-type: none"> <li>• Sustainable homes promote bulk deliveries of food ordered via the Internet, car pools, secure cycle storage, and good public transport links that reduce energy use (transport accounts for over 30% of the UK's energy consumption), pollution and congestion.</li> <li>• Reduced traffic levels would result in better air quality and decreased accident rates.</li> </ul>
<b>Toxics</b>	<ul style="list-style-type: none"> <li>• Reduction of risks presented by chemicals to the environment and human health - while maintaining the competitiveness of industry</li> </ul>	<ul style="list-style-type: none"> <li>• Sustainable homes avoid use of toxic chemicals commonly found in building materials resulting in health and environmental benefits.</li> </ul>
<b>Planning</b>	<ul style="list-style-type: none"> <li>• Planning system reform to speed up supply and contribute to sustainable development.</li> </ul>	<ul style="list-style-type: none"> <li>• Sustainable homes will 'trail blaze' integrated planning for sustainable development.</li> <li>• The Planning system need not act as a barrier to increasing supply. Sustainable Homes should be fast-tracked through the system.</li> <li>• Sustainable homes will mitigate risk.</li> </ul>

## Sustainability – three planets into one planet

Ecological footprinting (EF) analysis is an accounting tool that represents the environmental impacts of a process or person's lifestyle in terms of an area of land required to sustainably produce a particular natural resource or to absorb waste from consumption. It measures the area of biologically productive land that is required to meet the needs of a given product, person or population. It compares this area with the actual available area on Earth and informs us whether we are living within the Earth's regenerative capacity.

A person's ecological footprint is made up of the footprints of all of their activities, products consumed and waste produced. It includes the area of forest required to sequester the CO<sub>2</sub> emissions attributed to that person, and 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 do their food consumption, transport, work activities and leisure activities.

Eco-footprinting figures in WWF's *Living Planet Report 2002*<sup>5</sup>, inform us that it takes around 5.35 global hectares of biologically productive land to support each person in the UK<sup>6</sup>. Research carried out by Stockholm Environment Institute (SEI-Y) for this study suggests that if the EF for a typical UK citizen is calculated using the methodology and criteria established in this study, it would be approximately 5.71 global hectares. The actual available productive area on Earth is 1.9 global hectares per person.

Hence, it can be concluded that if everyone on the planet consumed as much as the average person in the UK, we would need three planets to support us.



This analysis suggests the UK needs to reduce its consumption of fossil fuels and virgin materials by two-thirds to be environmentally sustainable as part of a concept of living within a fair share of the Earth's resources. To achieve this reduction in consumption we need to develop lifestyles that are consistent with one planet sustainable ways of living.

Ecological footprinting (EF) analysis indicates that how people live, work, play and consume in their day-to-day lives is as important as the environmental impact of their homes in themselves. It is probable that the only way to reduce the ecological footprint from a three-planet level to *One Planet Living* is a through a coherent approach based on the compact city form<sup>7</sup>, based on a circular metabolism<sup>8</sup> and bioregional principles of meeting more of everyday needs from local renewable and waste resources<sup>9</sup>.

A wider definition of sustainability covers more than environmental impact. It is frequently defined in terms of the 'triple bottom line' comprising social, environmental and economic sustainability. For our future developments and communities to be truly sustainable, they must address the social amenity, creating sustainable communities with spaces people want to live and work in. Developments must also offer financially sustainable solutions which are viable within a market economy.

<sup>5</sup> WWF International (2002), 'Living Planet Report 2002', Avenue de Mont-Blanc, 1196 Gland, Switzerland

<sup>6</sup> Stockholm Environment Institute (York) refer to the latest figure of 5.45 gha, calculated by Mathis Wackernagel.

<sup>7</sup> Richard Rogers, *Cities of a Small Planet*

<sup>8</sup> Herbert Girardet, *The Metabolism of Cities*

<sup>9</sup> Desai and Riddlestone, *BioRegional Solutions for Living on One Planet*

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The environmental, social and financial issues surrounding sustainable development are particularly closely interlinked in the housing sector. Ensuring access to appropriate, efficient and safe homes plays an important role in community wellbeing and regeneration, as does ensuring that such homes are affordable to build, buy and run, in addition to being designed to tackle issues such as fuel poverty.

## Four Scenarios for the Thames Gateway

BioRegional has developed data-sets for 4 lifestyle scenarios with the purpose of comparing the sustainability of different ways of living suggested from the occupation of different homes. The scenarios were developed to reflect the impact of different lifestyles facilitated by living in communities and homes built to differing environmental standards. These range from a new UK home built to current Building Regulations occupied by a 'typical' UK resident with average consumption patterns and energy demands, to an enthusiastic sustainability-minded resident living in an energy efficient home based on the ZED model developed at Beddington Zero Energy Development (see below) within a compact  $Z^2$  (zero fossil energy, zero waste) community. Located between these two scenarios are two scenarios based on communities of homes which achieve a score of 'Very Good' on EcoHomes, the Building Research Establishment's sustainability assessment tool. In the first, the residents live typical lifestyles, in the second they have made lifestyle decisions to try to reduce their environmental impact.

Scenario	Description
1	Typical UK resident in typical new UK home to 2002 Building Regulations
2	Typical UK resident in typical new UK home to EcoHomes 'Very Good'
3	Environmentally aware resident in typical new home to EcoHomes 'Very Good'
4	Keen resident living in a $Z^2$ – zero fossil energy, zero waste Community

### Scenario 1: Building Regulations

The Building Regulations are made under powers provided in the Building Act 1984. They apply in England and Wales where the majority of building projects are required to comply with them. They contain a list of requirements designed to ensure the health, safety and welfare of people in and around buildings, as well as providing for energy conservation. The Building Regulations deal with the minimum standards required for buildings.

The Building Regulations contain various sections dealing with definitions, procedures, and what is expected in terms of the technical performance of building work. Anyone wanting to carry out building work which is subject to the Building Regulations is required by law to make sure it complies with the regulations.

The new Building Regulations took effect on 1 April 2002 in England and Wales; there are major changes regarding the conservation of the fuel and power from the previous 1995 edition. As a result of the Kyoto Protocol and UK government targets to reduce CO<sub>2</sub> emissions, the new Approved Documents L1 and L2 have switched to a measurement of performance based on carbon output. The legal requirements set out under Approved Document L1: *Conservation of fuel and power in dwellings* are as follows:

*'Reasonable provision shall be made for the conservation of fuel and power in dwellings by:*

- a) *Limiting heat loss:*
  - i. *through the fabric of the building;*
  - ii. *from hot water pipes and hot air ducts used for space heating;*
  - iii. *from hot water vessels;*

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- b) *Providing space heating and hot water systems which are energy efficient;*
- c) *Providing lighting systems with appropriate lamps and sufficient controls so that energy can be used efficiently;*
- d) *Providing sufficient information with the heating and hot water services so that building occupiers can operate and maintain the services in such a manner as to use no more energy than is reasonable in the circumstances.'*

The information used to compile the data-set for Scenario 1 for a resident living in the Thames Gateway and occupying a typical new home built to current Building Regulations is primarily based on figures published by the government and the Building Research Establishment (BRE) on average lifestyle and consumption data for the UK or South-east, and energy and services demands for typical new homes.

In this scenario, assumptions have been made on the levels of shared infrastructure and services associated with typical UK living. Some of the headline data is taken from the Thames Gateway Strategic Executive Partnership's suggested figures of 180 primary schools, 30 secondary schools, 72 primary care centres and 224 GP surgeries. Further approximations on the levels of shared infrastructure have been produced in consultation with Fulcrum Consulting.

### **Scenarios 2 and 3: EcoHomes 'Very Good'**

It is widely accepted in the construction sector that BRE EcoHomes is the most comprehensive and successful sustainability assessment tool for housing currently available. EcoHomes considers the broad environmental concerns of climate change, resource use and impact on wildlife, and balances these against the need for a high quality of life, and a safe and healthy internal environment. The BRE tool addresses the environmental sustainability of new developments and refurbishments under seven criteria (energy, water, land use and ecology, transport, health and wellbeing, pollution, and materials) with the aim of providing an indication of the sustainability of a home.

EcoHomes assessments can be carried out at the design stage and although every house type on a site must be considered, the award is given for the whole development. This enables the developers to use the result to promote whole sites – every house that is part of the development has the same rating. EcoHomes is the homes version of BREEAM (the BRE Environmental Assessment Method). BREEAM is a leading benchmark for the environmental performance of buildings.

EcoHomes is a reasonably straightforward, flexible and independently verified environmental assessment method. Environmental performance is expressed on a scale of *Pass, Good, Very Good* and *Excellent*.

It is an easily understood, credible label for new and renovated homes including houses and apartments. It rewards developers who improve environmental performance through good design, rather than high capital cost solutions.

As part of its *One Million Sustainable Homes Campaign*, WWF is calling on the UK government to follow through on policy directions set out in its recent Sustainable Communities Plan and the Energy White Paper, to ensure that its sustainable development aspirations become a reality. Under WWF's proposals, minimum construction standards would be set to ensure that all new and refurbished homes in the Thames Gateway and the other three priority growth areas meet a minimum of EcoHomes 'Very Good' or 'Excellent' standard. WWF believes that new

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communities should be developed to Z<sup>2</sup> standards to enable residents to live sustainably and achieve 'one planet living'.

EcoHomes rewards dwellings which are built with insulation levels in excess of minimum Building Regulation requirements and which, through energy efficient design and specification, have reduced CO<sub>2</sub> emissions associated with meeting energy demands. Credit is also given for locating homes with good access to public transport and amenities, and which are constructed of materials with low environmental impact. Reducing water demand and providing recycling storage facilities are also rewarded. Issues relating to the conservation and enhancement of the external natural environment and the quality of the internal environment for occupants are also assessed under the scheme.

Scenario 2 is based on a resident living in an EcoHomes 'Very Good' home and hence makes some environmental savings, but who otherwise essentially lives a typical UK lifestyle with associated demands, resource use and pollution. Scenario 3 is based on the impact of a resident living in a similar EcoHomes 'Very Good' home in the same community, but who has made some lifestyle choices to reduce their environmental impact.

### **Scenario 4: Z<sup>2</sup> for One Planet Living**

The BioRegional vision for building a new community in Thames Gateway hopes to demonstrate how we can build and live sustainably in the future within the capacity of one planet. The vision comprises a series of well-connected smaller Z<sup>2</sup> (zero fossil energy and zero waste) sustainable communities, each a distinct element within the unified whole. A key principle of designing sustainable communities is to build at high densities around transport interchanges as advocated by Richard Rogers in *Cities for a Small Planet*. These communities need to integrate a variety of residential, commercial and leisure uses so that most facilities are within walking distance with efficient public transport making it easier to live without a car. In these compact communities, heat and power are generated locally, waste is minimised and sustainably managed, and a hinterland provides space for recreation, growing food and wildlife habitats. BioRegional believe this model of a sustainable compact community should be used to inform future development in Thames Gateway London.

The model for such communities would build on the achievements at the ground-breaking Beddington Zero (fossil) Energy Development, but would additionally be designed and built to tackle sustainable living issues at the community and urban town level.

### **Beddington Zero (fossil) Energy Development**

BioRegional initiated the construction of an urban eco-village in South London, Beddington Zero (fossil) Energy Development – BedZED, designed by architect Bill Dunster and developed by the Peabody Trust in partnership with BioRegional. The aim has been to show how green living is a real, attractive and affordable option. This is created by integrating energy efficiency, renewable energy and water harvesting with services like car pools and local organic food deliveries.

BedZED comprises 82 homes, office space and live-work units and is the UK's largest eco-village. It has a mix of social housing for people on low incomes and private homes for sale at prices comparable to more conventional homes in the area. It is designed for a comfortable and highly resource-efficient way of life.

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BedZED was designed to push the boundaries of 'best practice' in environmental performance, and is widely acknowledged as a pioneering development which sets new standards in sustainability. BedZED was not designed to meet the requirements of any particular eco-label or environmental scheme, but to achieve net carbon neutrality, and to create the opportunity for residents to 'buy into' a whole sustainable lifestyle. The development has been assessed under BRE EcoHomes and achieved the 'Excellent' rating.

Analysis and monitoring of BedZED in use has indicated that environmental savings can be made by residents living there and that keen environmentally-minded occupants can reduce their ecological footprints and get closer to living sustainably within the means of one planet. Subsequent EF assessment has shown that a significant part of a person's environmental impact is related to their portion of shared infrastructure and services. It is anticipated that by building developments of sustainable communities which are 2500+ homes (Scenario 4) rather than the 100 units of BedZED, the impact of these 'shared' elements can be tackled more comprehensively. Developing at a larger scale holistic masterplan enables reductions in the amount of transport infrastructure required, the development of community-wide zero waste strategies and designs to enable local food production.

## Impact criteria

The environmental impact of each lifestyle Scenario is sub-divided into 9 criteria:



Energy use in the home
Transport
Infrastructure (homes)
Infrastructure (shared)
Waste and consumer items
Water
Built land
Services
Food

For each of these criteria for each scenario, BioRegional has worked closely with other consultants (including Stockholm Environment Institute and Fulcrum Consulting) to calculate the associated environmental footprints, CO<sub>2</sub> emissions attributable and the estimated cost implications in terms of capital outlay and day-to-day costs for the residents. The master table below illustrates the data-sets for the assumed lifestyle demands and consumption levels for each of the assessment criteria. A more comprehensive version of the table appears in Appendix 2.

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ISSUE	Scenario 1 Typical UK resident in typical new UK home to 2002 Building Regulations	Scenario 2 Typical UK resident in typical new UK home to EcoHomes 'Very Good'	Scenario 3 Environmentally-concerned resident In typical new UK home to EcoHomes 'Very Good'	Scenario 4 Z <sup>2</sup> : Zero fossil energy, zero waste community
Energy use in the home	<ul style="list-style-type: none"> <li>Typical UK energy demand for new homes</li> <li>2002 Building Regulation insulation levels</li> <li>'A-C'-rated white goods</li> <li>Non-condensing boiler</li> </ul>	<ul style="list-style-type: none"> <li>Lower energy demand</li> <li>Better insulation levels</li> <li>'A'-rated white goods</li> <li>Condensing boiler</li> </ul>	<ul style="list-style-type: none"> <li>As Scenario 2</li> </ul>	<ul style="list-style-type: none"> <li>Zero (fossil) Energy</li> <li>Very low UK energy demand</li> <li>Super-insulated</li> <li>'A'-rated white goods</li> <li>On-site waste CHP/pyrolysis plant</li> </ul>
Transport	<ul style="list-style-type: none"> <li>Average UK travel pattern</li> <li>No home office</li> </ul>	<ul style="list-style-type: none"> <li>Lower private car use</li> <li>Home office</li> <li>5% overall journey reduction</li> <li>10% reduction in private car use</li> </ul>	<ul style="list-style-type: none"> <li>Resident is a member of a car club</li> <li>Sometimes works from home</li> <li>20% overall journey reduction</li> <li>40% reduction in car use</li> </ul>	<ul style="list-style-type: none"> <li>Sustainable Travel packages</li> <li>40% overall journey reduction</li> <li>Majority of journeys by foot/cycle</li> <li>85% reduction in car miles, no private fossil fuel miles, all via car club</li> <li>Home office &amp; local employment</li> </ul>
House Materials	<ul style="list-style-type: none"> <li>Typical UK new home construction</li> </ul>	<ul style="list-style-type: none"> <li>Typical UK home construction, with more insulation and materials with lower environmental impacts</li> </ul>	<ul style="list-style-type: none"> <li>As Scenario 2</li> </ul>	<ul style="list-style-type: none"> <li>ZED-type homes</li> <li>Similar embodied energy to typical UK new home construction, but with much more insulation and more inert materials. Reclaimed, recycled and locally sourced materials extensively used</li> </ul>
Shared Infrastructure	<ul style="list-style-type: none"> <li>Current levels of infrastructure shared equally</li> </ul>	<ul style="list-style-type: none"> <li>Reduced transport and energy infrastructure</li> <li>Less waste landfill, but some more waste processing infrastructure</li> <li>Reduced water processing infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>Reduced transport and energy infrastructure</li> <li>Less waste landfill, but some more waste processing infrastructure</li> <li>Reduced water processing infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>Further reduced transport and energy infrastructure</li> <li>Even less waste landfill, with more waste processing infrastructure</li> <li>Further reduced water infrastructure</li> <li>Reduced material extraction &amp; transport infrastructure, increased material recycling and reclaiming facilities</li> <li>Fewer airports and infrastructure due to air-freighted imported goods</li> </ul>
Waste & consumer items	<ul style="list-style-type: none"> <li>Average UK consumption</li> <li>Average UK domestic waste production of 520 kg/person/year</li> <li>Typical recycling rate of 12%, 79% landfill and 9% incineration</li> </ul>	<ul style="list-style-type: none"> <li>Average UK consumption</li> <li>Average UK waste production of 520 kg/person/year</li> <li>25% higher recycling levels of 15.5%</li> </ul>	<ul style="list-style-type: none"> <li>Consumption reduced by 15% through lifestyle choices</li> <li>Waste levels reduced by 15%</li> <li>25% of domestic waste recycled or composted</li> <li>70% landfill and 5% incinerated</li> </ul>	<ul style="list-style-type: none"> <li>Reclaimed &amp; recycled goods promoted</li> <li>25% reduced consumption</li> <li>25% lower packaging levels</li> <li>25% overall less waste than UK av.</li> <li>25% of which is recycled</li> <li>25% of which is composted</li> <li>25% of which is converted to energy via gasification CHP</li> <li>25% of which is sent to landfill</li> </ul>
Water	<ul style="list-style-type: none"> <li>Average UK water consumption</li> <li>134 litres/person/day metered water</li> </ul>	<ul style="list-style-type: none"> <li>Low water consumption</li> <li>82 litres/person/day</li> </ul>	<ul style="list-style-type: none"> <li>As Scenario 2</li> </ul>	<ul style="list-style-type: none"> <li>Very low water consumption 47 litres/person/day</li> <li>On-site grey water processing</li> <li>Rainwater harvesting meets external water demand</li> </ul>
Built land	<ul style="list-style-type: none"> <li>40 homes/hectare in core</li> <li>2 storey development average</li> </ul>	<ul style="list-style-type: none"> <li>40 homes/hectare in core</li> <li>2.5 storey development average</li> </ul>	<ul style="list-style-type: none"> <li>As Scenario 2</li> </ul>	<ul style="list-style-type: none"> <li>80 homes/hectare in core</li> <li>3 storey development average</li> </ul>
Services	<ul style="list-style-type: none"> <li>Average use of:</li> <li>Retail, recreation, healthcare, hotel &amp; catering, communications, banking and finance</li> </ul>	<ul style="list-style-type: none"> <li>As Scenario 1</li> </ul>	<ul style="list-style-type: none"> <li>Fewer commercial services used due to reduced consumption</li> </ul>	<ul style="list-style-type: none"> <li>Fewer commercial services used</li> <li>Less healthcare needed</li> <li>Less consumption</li> <li>Less travel</li> </ul>
Food	<ul style="list-style-type: none"> <li>Average UK consumption</li> </ul>	<ul style="list-style-type: none"> <li>As Scenario 1</li> </ul>	<ul style="list-style-type: none"> <li>Increased consumption of local and organic food</li> </ul>	<ul style="list-style-type: none"> <li>Low meat and dairy lifestyle</li> <li>Increased fruit and vegetable intake</li> <li>Promotion of local and organic food</li> <li>Less packaging</li> </ul>

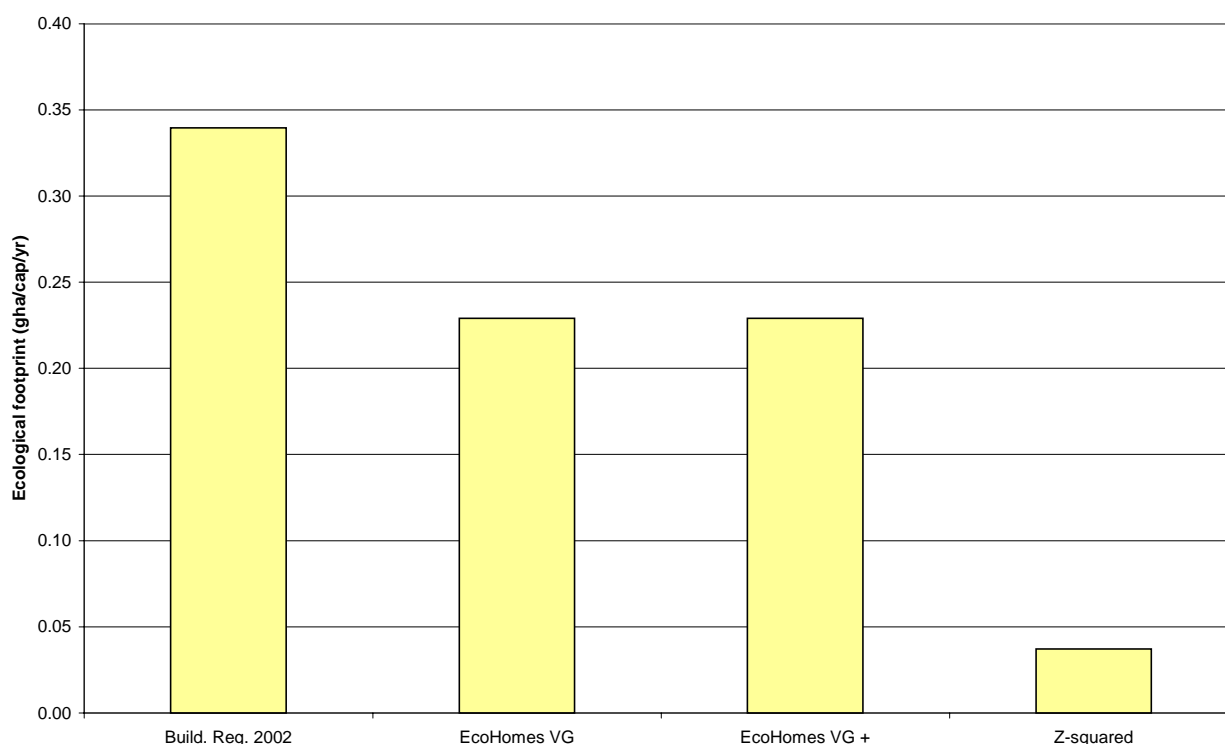
## Energy use in the home

ISSUE	Scenario 1 Typical UK resident in typical new UK home to 2002 Building Regulations	Scenario 2 Typical UK resident in typical new UK home to EcoHomes 'Very Good'	Scenario 3 Environmentally-aware resident in typical new UK home to EcoHomes 'Very Good'	Scenario 4 Z <sup>2</sup> : Zero fossil energy, zero waste community
Energy use in the home	<ul style="list-style-type: none"> <li>Typical UK energy demand for new homes</li> <li>Building Regulations 2002 insulation levels</li> <li>'A-C'-rated white goods</li> <li>Non-condensing boiler</li> </ul>	<ul style="list-style-type: none"> <li>Lower energy demand</li> <li>Better insulation levels</li> <li>'A'-rated white goods</li> <li>Condensing boiler</li> </ul>	<ul style="list-style-type: none"> <li>As Scenario 2</li> </ul>	<ul style="list-style-type: none"> <li>Zero (fossil) Energy</li> <li>Very low UK energy demand</li> <li>UK better insulation levels</li> <li>'A'-rated white goods</li> <li>On-site waste CHP/pyrolysis plant</li> </ul>
EF	<b>0.340</b> gha <sup>(A)</sup>	<b>0.229</b> gha <sup>(A)</sup> <b>-32%</b>	<b>0.229</b> gha <sup>(A)</sup> <b>-32%</b>	<b>0.037</b> gha <sup>(A)</sup> <b>-89%</b>
CO <sub>2</sub>	<b>1.312</b> tonnes/person/annum <sup>(A)</sup>	<b>0.886</b> tonnes/person/annum <sup>(A)</sup> <b>-32%</b>	<b>0.886</b> tonnes/person/annum <sup>(A)</sup> <b>-32%</b>	<b>0.002</b> tonnes/person/annum <sup>(A)</sup> <b>-99%</b>
Personal budget	<b>£197</b> /person/annum <sup>(B)</sup>	<b>£127</b> /person/annum <sup>(C)</sup> <b>-36%</b>	<b>£127</b> /person/annum <sup>(C)</sup> <b>-36%</b>	<b>£103</b> /person/annum <sup>(C)</sup> <b>-48%</b>

<sup>(A)</sup> - Figure calculated by SEI

<sup>(B)</sup> - Figure calculated by BDG from *National Statistics Family Spending report 2001/2002*

<sup>(C)</sup> - Figure calculated by BDG



**Chart 1:** EF associated with domestic energy use of residents living in the different Scenarios

## **Scenario Data**

For the data-sets covering the four lifestyle Scenarios, informed estimates are made about the associated energy demands of the residents based on the thermal performance of their homes and the community-wide energy supply strategy. Minimum required domestic insulation levels have slowly been improving over the years. A dwelling built to current Building Regulations is considerably better insulated than a UK stock home, with reduced heat loss through walls, roof and floors, and better performing windows. Scenario 1 relates to a home built to comply with 2002 Building Regulations Part L1 and assumes a new efficient (but non-condensing) boiler is fitted and that the white goods will be of a reasonably high specification. This is based on the assumption that many residents moving into the new homes will be offered or will fit new domestic appliances, the majority of market-leading new white goods in the UK are 'A-rated'.

EcoHomes rewards developments which deliver building elements with thermal performance in excess of Building Regulation minimum requirements, as well as acknowledging the specification of energy efficient white goods, luminaires and boilers. These have been taken into account in the data-sets for Scenarios 2 and 3. EcoHomes further credits dwellings which reduce their CO<sub>2</sub> emissions by meeting their energy needs via sustainable sources.

The high performance homes built as part of Scenario 4 would be based on the ZED-model developed at BedZED. The homes would be super-insulated, with approximately three times the insulation thicknesses of a typical UK new home and large amounts of thermal mass to maximise heat storage, high levels of airtightness to reduce heat loss and passive energy-efficient ventilation systems. 'A-rated' domestic appliances would be fitted throughout the triple-glazed homes. Energy would be provided by local combined heat and power (CHP) and pyrolysis plants which would run on chipped tree-surgery waste, biomass fuels and gasified municipal waste as part of the 'zero waste' and 'carbon neutral' strategies. The localised systems would deliver both electricity and hot water for space heating with minimised transmission and distribution losses. Many of the dwellings at BedZED are being monitored for their energy use. The energy demand for Scenario 4 is based on the original building physics design targets and monitored data from BedZED for average of best three performing mid-sized monitored households. The energy demand data for Scenarios 1, 2 and 3 is based on BRE domestic research.

## **Ecological Footprint and Carbon Dioxide emissions**

The CO<sub>2</sub> emissions resulting from energy use in our homes accounts for approximately one-third of total CO<sub>2</sub> emissions associated with energy use in the UK. The amount of woodland required to sequester the CO<sub>2</sub> associated with the production of energy from fossil fuels is the primary component of the EF for this section.

The CO<sub>2</sub> and ecological footprint (EF) savings for this section are the highest achieved in this study. In Scenarios 2 and 3, by reducing energy demand through increased efficiency and insulation, the figures have been reduced by approximately one-third. The savings associated with energy use for both Scenarios 2 and 3 are assumed to be equal, this is because the majority of the savings are due to reduced demand through higher performing building fabric and low use appliances, hence not directly related to lifestyle.

In Scenarios 1, 2 and 3, the energy demands are met via the portfolio of current UK energy sources, because these primarily comprise the burning of fossil fuels there are high CO<sub>2</sub> emissions and EF implications. The EF and CO<sub>2</sub> savings achieved in Scenarios 1, 2 and 3 through reducing energy demand can be increased further by employing strategies to meet the reduced demand using sustainable energy sources. The figures for Scenario 4 illustrate that a

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resident's EF attributable to energy use in the home can be reduced by nearly 90 per cent if they live in a ZED-type home powered by sustainable energy sources when compared with a typical UK new home. The energy strategy for Scenario 4 involves generating energy from sustainable sources including waste, at BedZED the CHP runs on gasified chipped tree surgery waste. The installation has been sized to meet the community's energy needs over a year and is carbon-neutral due to the nature of the fuel used. The waste timber has already absorbed the same amount CO<sub>2</sub> during its lifetime as is released when it is converted to energy. This carbon-neutral strategy for generating energy has resulted in CO<sub>2</sub> emissions savings of more than 99 per cent, the small amount of carbon dioxide is related to transporting the fuel to the plant.

It should be noted that some of the construction materials used in Scenario 4 as part of the building physics strategy lead to a slightly higher embodied energy footprint and hence a slightly increased 'House Infrastructure' EF. This is discussed in greater detail later in this study. However, it should also be borne in mind that the increase in embodied energy is more than compensated for by the overall reduction in energy consumption during the lifetime of the building. These results highlight that energy efficiency in building fabric pays off.

### **Personal budget**

Data from the UK government produced *National Statistics Family Spending report 2001/2002* states that the average weekly household bill for electricity, gas and other fuels is £12.20 in the South-east, which suggests (using the DEFRA average figure of 2.33 people per household in the UK which is used throughout this study) an annual bill of £272 per person. This figure is based on existing UK homes (the majority of which would not pass current Building Regulations) and hence is not representative of new homes which have higher insulation levels.

Instead, the personal budget data for the 'new-build' Scenarios 1, 2 and 3 are based on DTI published standard energy unit costs of 1.64p/kwh for gas and 7.23p/kwh for electricity, these figures being inclusive of standing charges and averaged for credit and direct debit payment methods. The calculation for Scenario 4 is based on the energy costs that are charged at BedZED, these equating to 2.5p/kwh for hot water/space heating and electricity charges of 6.41p/kwh with a standing charge of 6.4p/day. Using these figures, annual energy bills are predicted as £197/person for Scenario 1, £127/person for Scenarios 2 and 3, and £103/person for Scenario 4. The financial savings for residents living in Scenario 4 are proportionally not as great as those indicated in the energy demand savings for two reasons:

- in the current UK market, the cost of producing energy from renewable sources is slightly higher than from conventional fossil fuel sources; this is primarily because of the R&D costs and small market share; and
- the unit costs for Scenario 4 are based on the 82-home BedZED development which is sized towards the minimum community size for CHP viability. Larger-scale mixed-use communities in the Thames Gateway would be ideally suited to CHP energy strategies and should prove financially competitive and more comparable to conventional energy sources.

It should also be noted that the UK energy market is slowly changing and that the industry will be forced to increase the amount of energy derived from renewable sources in the future. As 'green' energy develops a greater share of the market and fossil fuel energy becomes more difficult and expensive to produce, the financial balance will tip in favour of renewable energy. The homes that are planned for the Thames Gateway will still be standing and occupied 60+ years from now when the energy market will most likely be very different. Building communities today with integrated sustainable energy strategies will hopefully future-proof the development and will return increased financial savings to residents in the future.

## Transport

ISSUE	Scenario 1 Typical UK resident in typical new UK home to 2002 Building Regulations	Scenario 2 Typical UK resident in typical new UK home to EcoHomes 'Very Good'	Scenario 3 Environmentally-aware resident In typical new UK home to EcoHomes 'Very Good'	Scenario 4 Z <sup>2</sup> : Zero fossil energy, zero waste community
Transport	<ul style="list-style-type: none"> <li>Average UK travel pattern</li> <li>No home office</li> </ul>	<ul style="list-style-type: none"> <li>Lower private car use</li> <li>Home office</li> <li>5% overall journey reduction</li> <li>10% reduction in private car use</li> </ul>	<ul style="list-style-type: none"> <li>Resident is a member of a car club</li> <li>Sometimes works from home</li> <li>20% overall journey reduction</li> <li>40% lower car use</li> </ul>	<ul style="list-style-type: none"> <li>Sustainable Travel packages</li> <li>40% overall journey reduction</li> <li>Majority of journeys by foot/cycle</li> <li>85% reduction in car miles, no private fossil fuel miles, all via car club</li> <li>Home office &amp; local employment</li> </ul>
EF	<b>0.564</b> gha <sup>(A)</sup>	<b>0.524</b> gha <sup>(A)</sup> <b>-7%</b>	<b>0.463</b> gha <sup>(F)</sup> <b>-18%</b>	<b>0.148</b> gha <sup>(A)</sup> <b>-74%</b>
CO <sub>2</sub>	<b>2.123</b> tonnes/person/annum <sup>(A)</sup>	<b>1.972</b> tonnes/person/annum <sup>(A)</sup> <b>-7%</b>	<b>1.741</b> tonnes/person/annum <sup>(F)</sup> <b>-18%</b>	<b>0.551</b> tonnes/person/annum <sup>(A)</sup> <b>-74%</b>
Capital costs	<b>£172</b> /person/annum <sup>(B)</sup> Roads, local transport and (inter) national rail	<b>£172</b> /person/annum <sup>(C)</sup> Lower spending on roads Higher on public trans.	<b>£172</b> /person/annum <sup>(C)</sup> Lower spending on roads Higher on public trans.	<b>£172</b> /person/annum <sup>(C)</sup> Lower spending on roads Higher on public trans.
Personal budget	<b>£1635</b> /person/annum <sup>(D)</sup>	<b>£1595</b> /person/annum <sup>(E)</sup> <b>-3%</b>	<b>£1817</b> /person/annum <sup>(E)</sup> <b>+11%</b>	<b>£1113</b> /person/annum <sup>(E)</sup> <b>-32%</b>

(A) - Figure calculated by SEI (EF and CO2 figures for Scenario 3 have been reduced to represent minimal air travel)

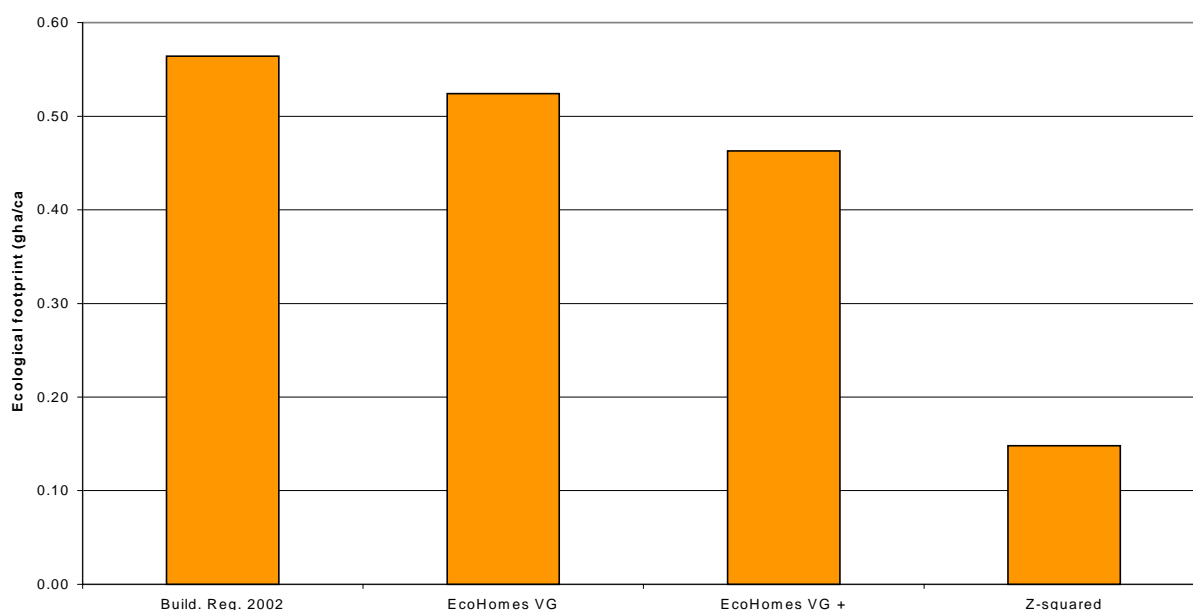
(B) - Figure calculated by BDG from *HM Treasury estimated figures for total managed expenditure 2001-02*

(C) - Figure estimated by BDG based on Fulcrum Consulting estimates and HM Treasury figures

(D) - Figure calculated by BDG from *National Statistics Family Spending report 2001/2002*

(E) - Figure calculated by BDG

(F) - Figure interpolated by BDG from SEI data



**Chart 2:** EF associated with the transport demands of residents living in the different Scenarios

### Scenario Data

The energy use and emissions levels associated with transport greatly depend on the relative location of home, place of work, shops and other amenities, as well as the availability of car parking and types of vehicles used. By reducing the length of common journeys and by encouraging the use of public transport over the private car, CO<sub>2</sub> emissions and energy use can be substantially reduced.

In areas of high transport, congestion, noise and airborne pollution can become problems and adversely affect the wellbeing and quality of life for local residents. The disturbance caused by transport and the potential for accidents can also be reduced. In addition, these health implications have associated financial and environmental impacts resulting from the increased levels of healthcare needed. BioRegional has worked with a health consultant, Dr Robin Stott, regarding this matter and other health benefits of living in sustainable communities. His comments are to be found in Appendix 1.

The data-set for Scenario 1 is taken from UK average travel data in the *2001 Travel Survey* compiled by the Department for Transport (DfT). It represents the typical travel pattern including total distances travelled by different modes of transport.

EcoHomes rewards building developments with safe and convenient access to local amenities and public transport, and it is assumed that compact city form masterplanning principles would provide such access under Scenarios 2 and 3. The provision of home office space is acknowledged as a means of reducing commuting requirements and associated environmental impact. Secure storage for bicycles is also rewarded. For Scenario 2, BioRegional has estimated that the provision of some of these facilities could result in a reduction in the total amount of journeys made (5 per cent less) and the percentage of those undertaken in a private car (10 per cent less). Scenario 3 is based on residents working from home where possible and being a member of a car club to negate the need for a second household vehicle. A Scenario 3 resident would also walk or cycle for most day-to-day short journeys.

The transport strategy for Z<sup>2</sup> communities under Scenario 4 would be based around a green travel plan which would be formulated at an early stage to form an integral part of the design methodology. The communities would be developed using compact city principles comprising dense mixed-use urban areas offering homes, workspace and shared facilities within easy access of each other. This masterplanning strategy would be expected to deliver a 40 per cent overall journey reduction and facilitate walking and cycling as the main means of day-to-day transport.

The strategy for meeting travel demands in Scenario 4 is based around the provision of 'mobility packages'. Cars provide so-called 'mobility insurance', but once people have purchased a car they tend to use it for all journeys. Cars enable freedom and flexibility in travel and although many journeys are unnecessary, there are some for which a car is the only practical option.

Z<sup>2</sup> residents will be able to join car clubs. The service allows them to hire a car by the hour when they need one, thereby providing mobility insurance without the need to own a car. Car clubs provide a variety of vehicle sizes to suit differing requirements and can empower the majority of people who do not have access to a private car. For financial reasons, car clubs work most successfully in mixed-use developments which offer primarily business use during the day and private use in the evenings and at weekends to keep utilisation rates high.

A car club is successfully in operation at BedZED (in partnership with Smart Moves) and there is an increasing number of similar clubs being set up across the capital by London City Car Clubs. BioRegional believes that the strategy is equally applicable for larger scale communities where

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clubs would be located in individual neighbourhoods as part of a region-wide network. At BedZED, local train operators have agreed to offer discounted season tickets and travel incentives to car club members. When this is coordinated with safe cycle routes and storage facilities, 'mobility packages' can be developed enabling residents to make a variety of journeys by sustainable means, combining different modes of transport when necessary.

### ***Ecological Footprint and Carbon Dioxide emissions***

In the UK, transporting people between buildings accounted for 22 per cent of national energy use in 1996. Overall car traffic has increased almost 15 times in the last 50 years and CO<sub>2</sub> emissions due to transport are growing at roughly 4 per cent each year. These increases are primarily due to the rise in personal transport, but also freight transport (about half of which transports construction materials) which is responsible for 10 per cent of UK energy use.

To calculate the environmental impact of travel, data concerning the emissions of greenhouse gases, the energy requirements of manufacturing and maintenance, the fuel consumption and the land area occupied by roads are collected.

The ecological footprint (EF) and CO<sub>2</sub> figures for this section illustrate that a saving of approximately three-quarters can be made through addressing sustainable transport when comparing Scenario 4 with Scenario 1. This is based on a Scenario 4 resident making the most of the 'mobility packages' made available and choosing to fly less than average. Air travel has a very high environmental impact and if average flight pattern data is included for Scenario 4, the EF and CO<sub>2</sub> savings drop to nearer 60 per cent.

The figures for Scenario 2 and 3 (7 per cent and 18 per cent savings for EF/CO<sub>2</sub> compared with a typical UK resident) demonstrate that using public transport instead of a car can result in some environmental savings. The environmental impact per kilometre travelled for a car is approximately 2.5 times higher than for the train and 1.5 times higher than for bus travel.

The car club at BedZED includes a dual-fuelled car, using alternative fuels such as LPG can help to reduce the environmental impact of driving. The car clubs in Z<sup>2</sup> communities in Scenario 4 would form an integral part of the 'mobility packages' and could offer access to conventionally fuelled and hybrid club cars. These fleets could be augmented by electric vehicles in the future as the associated technology moves into the mainstream. Powering vehicles with electricity which has been derived from renewable sources reduces the environmental impact further still.

### ***Personal budget***

Data from the government-produced *National Statistics Family Spending report 2001/2002* states that the average weekly household bill for transport (including the purchase of vehicles, associated running costs, insurance and public spending on transport) is approximately £81 in the South-east, which suggests (using the DEFRA average figure of 2.33 people per household in the UK) an annual bill of £1,635 per person.

The costs associated with the travel patterns identified in Scenario 2 are estimated as £1,595 per person per annum. This has been calculated using percentage reductions of the National Statistics spending data based on the reduced travel needs and lower private car use identified in Scenario 2. The financial savings (3 per cent) are smaller than the EF savings (7 per cent) because proportionately, mile for mile, the prices paid for using public transport compared with private vehicles do not reflect the environmental benefits. For Scenario 3 the personal budget is slightly increased to an estimated £1,817 because of the greater public transport spending and

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the assumption that although one person in each household is a car club member, private car ownership may only be reduced to one car per household.

Despite some increases in public transport expenditure, a resident living in Scenario 4 would appear to spend less on transport (£1113/person/annum). These costs have been calculated using rates based on National Statistics data and costs based on existing car clubs at BedZED and across London and the South-east. Joining a car club can clearly save residents money as members do not have the cost of purchasing and keeping a car on the road. Furthermore, at BedZED (and the Z<sup>2</sup> communities) none of the units have allocated parking and although residents can choose to buy a parking permit, this is priced at around twice the cost of joining the car club. It should be emphasised that the success of car clubs is very much dependent on having strict on-site parking restrictions for private vehicles.

### ***Government capital spending***

The expenditure figures detailed above only consider the financial outlay by residents as part of their household budget and do not consider the amount of money raised via taxes and spent by the government on our behalf on shared transport infrastructure and subsidies. Treasury figures indicate that total managed expenditure on transport by the government in 2001-02 was estimated at more than £10 billion, which equates to approximately £172 per person per year based on a UK population of 58.79 million. Further analysis of the Treasury figures suggests annual spending on roads of £99/person/year, local transport of £32/person/year and national/international rail of £28/person/year.

In the table above, the costs for Scenarios 2, 3 and 4 have been maintained at the same level of £172 per person per annum. The aim of this study is not necessarily to demonstrate how the government could make savings in its expenditure on developing Thames Gateway (although this may prove to be the case), but to illustrate how environmental benefits and government sustainable development and energy targets can be met using the same budget.

There will be additional costs to both the taxpayer and the private sector to pay for the amount of new major transport infrastructure that will be required to enable the development of the Thames Gateway. Estimates of the amount of money required are discussed in the 'Shared infrastructure' section.

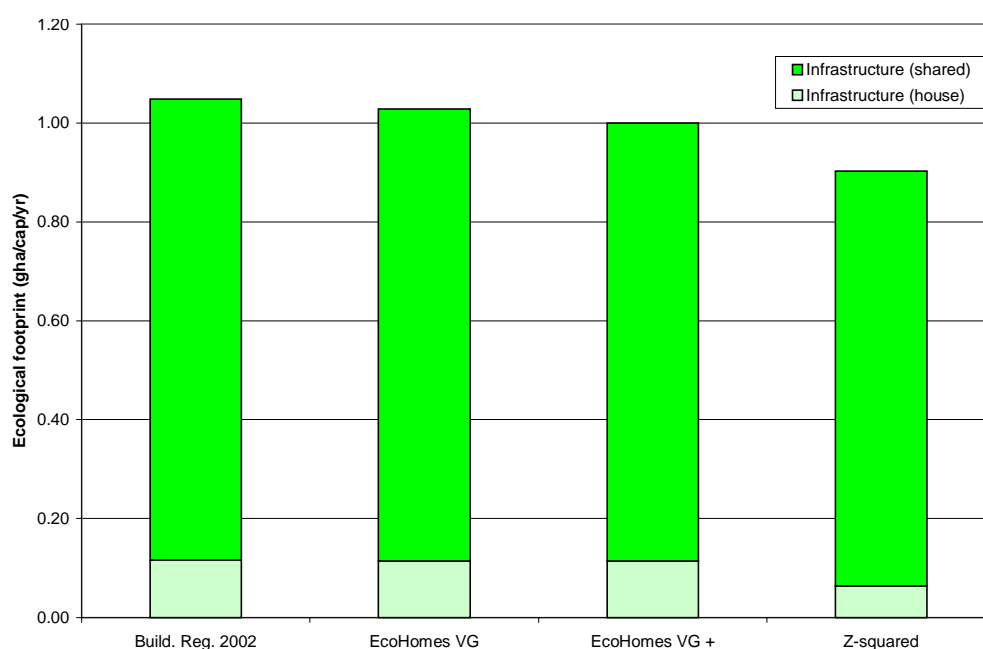
## House Infrastructure

ISSUE	Scenario 1 Typical UK resident in typical new UK home to 2002 Building Regulations	Scenario 2 Typical UK resident in typical new UK home to EcoHomes 'Very Good'	Scenario 3 Environmentally-aware resident in typical new UK home to EcoHomes 'Very Good'	Scenario 4 Z <sup>2</sup> : Zero fossil energy, zero waste community
House	<ul style="list-style-type: none"> <li>Typical UK new home construction</li> </ul>	<ul style="list-style-type: none"> <li>Typical UK new home construction, with more insulation and materials with lower environmental impacts</li> </ul>	<ul style="list-style-type: none"> <li>As Scenario 2</li> </ul>	<ul style="list-style-type: none"> <li>ZED-type homes</li> <li>Similar embodied energy to typical UK new home construction, but with much more insulation and more inert materials. Reclaimed, recycled and locally sourced materials extensively used</li> </ul>
EF	<b>0.116</b> <sub>gha<sup>(A)</sup></sub>	<b>0.114</b> <sub>gha<sup>(A)</sup></sub> <b>-2%</b>	<b>0.114</b> <sub>gha<sup>(A)</sup></sub> <b>-2%</b>	<b>0.064</b> <sub>gha<sup>(A)</sup></sub> <b>-45%</b>
CO <sub>2</sub>	<b>0.306</b> tonnes/person/annum <sup>(A)</sup>	<b>0.278</b> tonnes/person/annum <sup>(A)</sup> <b>-9%</b>	<b>0.278</b> tonnes/person/annum <sup>(A)</sup> <b>-9%</b>	<b>0.168</b> tonnes/person/annum <sup>(A)</sup> <b>-45%</b>
Capital costs	<b>£100,000</b> net build costs to developer <sup>(C)</sup>	<b>£101,000</b> net build costs to developer <sup>(C)</sup> <b>+1%</b>	<b>£101,000</b> net build costs to developer <sup>(C)</sup> <b>+1%</b>	<b>£105,000</b> net build costs to developer <sup>(C)</sup> <b>+5%</b>
Personal budget	<b>£3013</b> /person/annum <sup>(B)</sup>	<b>£3043</b> /person/annum <sup>(C)</sup> <b>+1%</b>	<b>£3043</b> /person/annum <sup>(C)</sup> <b>+1%</b>	<b>£3162</b> /person/annum <sup>(C)</sup> <b>+5%</b>

<sup>(A)</sup> - Figure calculated by SEI

<sup>(B)</sup> - Figure calculated by BDG from *National Statistics Family Spending report 2001/2002*

<sup>(C)</sup> - Figure calculated by BDG



**Chart 3:** EF associated with Infrastructure requirements of living in the different Scenarios

### **Scenario Data**

This section considers the materials that are used in the construction of dwellings, the costs of building them and the purchase costs to residents. There is a lack of published information regarding the quantities and types of materials incorporated in the average home, although more accurate data would assist the calculations, BioRegional anticipates that the percentage savings indicated in this section are broadly representative. The materials that are used for landscaping and external works are generally not included in this section, but are accounted for in the 'Shared infrastructure' section below. Data for Scenario 1 is based on BRE information detailing the amounts of construction materials used in a development of 100 typical UK homes.

EcoHomes rewards homes which have u-values<sup>10</sup> in excess of Building Regulation minimum requirements and consequently the homes proposed under Scenarios 2 and 3 contain more insulation and higher specification windows than a typical 'new build' home. The EcoHomes scheme also assesses the materials that are used in terms of environmental impact and credits the use of components with low impact. The majority of the higher scoring material specifications rewarded under the scheme could be broadly classified as 'traditional construction' and hence not substantially different from typical UK new-build. Two exceptions to this are the window frames which are considered to be timber in Scenarios 2 and 3 and uPVC in Scenario 1, and the insulation material specifications which would have zero Ozone Depleting Potential (ODP) in Scenarios 2 and 3.

At BedZED, the materials specification strategy was designed to reduce environmental impact. A policy of sourcing materials locally was developed to reduce the transport impact of the materials, 52 per cent were sourced within a 56km radius. Large quantities of reclaimed and recycled materials were also specified at BedZED to reduce the amount of finite virgin materials used and to further lessen the environmental impact through reduced haulage. A similar strategy could be employed for the homes built under Scenario 4. Since undertaking BedZED, the market in reclaimed and recycled construction materials has grown and has been enhanced through better guidance and legislation, BioRegional believes that targets for the specification of non-virgin material in Scenario 4 could exceed those set at BedZED.

### **Ecological Footprint and Carbon Dioxide emissions**

The ecological footprints and CO<sub>2</sub> emissions for Scenarios 1, 2 and 3 are broadly similar because of the minor differences in the amount and type of materials used. The minor savings indicated are primarily associated with the increased amount of insulation used offset by the specification of zero ODP materials and timber windows.

ZED homes are specified and constructed with a design life of 120 years compared with the typical value of 60 years in the UK. This strategy facilitates a reduction in the EF for Scenario 4, because the environmental impact of the materials incorporated in each home (although comparable overall) is divided by twice the amount of time, the impact is halved. If the homes built under Scenario 4 were constructed with 60 lifespans equal to those under Scenarios 1, 2 and 3, then the associated EF would be slightly higher. ZED-type developments contain slightly more construction materials than would be used in a more conventional home, in particular glazing, insulation and mass for thermal reasons. However, the environmental impact is tempered by the local sourcing policy and high use of reclaimed and recycled building materials which have lower embodied energy values.

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<sup>10</sup> U values (overall coefficient of heat transmission) indicate the heat flow through materials. The values vary for each particular material and method of construction; lower u-values indicate better insulating properties.

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The Stockholm Environment Institute (SEI) noted in its calculations that despite the local sourcing policy of the BedZED development, this does not seem to be reflected in terms of tonne-kilometres and no notable reduction in the transport component EF was calculated. However, SEI indicated that there might be an under-estimation of the real transport distances for other scenarios as national average figures had to be applied due to a lack of more specific data. BRE analysis of the materials used at BedZED has found that the total amount of embodied CO<sub>2</sub> per home is comparable to that of a typical new UK home.

### Government spending

For the purposes of this comparison, typical costs for new build dwellings have been assumed based on construction industry data. The figure used for Scenario 1 is £1,000/m<sup>2</sup>. Data from *Sustainable Homes*, the Housing Corporation-funded initiative aimed at promoting sustainability in the social housing sector, indicates that achieving EcoHomes 'Very Good' adds between £1,430 and £1,680 (depending on location issues) to the build costs of a standard specification housing association dwelling built to current Scheme Development Standards SDS2002<sup>11</sup>. These figures do not include the costs associated with undertaking the assessment. Although it could be argued that private sector homes are generally of a lower quality specification in terms of sustainability and may therefore cost more to achieve 'Very Good', there is a lack of available data to support an alternative calculation. For the purposes of this study, it is assumed that 2 per cent (around £2,000) is added to the build costs.

The build costs for Scenario 4 homes are assumed to be approximately 10 per cent higher than conventional build costs (i.e. £1,100/m<sup>2</sup>). This is based on the BedZED model and is reflective of the higher costs due to greater levels of airtightness, constructional complexities of high-density design and the specification of high performance components. Specification choices associated with the use of local, recycled and reclaimed materials proved to be cost-neutral overall and even cost beneficial in some cases. It is anticipated that for a larger ZED-type development, of the scale proposed for Thames Gateway, it would be possible to reduce the build costs to a level comparable with traditional domestic rates. This would be enabled through further refining and rationalising of design details, reducing component and material costs through bulk purchasing and generic efficiency gains that come from large-scale developments and increased repetition.

For Scenarios 2, 3 and 4 in this model, it is assumed that the requirement for meeting certain environmental targets would be made a planning condition of the site, namely EcoHomes 'Very Good' for Scenario 2 and Z<sup>2</sup> for Scenario 4. In both situations, it has been assumed that 50 per cent of the extra build costs associated with meeting these higher specifications would be recouped by the developer via planning gain. This is a mechanism under which a developer is permitted increased development by the local authority in exchange for meeting agreed environmental targets and can reduce transport infrastructure and parking provision as part of a green transport strategy. The remaining 50 per cent of the extra costs would be passed onto the consumer in the purchase price of the home. Hence, the scenario costs would be:

Scenario	Build cost	% above standard	% of extra met through planning gain	Net % above standard	Net build cost
1	£1000/m <sup>2</sup>	-	-	-	£1000/m <sup>2</sup>
2/3	£1020/m <sup>2</sup>	2%	50%	1%	£1010/m <sup>2</sup>
4	£1100/m <sup>2</sup>	10%	50%	5%	£1050/m <sup>2</sup>

For the purposes of this study the average new dwelling size is considered to be 100m<sup>2</sup>.

<sup>11</sup> Figure supplied by Sustainable Homes. *EcoHomes Costings*, e<sup>2</sup>S environmental consultants, December 2002

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### **Personal budget**

As stated above, it has been assumed that half of the extra build costs incurred for Scenarios 2, 3 and 4 would be borne by the consumer in the form of higher property purchase prices. It has been assumed for this study that this extra cost to the resident would be borrowed as part of their mortgage. Figures from [www.money.net.co.uk](http://www.money.net.co.uk) suggest that the average mortgage value in the UK is £94,200 (September 2002). Figures for the average UK mortgage value for new properties in the South-east would be beneficial to the accuracy of the study, but at the time of writing such data could not be sourced. BioRegional feels that the simple proportional cost implications calculated are adequate for this study. In the table below, repayments are based on an interest rate of 5.5 per cent over 25 years.

Scenario	% above standard	Estimated mortgage	Monthly payments per household	Annual payments per resident
1	-	£94,200	£585	£3,013
2/3	1%	£95,142	£591	£3,043
4	5%	£98,910	£614	£3,162

## Shared Infrastructure

ISSUE	Scenario 1 Typical UK resident in typical new UK home to 2002 Building Regulations	Scenario 2 Typical UK resident in typical new UK home to EcoHomes 'Very Good'	Scenario 3 Environmentally-aware resident In typical new UK home to EcoHomes 'Very Good'	Scenario 4 Z <sup>2</sup> : Zero fossil energy, zero waste community
Shared Infrastructure	<ul style="list-style-type: none"> <li>Current levels of infrastructure shared equally</li> </ul>	<ul style="list-style-type: none"> <li>Reduced transport and energy infrastructure</li> <li>Less waste landfill, but some more waste processing infrastructure</li> <li>Reduced water processing infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>Reduced transport and energy Infrastructure</li> <li>Less waste landfill, but some more waste processing infrastructure</li> <li>Reduced water processing infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>Further reduced transport and energy infrastructure</li> <li>Even less waste landfill, with some more waste processing infrastructure</li> <li>Further reduced water processing infrastructure</li> <li>Reduced material extraction and transport infrastructure, increased material recycling and reclaiming facilities</li> <li>Fewer airports and infrastructure associated with air-freighted imported goods</li> </ul>
EF	<b>0.932</b> <sub>gha<sup>(A)</sup></sub>	<b>0.914</b> <sub>gha<sup>(A)</sup></sub> <b>-2%</b>	<b>0.885</b> <sub>gha<sup>(B)</sup></sub> <b>-5%</b>	<b>0.839</b> <sub>gha<sup>(A)</sup></sub> <b>-10%</b>
CO <sub>2</sub>	<b>2.426</b> tonnes/person/annum <sup>(A)</sup>	<b>2.377</b> tonnes/person/annum <sup>(A)</sup> <b>-2%</b>	<b>2.305</b> tonnes/person/annum <sup>(B)</sup> <b>-5%</b>	<b>2.183</b> tonnes/person/annum <sup>(A)</sup> <b>-10%</b>
Capital costs	<b>£2575</b> /person/annum over 20 years <sup>(B)</sup> <b>£1.2b</b> /annum over 20 years <sup>(B)</sup>	<b>£2524</b> /person/annum over 20 years <sup>(B)</sup> <b>-2%</b>	<b>£2446</b> /person/annum over 20 years <sup>(B)</sup> <b>-5%</b>	<b>£2138</b> /person/annum over 20 years <sup>(B)</sup> <b>-10%</b>

<sup>(A)</sup> - Figure calculated by SEI

<sup>(B)</sup> - Figure estimated by BDG

### Scenario Data

While the previous section considers the infrastructure directly attributed to the fabric of the homes, this section addresses the remaining 'shared' constructed infrastructure including buildings, roads, bridges, warehouses etc. Gathering data and calculating any savings between the different scenarios is both complex and complicated, this is primarily due to the lack of data available and the inherent complexities of calculating any savings in shared infrastructure implied through living more sustainable lives in sustainable homes. The assumptions made for each of the three scenarios are summarised in the text and table below.

Scenario 1 is based on providing the proposed communities in the Thames Gateway with the level and quantity of shared infrastructure that would be considered 'typical' for new developments in the South-east of England. This scenario would also include large-scale new transport and flood protection infrastructure required for the Thames Gateway.

For Scenarios 2 and 3, estimates have been made on the reductions in shared infrastructure that could be achieved through building communities of dwellings meeting EcoHomes 'Very Good'. These savings are primarily going to be related to reduced transport and energy infrastructure which are facilitated through reducing demand. For Scenario 3 specifically, further savings are calculated for the 'transport', 'consumer items' and 'shared services' sections because of further lifestyle choices by residents. The Thames Gateway community under

Scenario 4 would include strategies for sustainable living which suggest savings could be made in several aspects of ‘shared’ infrastructure including transport, energy, water and waste.

The left-hand column of the table below gives an indication of the relative size of each of the identified shared infrastructure sub-sectors as a percentage of the total UK construction sector. This data is based on DETR information produced on the types of construction work undertaken (percentage by value) in the UK in 1998. The data indicates that approximately a quarter of construction work in that year in the UK was for the housing sector. This information is quoted in the *Construction Industry Mass Balance* report produced by CIRIA and Viridis within the Biffaward programme on sustainable resource use (Smith et al. 2002). This report further concludes that material resources incorporated into the built environment in 1998 totalled 363.4 Mt. Due to the limited resources of this study, a correlation is assumed between the size of a particular sub-section of the construction sector by value with the associated amount of resources consumed by it.

% of total construction sector	Shared infrastructure	Estimated infrastructure (mass) savings over Scenario 1		
		Scenario 2	Scenario 3	Scenario 4
4% (source: DETR)	<b>Energy:</b> Number, type and size of power stations and supply infrastructure	<b>-15%</b> <sup>(A)</sup> (Based on reduced energy demands)	<b>-15%</b> <sup>(A)</sup> (As Scenario 2)	<b>-25%</b> <sup>(B)</sup> (Based on reduced energy demands, but with higher amounts of local infrastructure)
7.3% (source: DETR)	<b>Transport:</b> Amount of roads, garages, petrol stations, bridges, car parks, airports, cycle paths etc	<b>-2%</b> <sup>(A)</sup> (Based on overall journey demand reduction, assume same number of routes but lower spec.)	<b>-10%</b> <sup>(A)</sup> (Based on overall journey demand reduction, assume same number of routes but lower spec.)	<b>-40%</b> <sup>(B)</sup> (Based on overall journey demand reduction, assume same number of routes but lower spec. Plus less airports & roads for transport of goods & food)
5.5% (DETR data suggests total for ‘Factories’ and ‘Warehouses’ of 10.9%, assume 50% relates to food and consumer goods)	<b>Food &amp; consumer goods:</b> Number and size of Regional Distribution Centres and processing facilities	<b>0%</b> <sup>(A)</sup> (Unchanged)	<b>-5%</b> <sup>(A)</sup> (Reduced overall consumption and increased local and organic food)	<b>-10%</b> <sup>(A)</sup> (Less imported food and reduced ‘food miles’ reduces storage and transport infrastructure)
6.2% (source: DETR)	<b>Water:</b> Number and size of water processing facilities and supply infrastructure	<b>-20%</b> <sup>(A)</sup> (Based on reduced water demand)	<b>-20%</b> <sup>(A)</sup> (As Scenario 2)	<b>-70%</b> <sup>(B)</sup> (Based on reduced water demands, with increased local infrastructure)
	<b>Rainwater:</b> Amount of rainwater drainage and infrastructure	<b>0%</b> <sup>(A)</sup> (Unchanged)	<b>0%</b> <sup>(A)</sup> (As Scenario 2)	<b>-10%</b> <sup>(A)</sup> (Reduced underground infrastructure offset against rainwater harvesting infrastructure)
2% (source: BDG estimate)	<b>Waste:</b> Number, type and size of recycling and waste-to-energy facilities, area of landfill	<b>0%</b> <sup>(A)</sup> (Recycling increased hence less landfill infrastructure, offset against increased recycling facilities)	<b>+2%</b> <sup>(A)</sup> (Recycling increased hence less landfill infrastructure, offset against increased recycling facilities)	<b>+5%</b> <sup>(B)</sup> (Waste reduced, recycling increased hence less landfill infrastructure, offset against increased recycling and reclamation facilities)
5.2% (source: DETR)	<b>Health:</b> Number, type and size of health facilities	<b>0%</b> <sup>(A)</sup> (Although increased exercise through walking and cycling may increase social health levels, there is no evidence of translation into infrastructure reductions)	<b>0%</b> <sup>(A)</sup> (As Scenario 2)	<b>0%</b> <sup>(A)</sup> (Although increased exercise through walking and cycling may increase social health levels, there is no evidence of translation into infrastructure reductions)
31.4% (source: DETR)	<b>Other shared services:</b> Shops, entertainment and offices	<b>0%</b> <sup>(A)</sup> (Reductions in consumption and general lifestyle changes not considered to be great enough to equate to a saving)	<b>-10%</b> <sup>(A)</sup> (Estimated saving based on reductions in consumption and general lifestyle changes)	<b>-10%</b> <sup>(A)</sup> (Estimated saving based on reductions in consumption and general lifestyle changes)
61.6%	<b>Total considered:</b> Estimate of total infrastructure saving	<b>-2%</b>	<b>-5%</b>	<b>-10%</b>

<sup>(A)</sup> - Figure estimated by BDG

<sup>(B)</sup> – Figure based on calculations by Fulcrum consulting

### ***Ecological Footprint and Carbon Dioxide emissions***

As mentioned previously, calculating the environmental impact of shared infrastructure is complicated by the lack of available source data. For this study the Stockholm Environment Institute has used PRODCOM (PROducts of the European COMmunity statistics) data to deduce an EF figure of 0.932gha/cap/annum and CO<sub>2</sub> figure of 2.426 tonnes/person/annum as the benchmark values for Scenario 1.

Linear and proportional reductions have been assumed for both the EF and CO<sub>2</sub> components for the other scenarios. This is based on the percentage decreases in mass of materials incorporated into shared infrastructure as suggested in the table above with an additional saving of 2 per cent added to Scenario 4 for EF, CO<sub>2</sub> and cost estimates to account for the use of local, reclaimed and recycled materials in the shared infrastructure.

### ***Government spending***

There is scarce publicly available data on the anticipated costs of building the infrastructure required to facilitate the development of the Thames Gateway. Some of the available data and estimates are indicated below, with a rationale for the figures used in this study.

- the Environment Agency (EA) anticipates the costs of improving flood protection to the Thames and defending the Thames Gateway could be approximately £4billion; and
- government figures regarding the expected infrastructure costs total £1.2 billion with only a 3 per cent government contribution towards the total crossrail costs of £5.5billion

Thames Gateway Kent Partnership has produced figures regarding the public sector costs of delivering the North Kent Area Investment Framework (AIF) as part of the overall Thames Gateway redevelopment. The figures are indicated briefly below and are used as the basis for developing estimates for the 200,000 homes proposed as part of the Thames Gateway. The base assumptions regarding the level of investment required to achieve the objectives set out in the North Kent AIF are:

- 56,000 net increase in North Kent's population;
- 2.5 million m<sup>2</sup> of additional floor space;
- 84,000 new job opportunities that are taken up by North Kent residents; and
- 45,000 new dwellings that will accommodate some 104,000 people.

This model has been used to estimate very approximate public spending implications for this section. The extract below is taken from [www.thamesgateway-kent.org.uk](http://www.thamesgateway-kent.org.uk)

*“We estimate that the total gross additional public investment required in North Kent, over the period 2002-2021, to achieve the objectives set out in the North Kent AIF is around £11.6 billion. This is equivalent to additional annual expenditure averaging around £580 million p.a. over a period of 20 years.*

*The net cost to the public sector is likely to be considerably lower because of expected private sector contributions to the cost of development sites, new housing and other key projects. After taking these contributions into account, we estimate that the net additional cost to the public sector will be reduced from a gross figure of £11.6 billion to a net **£4.3 billion or around £215 million p.a. over a 20-year period**. There are also likely to be a number of development gains such as lower social security and higher receipts from business rates. If these are included, then*

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*the cost of the North Kent AIF to the public sector is likely to fall further to £2.1 billion or £210 million p.a.*

*This equates to a per capita spend of some £4,500 p.a. (an increase of £230 per person p.a. over a 20-year period on the current level of expenditure of £4,300 per capita p.a.). This level of per capital investment would still be below the estimate of £5,000 average per capita spending in other UK regeneration areas.”*

Using the TGKP model, a very approximate estimate for public sector expenditure associated with the planned 200,000 homes in the Thames Gateway can be suggested. The calculation assumes the same proportions of floor space created and jobs created, but does not take account of any particular key projects (e.g. transport links and flood defences):

North Kent AIF	£215 million / 45,000 homes	= <b>£4,778</b> per home
Thames Gateway	200,000 homes x £4,778/home	= <b>£955m</b> per annum over 20 years

If an estimate for specific transport and flood prevention infrastructure is added:

Flood prevention (see EA estimate above)	£4 billion	= <b>£200m</b> per annum over 20 years
Transport infrastructure (see above)	£1.2 billion	= <b>£60m</b> per annum over 20 years

<b>Total</b>	<b>£24.3 billion</b>	<b>= £1.2 billion per annum</b>
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In the calculations above, the costs for Scenarios 2, 3 and 4 have been reduced based crudely on the percentage infrastructure materials savings. Alternatively, public spending could be maintained at the same level of £2,575 per person per annum over 20 years. The aim of this study is not primarily to demonstrate how the government could make savings in its expenditure on developing Thames Gateway, although this may prove to be the case, but to illustrate how environmental benefits and government sustainable development and energy targets could be met using the same budget.

## Waste and Consumer items

ISSUE	Scenario 1 Typical UK resident in typical new UK home to 2002 Building Regulations	Scenario 2 Typical UK resident in typical new UK home to EcoHomes 'Very Good'	Scenario 3 Environmentally-aware resident in typical new UK home to EcoHomes 'Very Good'	Scenario 4 Z <sup>2</sup> : Zero fossil energy, zero waste community
Waste	<ul style="list-style-type: none"> <li>Average UK consumption</li> <li>Average UK domestic waste production of 520 kg/person/year</li> <li>Typical recycling rate of 12%</li> <li>79% landfill and 9% incineration</li> </ul>	<ul style="list-style-type: none"> <li>Average UK consumption</li> <li>Average UK waste production of 520 kg/person/year</li> <li>25% higher recycling levels of 15.5%</li> </ul>	<ul style="list-style-type: none"> <li>Consumption reduced by 15% via lifestyle</li> <li>Waste levels reduced by 15%</li> <li>25% of domestic waste recycled or composted</li> <li>70% landfill and 5% incinerated</li> </ul>	<ul style="list-style-type: none"> <li>Promotion of reclaimed and recycled goods.</li> <li>25% reduced consumption</li> <li>25% overall less waste</li> <li>25% of which is recycled</li> <li>25% of which is composted</li> <li>25% of which is converted to energy via gasification CHP</li> <li>25% of which is sent to landfill</li> </ul>
Tonnes sent to landfill	<b>957</b> kg/household/year <sup>(A)</sup>	<b>920</b> kg/household/year <sup>(A)</sup> <b>-4%</b>	<b>720</b> kg/household/year <sup>(A)</sup> <b>-25%</b>	<b>227</b> kg/household/year <sup>(A)</sup> <b>-76%</b>
EF	<b>0.898</b> gha <sup>(B)</sup>	<b>0.885</b> gha <sup>(B)</sup> <b>-2%</b>	<b>0.763</b> gha <sup>(E)</sup> <b>-15%</b>	<b>0.403</b> gha <sup>(B)</sup> <b>-55%</b>
CO <sub>2</sub>	<b>1.628</b> tonnes/person/annum <sup>(B)</sup>	<b>1.613</b> tonnes/person/annum <sup>(B)</sup> <b>-1%</b>	<b>1.465</b> tonnes/person/annum <sup>(E)</sup> <b>-10%</b>	<b>1.014</b> tonnes/person/annum <sup>(B)</sup> <b>-38%</b>
Personal budget – waste disposal	<b>£22</b> /person/annum <sup>(D)</sup>	<b>£25</b> /person/annum <sup>(D)</sup> <b>+14%</b>	<b>£28</b> /person/annum <sup>(D)</sup> <b>+27%</b>	<b>£34</b> /person/annum <sup>(F)</sup> <b>+60%</b>
Personal budget – Consumer goods	<b>£2410</b> /person/annum <sup>(G)</sup>	<b>£2410</b> /person/annum <sup>(G)</sup> <b>0%</b>	<b>£2049</b> /person/annum <sup>(G)</sup> <b>-15%</b>	<b>£1928</b> /person/annum <sup>(E)</sup> <b>-20%</b>

(A) – BioRegional estimate based on average waste data, BRE EcoHomes data and SEI input

(B) - Figure calculated by SEI

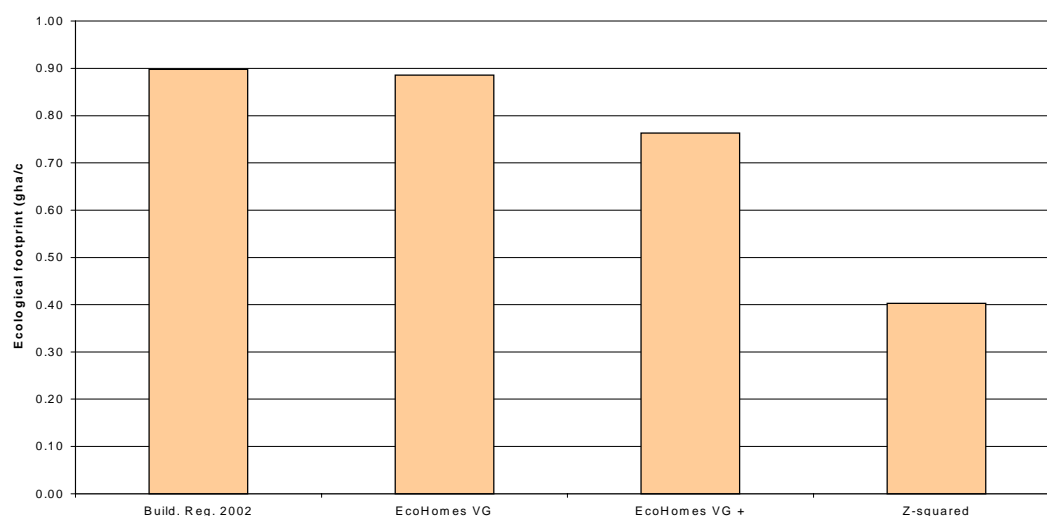
(C) - Figure calculated by BDG

(D) - Figure calculated by BDG from figure of £50/hh/annum from *Waste not, want not*, Strategy Unit November 2002

(E) - Figure estimated by BDG

(F) - Figure calculated by BDG following discussions with Biffa

(G) - Figure calculated by BDG from *National Statistics Family Spending report 2001/2002*



**Chart 4:** EF associated with the materials consumption and waste patterns of residents  
**Scenario Data**

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The data-sets for Scenarios 1 and 2 are broadly the same. They are based on typical UK household waste production levels, but with increased recycling rates for the EcoHomes 'Very Good' Scenario because the scheme rewards the provision of segregated bins in homes to encourage recycling (EcoHomes also awards credits for integration with the local authority's recycling schemes). Scenario 3 is based on a resident reviewing their personal consumption levels to facilitate a reduction of 15 per cent in consumer goods<sup>12</sup> and a corresponding saving in total waste produced. The residents under this scenario also recycle and compost more than their neighbours under Scenario 2, but the remaining waste is still mostly sent to landfill.

For Scenario 4, the waste and recycling strategy is more comprehensive and extends from segregated bins in all kitchens to external bulk bins and integration into the local authority's recycling schemes. There are also on-site composting facilities for organic kitchen waste and local 'waste-to-energy' gasification or pyrolysis combined heat and power plants.

For Scenario 1, the waste management breakdown for England in 2000/01 has been used (i.e. 79 per cent of waste sent to landfill, 9 per cent to incineration and 12 per cent being recycled or composted). For Scenario 2, recycling rates have been increased although overall waste levels remain the same, the rest of the waste going either to landfill (90 per cent of that rest) or to incineration (10 per cent of that rest). For Scenario 3, waste production is reduced and recycling increased. For Scenario 4, a four-quarters strategy has been proposed with 25 per cent of waste being composted, 25 per cent being recycled, 25 per cent being converted into energy and 25 per cent landfilled. Additionally, it has been calculated that an overall reduction in domestic waste levels of one-quarter could be achieved.

### **Ecological Footprint and Carbon Dioxide emissions**

The EF for 'waste and consumer items' has the potential to be reduced considerably through changes in lifestyle and attitudes towards waste implied in the four scenarios. The savings are particularly noticeable for Z<sup>2</sup> residents in Scenario 4 where the measures taken on waste avoidance and recycling result in a 55 per cent overall EF reduction compared to the UK average. This illustrates that shifting perceptions to view waste as a resource can have significant environmental benefits.

The Stockholm Environment Institute notes that with increased recycling rates, the associated EF increases slightly. However, this increase is still far less than the corresponding decrease of the landfill footprint. The EF of incineration is relatively small due to the small amount of materials that are incinerated. It must be stated however, that this depends on the regional waste management strategy and that EF methodology does not take account of pollution.

The most significant reduction in the EF of waste is due to waste avoidance. It can be concluded from this that there is little sense in viewing alternative treatment technologies outside of the wider question of society's pattern of resource consumption, which currently gives rise to a vast amount of waste through ever-increasing consumption levels. Our consumption patterns themselves need to change, because the replacement of one mass disposal method with another will not lead to a sustainable solution.

### **Personal budget**

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<sup>12</sup> Figure for 'personal budget' for consumer goods is based on *National Statistics Family Spending report 2001/2002*. Sections of total household budget taken into account are: 3 – *Clothing & footwear*, 5 – *Household goods and services*, 9 (9.1, 9.2, 9.3, & 9.5 only) *Recreation and culture*, and 12 (12.1 & 12.2 only) *Miscellaneous goods and services*. Data for South east households is used and assumed occupancy of 2.33 residents per household.

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In the *Waste not, want not* report published by the UK government in 2002, it is stated that because of this country's reliance on landfill, householders pay some of the lowest rates for waste collection and disposal in Europe – around £50 per year on average. This figure is approximately half the EU average and about 30 per cent of the rate of high-performing countries.

Figures from Biffa waste management suggest that a 'four-quarters' waste strategy (as discussed above) for a reasonably sized community of at least 100,000 households could be implemented for approximately £80 per household per year (Scenario 4). This highlights the fact that under current market conditions, landfilling waste is not priced in step with the associated environmental impact, or at a price to make people carefully consider alternative ways of managing their unwanted goods and services. For Scenarios 2 and 3, assumptions have been made on small increases in expenditure on waste disposal (via Council Tax payments) to reflect the increased infrastructure and costs currently associated with increased recycling levels.

Costs for the collection and disposal of domestic waste are passed on to residents as part of their Council Tax payments to local government. In the future, as local authorities cope with higher government targets and higher Landfill Tax levels, it is likely that homes will be charged more for their waste sent to landfill and may pay based on the amount they produce.

## Water

ISSUE	Scenario 1 Typical UK resident in typical new UK home to 2002 Building Regulations	Scenario 2 Typical UK resident in typical new UK home to EcoHomes 'Very Good'	Scenario 3 Environmentally-aware resident In typical new UK home to EcoHomes 'Very Good'	Scenario 4 Z <sup>2</sup> : Zero fossil energy, zero waste community
Water	<ul style="list-style-type: none"> <li>Average UK water consumption</li> <li>134 litres/person/day metered water (OFWAT)</li> </ul>	<ul style="list-style-type: none"> <li>low water consumption</li> <li>82 litres/person/day</li> </ul>	<ul style="list-style-type: none"> <li>As Scenario 2a</li> </ul>	<ul style="list-style-type: none"> <li>Very low water consumption 47 litres/person/day</li> <li>On-site grey water processing</li> <li>Rainwater harvesting meets external water demand</li> </ul>
Demand	<b>312</b> litres/household/day <sup>(A)</sup>	<b>191</b> litres/household/day <sup>(B)</sup> <b>-39%</b>	<b>191</b> litres/household/day <sup>(B)</sup> <b>-39%</b>	<b>110</b> litres/household/day <sup>(C)</sup> <b>-65%</b>
EF	<b>0.006</b> gha <sup>(D)</sup>	<b>0.003</b> gha <sup>(D)</sup> <b>-39%</b>	<b>0.003</b> gha <sup>(D)</sup> <b>-39%</b>	<b>0.002</b> gha <sup>(D)</sup> <b>-65%</b>
CO <sub>2</sub>	<b>0.022</b> tonnes/person/annum <sup>(D)</sup>	<b>0.013</b> tonnes/person/annum <sup>(D)</sup> <b>-39%</b>	<b>0.013</b> tonnes/person/annum <sup>(D)</sup> <b>-39%</b>	<b>0.008</b> tonnes/person/annum <sup>(D)</sup> <b>-66%</b>
Personal budget	<b>£113</b> /person/annum <sup>(E)</sup>	<b>£87</b> /person/annum <sup>(E)</sup> <b>-23%</b>	<b>£87</b> /person/annum <sup>(E)</sup> <b>-23%</b>	<b>£74</b> /person/annum <sup>(E)</sup> <b>-35%</b>

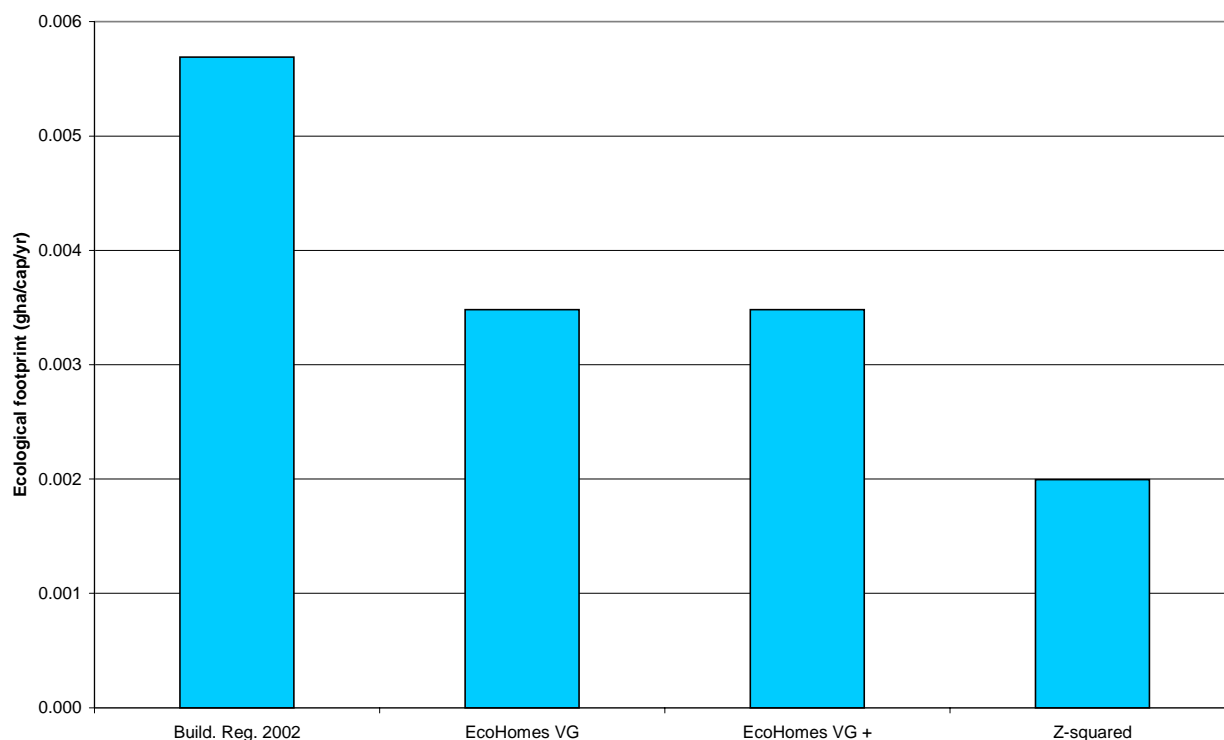
<sup>(A)</sup> – Figure for water use per person for metered dwellings from OFWAT, multiplied by DEFRA figure of 2.33 persons per household

<sup>(B)</sup> – BioRegional estimate based on BRE EcoHomes data and DEFRA figure of 2.33 persons per household

<sup>(C)</sup> – BioRegional estimate based on average of best performing homes at BedZED (monitored data)

<sup>(D)</sup> - Figure calculated by SEI

<sup>(E)</sup> - Figure calculated by BDG based on OFWAT Tariff structure and charges report 2003-03



**Chart 5:** EF associated with the water consumption of residents living in the different Scenarios

### **Scenario Data**

While the UK as a whole is not water-stressed, local and regional areas are increasingly suffering from water management problems. Areas such as the South-east are getting drier as they become more developed and population density increases, whereas previously industrial areas find their water tables rising as water demand falls.

Average UK water consumption data is used for Scenario 1, these figures being based on typical consumption in a metered home and are calculated per person (sources: OFWAT). Consumption data for Scenarios 2 and 3 has been estimated based on reduced water demand which is rewarded under the EcoHomes scheme. It is assumed that the homes built under Scenarios 2 and 3 would have low-flush toilets, showers with flow restrictors, low water use appliances and water butts for collecting rainwater for external use. The water demand and hence savings are assumed to be equal for Scenarios 2 and 3, because although lifestyle choices and water use patterns can clearly effect overall demand, the savings are mainly facilitated through the 'hardware' of low flow and low demand appliances and fittings.

Scenario 4 is based on the sustainable water management strategy developed at BedZED. The three facets of the strategy are reducing water demand through the specification of low use fittings and appliances, collection of rainwater to reduce potable water demand further, and treatment of 'waste' water locally for re-use.

At BedZED, an on-site indoor reed bed system treats sewage from the homes and businesses on the development. The technology used mirrors processes that occur in the natural world, but replicates them more intensively. The installation uses plants to reduce the amount of nitrogen and phosphorous in the 'black water', producing sufficiently clean 'green water' to be used for irrigation and flushing toilets. The treated water is mixed with filtered harvested rainwater in underground storage tanks before being used in the dwellings, any excess treated water is used for irrigation of the landscape, and the remainder is discharged under licence into a local watercourse. For larger Thames Gateway communities, the sustainable water management principles would be similar although the implementation may differ.

The management of water falling on developments as rain would also be considered in Scenario 4. The use of permeable paving would allow the absorption of rainwater peaks thereby reducing the stresses on drainage and river systems. Using porous drainage systems allows rainwater to replenish ground water supplies and reduce the need for extensive underground drainage.

As mentioned previously with respect to energy use, monitored consumption data has been gathered at BedZED and the values have been used to inform the water consumption for Scenario 4.

### **Ecological Footprint and Carbon Dioxide emissions**

The ecological footprint (EF) and CO<sub>2</sub> emissions associated with water use is insignificant when compared with other resource consumption patterns and lifestyle elements. This is primarily because the energy input per litre of pumping potable water and treating waste water is low. By reducing the water consumption as detailed in the four scenarios, the EF and CO<sub>2</sub> levels can be reduced accordingly.

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### ***Personal budget***

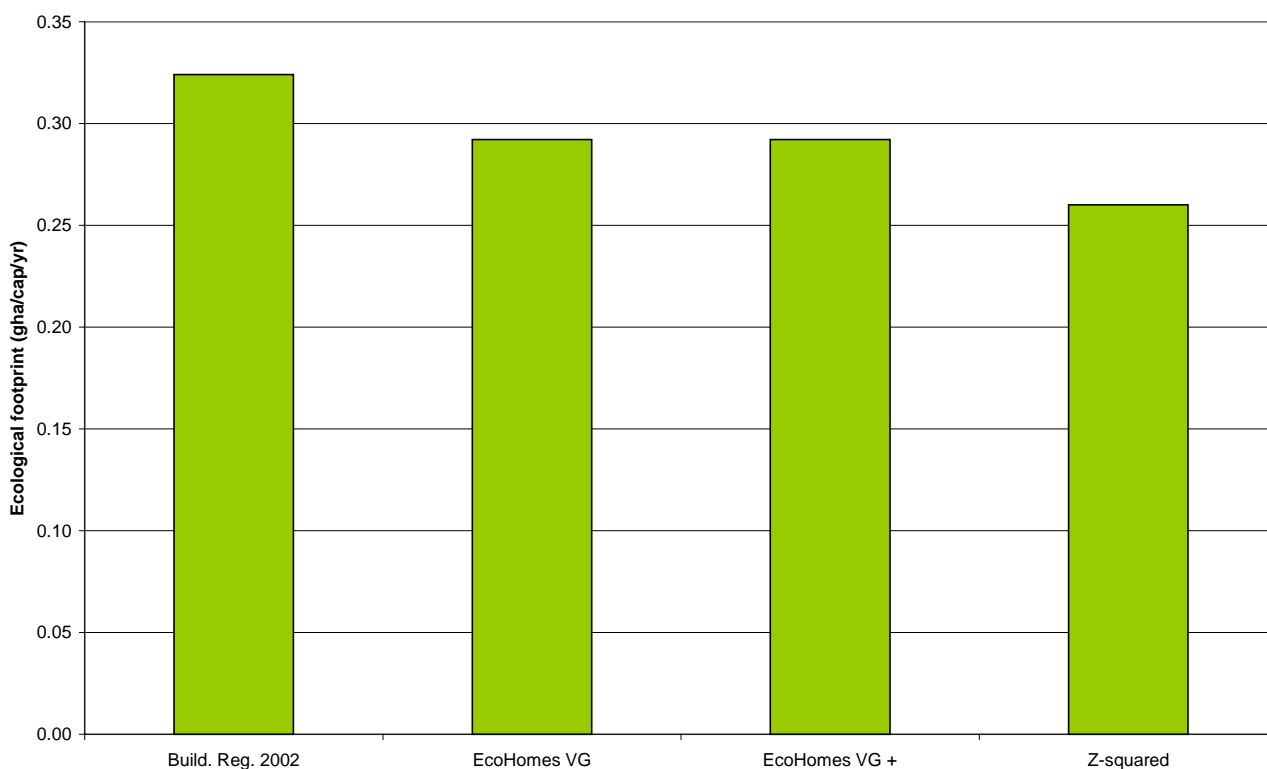
The charges for the domestic supply of water and collection of sewerage for Scenarios 1, 2 and 3 are calculated using figures reported in the *OFWAT Tariff structure and charges report 2002-03*. The saving achieved under Scenario 4 is calculated using a different methodology and is based on the BedZED charging strategy. Under the scheme, residents are charged metered unit rates for mains water, whilst 'green water' and sewerage are charged according to a formula based on the metered mains consumption and the size of the property. The figures suggest that residents could reduce their annual water bills by up to 35 per cent by living in a Z<sup>2</sup> community compared with a more conventional new-build development.

The unit rates and standing charges for supply and collection under Scenario 4 are broadly comparable to the OFWAT average UK data. It should be noted however, that the sustainable water management strategy employed at BedZED is towards the lower end of financial viability on a development of 100 properties. The scales of the communities in the Thames Gateway will be more suited to large-scale water management strategies which could be realised economically.

**Built land**

ISSUE	Scenario 1 Typical UK resident in typical new UK home to 2002 Building Regulations	Scenario 2 Typical UK resident in typical new UK home to EcoHomes 'Very Good'	Scenario 3 Environmentally-aware resident in typical new UK home to EcoHomes 'Very Good'	Scenario 4 Z <sup>2</sup> : Zero fossil energy, zero waste community
Built land	<ul style="list-style-type: none"> <li>40 homes/hectare in core</li> <li>2 storey development average</li> </ul>	<ul style="list-style-type: none"> <li>40 homes/hectare in core</li> <li>2.5 storey development average</li> </ul>	<ul style="list-style-type: none"> <li>As Scenario 2</li> </ul>	<ul style="list-style-type: none"> <li>80 homes/hectare in core</li> <li>3 storey development average</li> </ul>
EF	<b>0.324</b> gha <sup>(A)</sup>	<b>0.292</b> gha <sup>(A)</sup> <b>-10%</b>	<b>0.292</b> gha <sup>(A)</sup> <b>-10%</b>	<b>0.260</b> gha <sup>(A)</sup> <b>-20%</b>
CO <sub>2</sub>	-	- -	- -	- -

<sup>(A)</sup> - Figure calculated by SEI



**Chart 6:** EF associated with a resident's 'built land' component for the different Scenarios

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### ***Scenario Data***

This 'Built Land' section considers the physical area of land attributable to a person's home, mobility needs, and goods and services infrastructure. For the purposes of this study it has been assumed that for Scenario 1, development is two storeys high at a density of 40 homes per hectare in developed areas.

EcoHomes rewards developments where the ratio of the total floor area divided by the building footprint is greater than 2.5 for a certain percentage of the site. Under EcoHomes, no direct credit is given for building developments at high densities. Consequently, the data-set for Scenarios 2 and 3 is based on development achieving an average of 2.5 storeys high, but built at 40 homes per hectare (equal to Scenario 1).

For Scenario 4, the compact city form comprising ZED-type homes will facilitate a high density development averaging at least 3 storeys and achieving 80 homes per hectare in developed areas.

### ***Ecological Footprint and Carbon Dioxide emissions***

The 'built land' EF for an average UK resident (Scenario 1) is 0.324 gha/cap/yr and consists of the built land area for shelter (0.096 gha/cap/yr), mobility (0.049 gha/cap/yr) and goods and services (0.179 gha/cap/yr). These figures represent the actual land coverage of the uses (in hectares) and should not be confused with EF measurement (in hectares) of the materials used in the construction which are accounted for under the infrastructure sections.

The EF associated with Scenarios 2 and 3 is slightly lower because the increased building height reduces the amount of ground area used to accommodate the same population. Scenario 4 boasts a lower EF because the compact high density development form achieves a high number of homes/hectare and reduced parking levels.

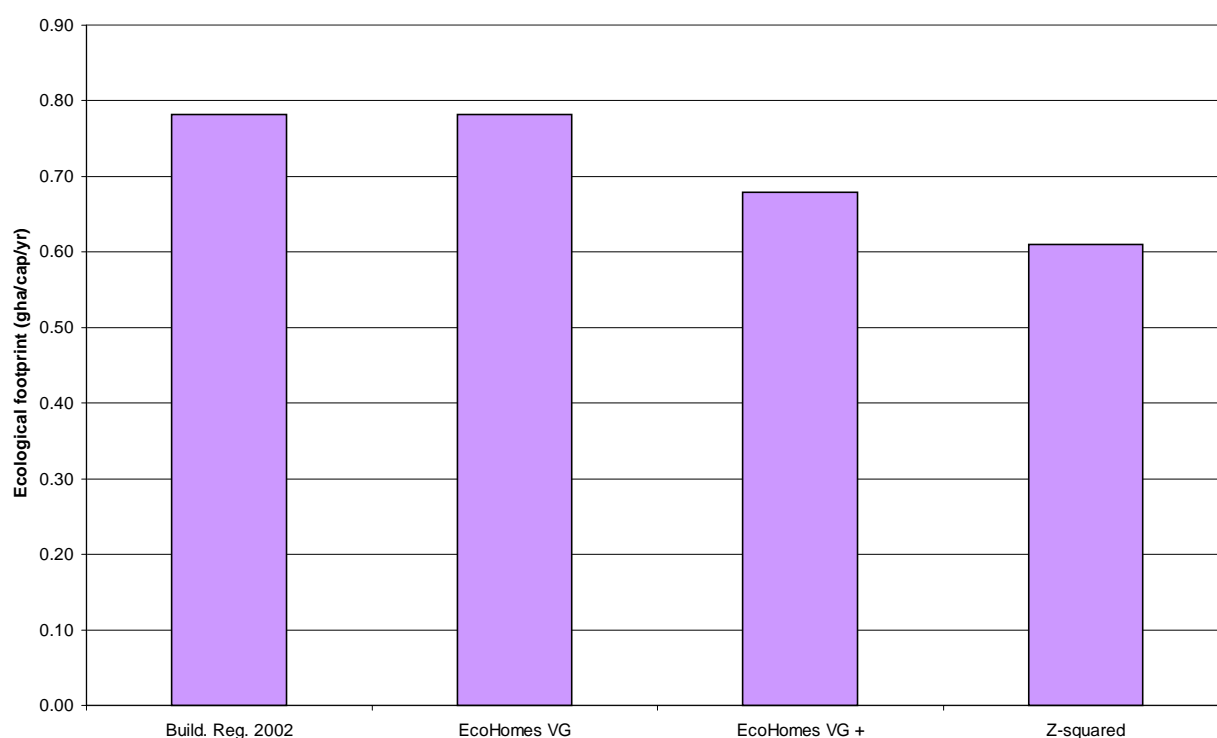
## Services

ISSUE	Scenario 1 Typical UK resident in typical new UK home to 2002 Building Regulations	Scenario 2 Typical UK resident in typical new UK home to EcoHomes 'Very Good'	Scenario 3 Environmentally-aware resident in typical new UK home to EcoHomes 'Very Good'	Scenario 4 Z <sup>2</sup> : Zero fossil energy, zero waste community
Services	<ul style="list-style-type: none"> <li>Average use of: Retail, recreation, healthcare, hotel &amp; catering, communications, banking and finance</li> </ul>	<ul style="list-style-type: none"> <li>As Scenario 1</li> </ul>	<ul style="list-style-type: none"> <li>Fewer commercial services used due to reduced consumption</li> </ul>	<ul style="list-style-type: none"> <li>Fewer commercial services used</li> <li>Less healthcare needed</li> <li>Less consumption</li> <li>Less travel</li> </ul>
EF	<b>0.782</b> <sub>gha<sup>(A)</sup></sub>	<b>0.782</b> <sub>gha<sup>(A)</sup></sub> <b>0%</b>	<b>0.679</b> <sub>gha<sup>(C)</sup></sub> <b>-13%</b>	<b>0.610</b> <sub>gha<sup>(A)</sup></sub> <b>-22%</b>
CO <sub>2</sub>	<b>1.397</b> tonnes/person/annum <sup>(A)</sup>	<b>1.397</b> tonnes/person/annum <sup>(A)</sup> <b>0%</b>	<b>1.213</b> tonnes/person/annum <sup>(C)</sup> <b>-13%</b>	<b>1.090</b> tonnes/person/annum <sup>(A)</sup> <b>-22%</b>
Personal budget	<b>£6682</b> /person/annum <sup>(B)</sup>	<b>£6682</b> /person/annum <sup>(C)</sup> <b>0%</b>	<b>£5813</b> /person/annum <sup>(C)</sup> <b>-13%</b>	<b>£5212</b> /person/annum <sup>(C)</sup> <b>-22%</b>

<sup>(A)</sup> - Figure calculated by SEI

<sup>(B)</sup> - Figure calculated by BDG from *National Statistics Family Spending report 2001/2002*

<sup>(C)</sup> - Figure estimated by BDG



**Chart 7:** EF associated with a resident's 'services' component for the different Scenarios

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### ***Scenario Data***

When considering the environmental impact associated with our lifestyles, there is one sector that is used by everyone (to a varying degree), but which is difficult to define and quantify. This is the *Service* sector which includes retailing, hotel and catering, communications, banking and finance, insurance and recreation. Our use of health services is also included under this section.

This sector can be further divided into commercial and public services. For Scenario 2, the use of commercial services has been reduced by 15 per cent to reflect an equivalent reduction in consumer goods demand, whilst Scenario 4 has a 25 per cent saving in commercial services to reflect its one-quarter reduction in consumption of consumer goods. For all four scenarios, the level of public services used is assumed to be equal, it is beyond the scope of this study to consider the complex matter of any savings in the sector.

### ***Ecological Footprint and Carbon Dioxide emissions***

SEI is currently working on a methodology to calculate the material flows and footprints for the *services* sector as part of a major study, first estimates indicate that the EF for services is approximately 0.7-0.8 global hectares/person/year (approximately 0.7 gha is associated with commercial services and 0.1 gha with public services). The CO<sub>2</sub> emissions for the two sectors together are approximately 1.4 tonnes/person/annum as a UK average.

Calculating accurate potential environmental savings on these figures resulting from living in the four different scenarios is a complex matter and beyond the scope of this study, estimates have been made by BioRegional. These are based on the assumption that people who consume less than average, live a healthier lifestyle and travel less, will use fewer resources from the services sector.

### ***Personal budget***

The personal annual spending figure of £6682/person/annum for Scenarios 1 and 2 is based on data from the National Statistics *Family Spending report 2001/2002* and estimates for Scenarios 3 and 4 have been made based on proportional percentage reductions in line with environmental savings.

**Food**

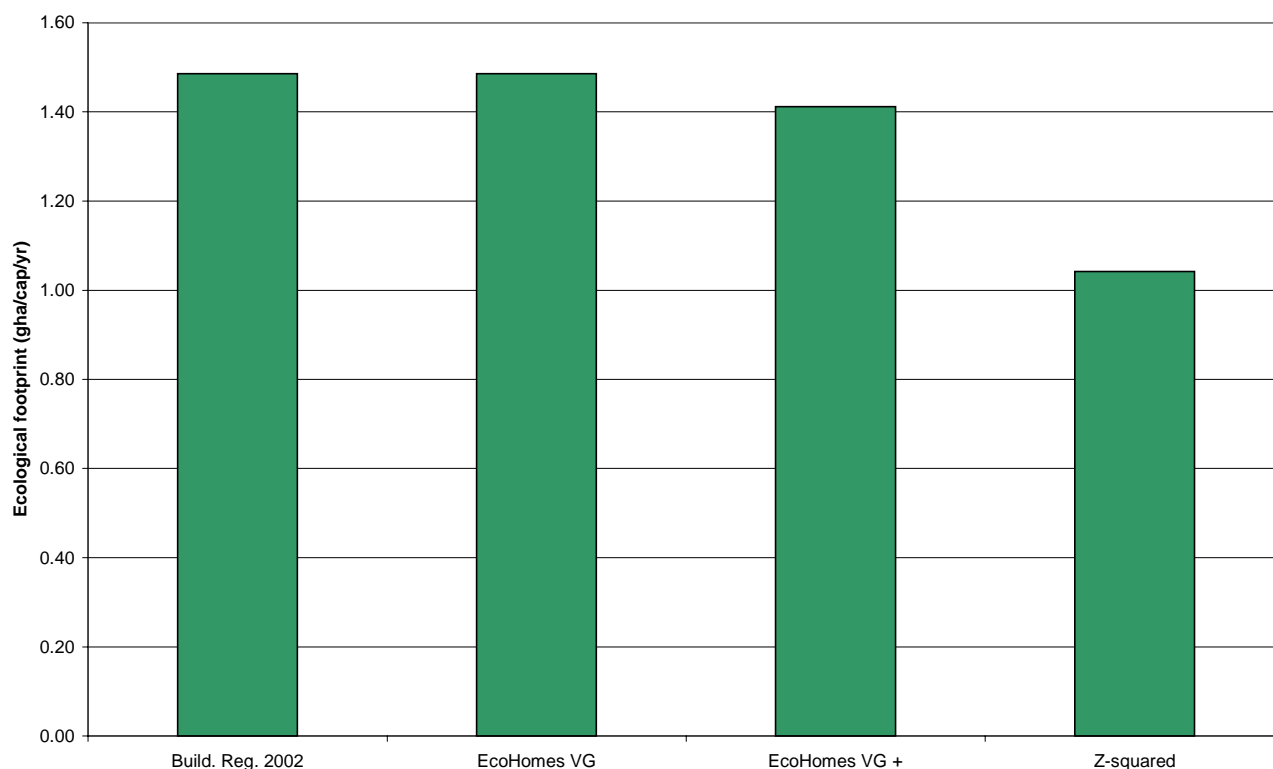
ISSUE	Scenario 1 Typical UK resident in typical new UK home to 2002 Building Regulations	Scenario 2 Typical UK resident in typical new UK home to EcoHomes 'Very Good'	Scenario 3 Environmentally-aware resident In typical new UK home to EcoHomes 'Very Good'	Scenario 4 Z <sup>2</sup> : Zero fossil energy, zero waste community
Food	▪ Average UK consumption	▪ Average UK consumption	▪ Increased consumption of local and organic food	▪ Minimal meat or vegetarian lifestyle ▪ Promotion of local and organic food. ▪ Less packaging
EF	<b>1.486</b> gha <sup>(A)</sup>	<b>1.486</b> gha <sup>(A)</sup> <b>0%</b>	<b>1.412</b> gha <sup>(D)</sup> <b>-5%</b>	<b>1.042</b> gha <sup>(A)</sup> <b>-30%</b>
CO <sub>2</sub>	<b>2.692</b> tonnes/person/annum <sup>(A)</sup>	<b>2.692</b> tonnes/person/annum <sup>(A)</sup> <b>0%</b>	<b>2.557</b> tonnes/person/annum <sup>(D)</sup> <b>-5%</b>	<b>1.953</b> tonnes/person/annum <sup>(A)</sup> <b>-27%</b>
Personal budget	<b>£984</b> /person/annum <sup>(B)</sup>	<b>£984</b> /person/annum <sup>(B)</sup> <b>0%</b>	<b>£984</b> /person/annum <sup>(C)</sup> <b>0%</b>	<b>£984</b> /person/annum <sup>(C)</sup> <b>0%</b>

(A) - Figure calculated by SEI

(B) - Figure calculated by BDG from *National Statistics Family Spending report 2001/2002*

(C) - Figure calculated by BDG

(D) - Figure estimated by BDG



**Chart 8:** EF associated with the food sourcing and consumption patterns associated with a resident living in the different Scenarios

### ***Scenario Data***

The environmental impact associated with our food consumption is considerable and the largest single EF component identified in this study. Approximately a third of our total CO<sub>2</sub> emissions in the UK are attributable to the production and transporting of our food. The data-sets for Scenarios 1 and 2 are identical and taken from government figures on typical consumption. Sustainability with regards to food consumption does not fall within the remit of EcoHomes and hence strategies to reduce the environmental impact are not considered under Scenario 2. Scenario 3 is based on an 'environmentally concerned' resident living in an EcoHomes 'Very Good' home. As part of their lifestyle choices to reduce their environmental impact, it is assumed that they would try to eat more local and organic produce to reduce the transport and packaging impacts.

The data-set for Scenario 4 is based upon building on the ideas developed at BedZED. There is more scope for developing strategies to reduce the environmental impact of food consumption when building communities larger than BedZED. There is greater potential to operate closed-loop local food production at a neighbourhood rather than a development-wide level.

At BedZED, local and organic food is actively promoted. This includes the provision of mini-allotments for residents to grow their own produce and co-ordinated bulk deliveries of local organic food. We believe that keen BedZED residents have also addressed their food consumption more broadly, by choosing to eat little or no meat and minimise the amount of air-freighted food eaten. Local produce often has less packaging because it needs less protection from being damaged during transport, this also contributes towards footprint reduction.

### ***Ecological Footprint and Carbon Dioxide emissions***

Approximately one third of CO<sub>2</sub> emissions attributable to our domestic activities are due to 'food miles' and the energy required to grow, process and transport produce. The EF and CO<sub>2</sub> savings for Scenario 3 are attributable to the reduced packaging and transport components due to the increased consumption of local produce. The savings for Scenario 4 result from the specification of diet consisting of low amounts of meat and dairy, increased levels of fresh fruit and vegetables and a policy of choosing local organic food to reduce the associated transport impact.

SEI states that, although it is widely published that meat is the largest component of our food EF totals, eating a low meat diet does not necessarily result in marked savings. The data used by SEI on embodied energy in different food types has also concluded that the EF associated with dairy products is comparable to that of meat. Total EF food estimates are very sensitive to the exact composition of the diet and the land used for growing the produce, SEI report that the embodied energy data for growing vegetables grown in a field or in greenhouses can vary by a factor of 100!

### ***Personal budget***

There are some sources and articles which indicate that purchasing food to enable a diet as used for Scenario 4 (low meat and dairy with local and organic produce) will have cost implications for residents. These assumptions are often based on anecdotal evidence relating to the cost of organic produce. Although it is reasonable to state that fresh, organic produce may cost more when purchased from a supermarket, there is an equal amount of evidence to suggest that purchasing the same food through farmers markets and local food box schemes can be cheaper. On balance, it has been assumed that the dietary decisions are cost neutral for the resident.

## Key findings

This study has investigated the implications of building 200,000 homes in the Thames Gateway to different environmental standards in terms of ecological footprint (EF), carbon dioxide (CO<sub>2</sub>) emissions and household expenditure in addition to anticipated capital costs. The lifestyle scenarios considered are:

Scenario	Description
1	Typical UK resident in typical new UK home built to 2002 Building Regulations.
2	Typical UK resident in typical new UK home built to EcoHomes 'Very Good'
3	Environmentally aware resident in typical new home built to EcoHomes 'Very Good'
4	Keen resident living in a Z <sup>2</sup> 'Zero fossil energy, zero waste' Community

## Headline figures

ISSUE	Scenario 1	Scenario 2	Scenario 3	Scenario 4
<b>CO<sub>2</sub> emissions from energy use in the home</b>	<b>3.057</b> tonnes/household/annum <sup>(A)</sup>	<b>2.064</b> tonnes/household/annum <sup>(A)</sup> <b>-32%</b>	<b>2.064</b> tonnes/household/annum <sup>(A)</sup> <b>-32%</b>	<b>0.005</b> tonnes/household/annum <sup>(A)</sup> <b>-99%</b>
<b>Water use</b>	<b>312</b> litres/household/day <sup>(B)</sup>	<b>191</b> litres/household/day <sup>(C)</sup> <b>-39%</b>	<b>191</b> litres/household/day <sup>(C)</sup> <b>-39%</b>	<b>110</b> litres/household/day <sup>(D)</sup> <b>-65%</b>
<b>Waste- tonnes sent to landfill</b>	<b>957</b> kg/household/year <sup>(E)</sup>	<b>920</b> kg/household/year <sup>(E)</sup> <b>-4%</b>	<b>720</b> kg/household/year <sup>(E)</sup> <b>-25%</b>	<b>227</b> kg/household/year <sup>(E)</sup> <b>-76%</b>
<b>Ecological Footprint</b>	<b>5.448</b> hectares per person <sup>(F)</sup>	<b>5.229</b> hectares per person <sup>(F)</sup> <b>-4%</b>	<b>4.840</b> hectares per person <sup>(G)</sup> <b>-11%</b>	<b>3.405</b> hectares per person <sup>(F)</sup> <b>-38%</b>

<sup>(A)</sup> – Figure for CO<sub>2</sub> per person calculated by SEI, multiplied by DEFRA figure of 2.33 persons per household

<sup>(B)</sup> – Figure for water use per person for metered dwellings from OFWAT, multiplied by DEFRA figure of 2.33 persons per household

<sup>(C)</sup> – BioRegional estimate based on BRE EcoHomes data and DEFRA figure of 2.33 persons per household

<sup>(D)</sup> – BioRegional estimate based on average of best performing homes at BedZED (monitored data)

<sup>(E)</sup> – BioRegional estimate based on average waste data, BRE EcoHomes data and SEI input

<sup>(F)</sup> – Figure for EF per person calculated by SEI

<sup>(G)</sup> – Figure estimated by BDG using SEI EF data

## Carbon Dioxide emissions from energy use in the home

Many published carbon dioxide emission figures associated with our homes are commonly based only on the emissions due to the energy used to power, light and heat them. The CO<sub>2</sub> savings relating to this section for the four Scenarios are indicated below.

ISSUE	Scenario 1	Scenario 2	Scenario 3	Scenario 4
<b>CO<sub>2</sub> emissions from energy use in the home</b>	<b>3.057</b> tonnes/hh/annum <sup>(A)</sup>	<b>2.064</b> tonnes/hh/annum <sup>(A)</sup>	<b>2.064</b> tonnes/hh/annum <sup>(A)</sup>	<b>0.005</b> tonnes/hh/annum <sup>(A)</sup>
<b>Saving</b>		<b>0.993 (-32%)</b>	<b>0.993 (-32%)</b>	<b>3.052 (-99%)</b>

<sup>(A)</sup> – Figure for CO<sub>2</sub> per person calculated by SEI, multiplied by DEFRA figure of 2.33 persons per household

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Based on these figures, it is then possible to extrapolate the total figures of carbon dioxide and carbon for the planned 200,000 homes and to compare this to the government's 2020 projection of CO<sub>2</sub> reductions of 4-6 MtC (a mid-point of 5MtC is assumed) in the domestic sector by 2020.

Scenarios 2 and 3: 200,000 homes in the Thames Gateway
Saves <b>0.993 tonnes of CO<sub>2</sub></b> per household per year
Saves <b>198,840 tonnes of CO<sub>2</sub></b> per year for 200,000 homes
Equates to <b>54,220 tonnes of Carbon</b> per year for 200,000 homes
<b>This equates to approximately 1.1 per cent of 5MtC domestic sector reduction target for 2020<sup>13</sup></b>

Scenario 4: 200,000 homes in the Thames Gateway
Saves <b>3.052 tonnes of CO<sub>2</sub></b> per household per year
Saves <b>610,640 tonnes of CO<sub>2</sub></b> per year for 200,000 homes
Equates to <b>166,540 tonnes of Carbon</b> per year for 200,000 homes
<b>This equates to approximately 3.3 per cent of 5MtC domestic sector reduction target for 2020</b>

### Carbon Dioxide emissions associated with built form and utilities use

The CO<sub>2</sub> emissions resulting from providing power, heat and light, account for only part of the total emissions attributable to our homes. To get a more complete picture of the CO<sub>2</sub> emissions, the energy embodied within the construction materials and that resulting from the provision and treatment of domestic water can also be considered. Extracting, refining, manufacturing and transporting materials requires large amounts of energy and this has an associated carbon dioxide emission, this energy is embodied within the products and components. The energy demands associated with the supply and processing of water for the domestic sector is relatively small per litre, hence the carbon dioxide emissions are also small. The results for the four scenarios (if these components are considered) are shown below.

ISSUE	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Energy use	<b>9.473</b> tonnes/hh/annum <sup>(B)</sup>	<b>8.281</b> tonnes/hh/annum <sup>(B)</sup>	<b>8.113</b> tonnes/hh/annum <sup>(B)</sup>	<b>5.501</b> tonnes/hh/annum <sup>(B)</sup>
House infrastructure				
Shared infrastructure				
Water				
<b>Saving</b>		<b>1.192 (-13%)</b>	<b>1.360 (-14%)</b>	<b>3.972 (-42%)</b>

(B) – Figure for CO<sub>2</sub> per person calculated by SEI, multiplied by DEFRA figure of 2.33 persons per household

<sup>13</sup> The Government White Paper on energy, *Our energy future – creating a low carbon economy*, identifies an intermediate reduction target of 15-25 million tonnes of carbon (MtC) by 2020. The White Paper indicates that 4-6 MtC of the total 15-25 MtC reduction could be achieved through energy efficiency in households. A mid-point figure of 5MtC is taken as a target for the domestic sector in this study.

<b>Scenario 2 : 200,000 homes in the Thames Gateway</b>
Saves <b>1.192 tonnes of CO<sub>2</sub></b> per household per year
Saves <b>238,400 tonnes of CO<sub>2</sub></b> per year for 200,000 homes
Equates to <b>65,000 tonnes of carbon</b> per year for 200,000 homes

<b>Scenario 3 : 200,000 homes in the Thames Gateway</b>
Saves <b>1.360 tonnes of CO<sub>2</sub></b> per household per year
Saves <b>272,000 tonnes of CO<sub>2</sub></b> per year for 200,000 homes
Equates to <b>74,180 tonnes of carbon</b> per year for 200,000 homes

<b>Scenario 4: 200,000 homes in the Thames Gateway</b>
Saves <b>3.972 tonnes of CO<sub>2</sub></b> per household per year
Saves <b>794,400 tonnes of CO<sub>2</sub></b> per year for 200,000 homes
Equates to <b>216,650 tonnes of carbon</b> per year for 200,000 homes

### **Carbon Dioxide emissions associated with lifestyle**

The transport of people and goods, our consumer products and food, and how we deal with our waste, all have energy demands and hence carbon dioxide emissions associated with them. The impacts of these aspects of our lives have been studied to help provide a better indication of the environmental implications of our lifestyles and the relative importance of lifestyle aspects compared to the fabric of our homes and the energy required to run them.

The CO<sub>2</sub> emissions associated with our lifestyles are considerable when compared with those attributable directly to our homes. Professor Brenda Vale and Dr Robert Vale<sup>14</sup> have concluded that for a typical household in the UK, approximately one-third of their CO<sub>2</sub> emissions are attributable to heating and powering the home, another third is due to transport and commuting with the final third arising from food miles. These CO<sub>2</sub> figures for the remaining four scenario components (Built Land does not have a CO<sub>2</sub> emission and hence is not included) are shown below.

<b>ISSUE</b>	<b>Scenario 1</b>	<b>Scenario 2</b>	<b>Scenario 3</b>	<b>Scenario 4</b>
Transport	<b>18.27</b> tonnes/hh/annum <sup>(C)</sup>	<b>17.88</b> tonnes/hh/annum <sup>(C)</sup>	<b>16.25</b> tonnes/hh/annum <sup>(C)</sup>	<b>10.74</b> tonnes/hh/annum <sup>(C)</sup>
Waste & consumption				
Services				
Food				
<b>Saving</b>		<b>0.390 (-2%)</b>	<b>2.020 (-11%)</b>	<b>7.530 (-41%)</b>

(C) – Figure for CO<sub>2</sub> per person calculated by SEI, multiplied by DEFRA figure of 2.33 persons per household

<sup>14</sup> Professor Brenda Vale and Dr. Robert Vale are academics at the University of Auckland, where they are both members of the Sustainable Design Research Centre, of which Brenda is the Director.

<b>Scenario 2 : 200,000 homes in the Thames Gateway</b>
Saves <b>0.390 tonnes of CO<sub>2</sub></b> per household per year
Saves <b>78,000 tonnes of CO<sub>2</sub></b> per year for 200,000 homes
Equates to <b>21,270 tonnes of carbon</b> per year for 200,000 homes

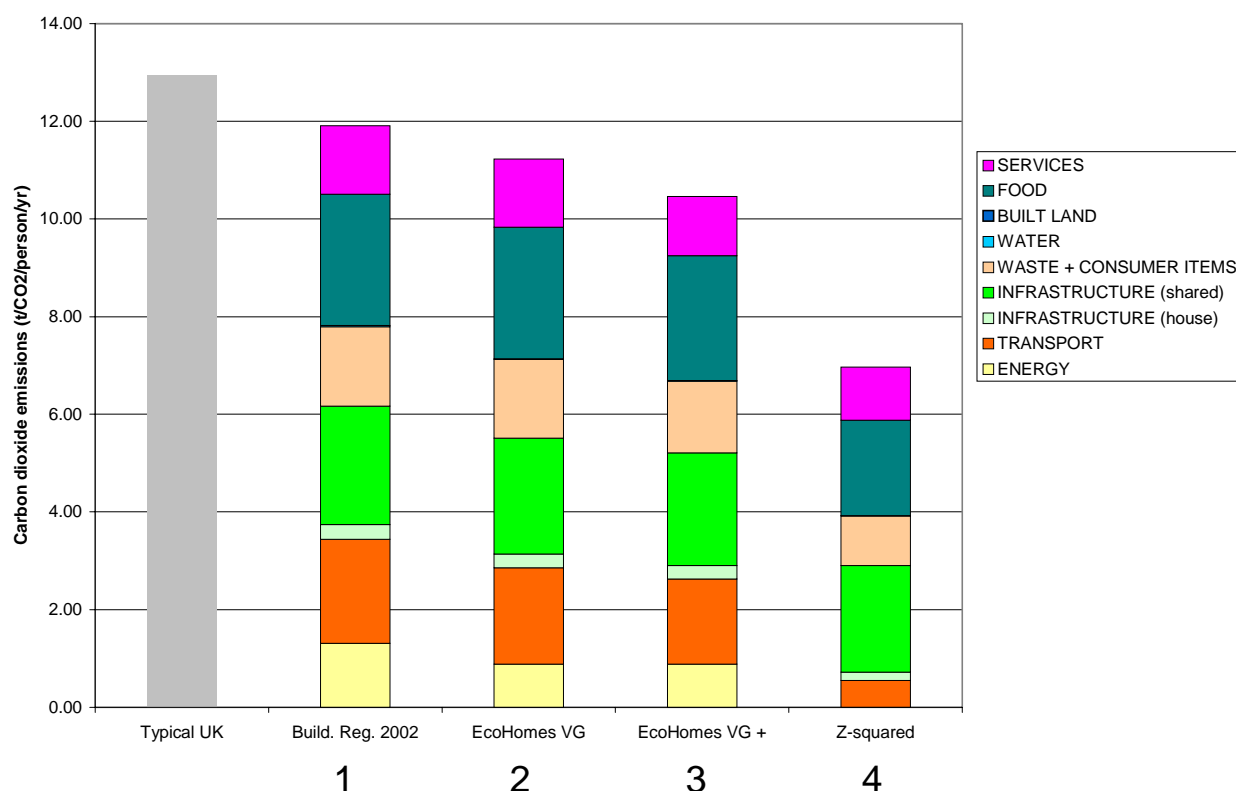
<b>Scenario 3 : 200,000 homes in the Thames Gateway</b>
Saves <b>2.020 tonnes of CO<sub>2</sub></b> per household per year
Saves <b>404,000 tonnes of CO<sub>2</sub></b> per year for 200,000 homes
Equates to <b>110,180 tonnes of carbon</b> per year for 200,000 homes

<b>Scenario 4: 200,000 homes in the Thames Gateway</b>
Saves <b>7.530 tonnes of CO<sub>2</sub></b> per household per year
Saves <b>1,506,000 tonnes of CO<sub>2</sub></b> per year for 200,000 homes
Equates to <b>410,720 tonnes of carbon</b> per year for 200,000 homes

### **Total Carbon Dioxide emissions**

The figures representing total CO<sub>2</sub> emissions resulting from the fabric and running demands of our homes in addition to the emissions due to our lifestyles are shown below. These are indicated in tonnes/person/year, figures for emissions per household are based on occupation rates of 2.33 residents/household. Sub-dividing the impact of our lifestyles into the 9 aspects shown, enables the calculation of total CO<sub>2</sub> emissions and ecological footprint values as well as offering an insight into the relative importance of each aspect.

ISSUE	Scenario 1	Scenario 2		Scenario 3		Scenario 4	
Energy use in the home	1.312	0.886	<b>-32%</b>	0.886	<b>-32%</b>	0.002	<b>-99%</b>
Transport	2.123	1.972	<b>-7%</b>	1.741	<b>-18%</b>	0.551	<b>-74%</b>
House Infrastructure	0.306	0.278	<b>-9%</b>	0.278	<b>-9%</b>	0.168	<b>-45%</b>
Shared Infrastructure	2.426	2.377	<b>-2%</b>	2.305	<b>-5%</b>	2.183	<b>-10%</b>
Waste & consumer items	1.628	1.613	<b>-1%</b>	1.465	<b>-10%</b>	1.014	<b>-38%</b>
Water	0.022	0.013	<b>-40%</b>	0.013	<b>-40%</b>	0.008	<b>-60%</b>
Built land	-	-	-	-	-	-	-
Services	1.397	1.397	<b>-0%</b>	1.213	<b>-13%</b>	1.090	<b>-27%</b>
Food	2.692	2.692	<b>-0%</b>	2.557	<b>-5%</b>	1.953	<b>-22%</b>
<b>TOTAL</b>	<b>11.91</b> t/CO2/person/annum	<b>11.23</b> t/CO2/person/annum	<b>-6%</b>	<b>10.46</b> t/CO2/person/annum	<b>-12%</b>	<b>6.969</b> t/CO2/person/annum	<b>-41%</b>
			Saving over Scenario 1		Saving over Scenario 1		Saving over Scenario 1



**Chart 9:** Total CO<sub>2</sub> emissions per resident associated with each of the Scenarios

Scenario 2 : 200,000 homes in the Thames Gateway
Saves <b>1.584 tonnes of CO<sub>2</sub></b> per household per year
This represents a saving of <b>6 per cent</b> compared to <b>UK new build figure of 27.74</b> and <b>13 per cent</b> compared with <b>UK average figures</b> for all homes
Saves <b>316,880 tonnes of CO<sub>2</sub></b> per year for 200,000 homes
Equates to <b>86,420 tonnes of carbon</b> per year for 200,000 homes

Scenario 3 : 200,000 homes in the Thames Gateway
Saves <b>3.379 tonnes of CO<sub>2</sub></b> per household per year
This represents a saving of <b>12 per cent</b> compared with <b>UK new build figure of 27.74 per cent</b> and <b>19 per cent</b> compared with <b>UK average figures</b> for all homes
Saves <b>675,700 tonnes of CO<sub>2</sub></b> per year for 200,000 homes
Equates to <b>184,280 tonnes of carbon</b> per year for 200,000 homes

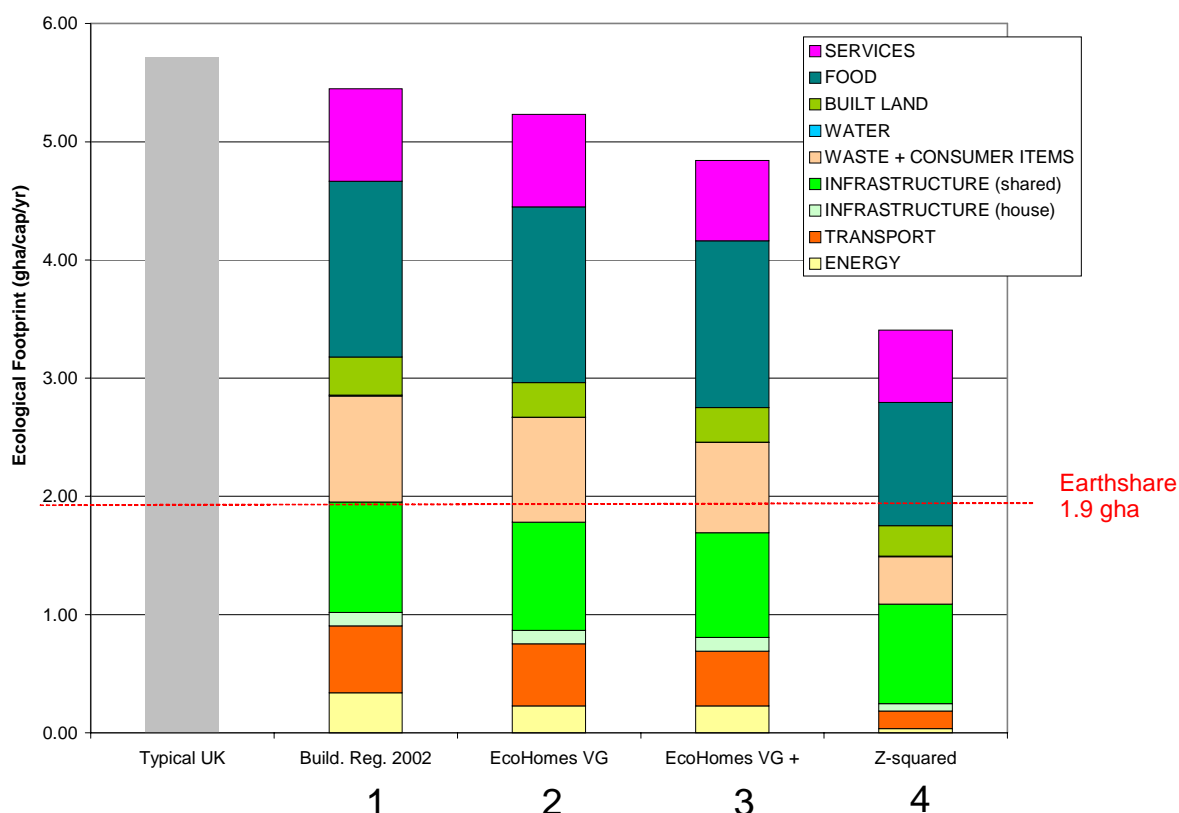
<b>Scenario 4 : 200,000 homes in the Thames Gateway</b>
Saves <b>11.51 tonnes of CO<sub>2</sub></b> per household per year
This represents a saving of <b>41 per cent</b> compared with <b>UK new build figure of 27.74 per cent</b> and <b>46 per cent</b> compared with <b>UK average figures</b> for all homes
Saves <b>2,302,500 tonnes of CO<sub>2</sub></b> per year for 200,000 homes
Equates to <b>627,950 tonnes of carbon</b> per year for 200,000 homes

Figures based on occupation of 2.33 residents per home

The findings regarding carbon dioxide emissions indicated above, highlight the importance of considering our entire lifestyles when calculating our environmental impact. Ecological Footprinting analysis informs us that to live sustainably within the resources of one planet, we must consider how we build, our levels of shared infrastructure and services, our travel demands and our consumption of goods and food.

### **Ecological Footprint**

ISSUE	Scenario 1	Scenario 2		Scenario 3		Scenario 4	
Energy use in the home	0.340	0.229	<b>-32%</b>	0.229	<b>-32%</b>	0.037	<b>-89%</b>
Transport	0.564	0.524	<b>-7%</b>	0.463	<b>-18%</b>	0.148	<b>-74%</b>
House Infrastructure	0.116	0.114	<b>-2%</b>	0.114	<b>-2%</b>	0.064	<b>-45%</b>
Shared Infrastructure	0.932	0.914	<b>-2%</b>	0.885	<b>-5%</b>	0.839	<b>-10%</b>
Waste & consumer items	0.898	0.885	<b>-2%</b>	0.763	<b>-15%</b>	0.403	<b>-55%</b>
Water	0.006	0.003	<b>-50%</b>	0.003	<b>-50%</b>	0.002	<b>-66%</b>
Built land	0.324	0.292	<b>-10%</b>	0.292	<b>-10%</b>	0.260	<b>-20%</b>
Services	0.782	1.486	<b>-0%</b>	1.412	<b>-5%</b>	1.042	<b>-30%</b>
Food	1.486	0.782	<b>-0%</b>	0.679	<b>-13%</b>	0.610	<b>-22%</b>
<b>TOTAL</b>	<b>5.448</b> gha	<b>5.229</b> gha	<b>-4%</b>	<b>4.840</b> gha	<b>-11%</b>	<b>3.405</b> gha	<b>-38%</b>
			Saving over Scenario 1		Saving over Scenario 1		Saving over Scenario 1



**Chart 10:** Ecological Footprint per resident associated with each of the Scenarios

**Scenario 2:**  
 Compared with Scenario 1, **Scenario 2** reduces the Ecological Footprint of a resident by around **4 per cent**, or approximately **8 per cent** compared with UK typical figure of 5.71 gha

**Scenario 3:**  
 Compared with Scenario 1, **Scenario 3** reduces the Ecological Footprint of a resident by around **11 per cent**, or approximately **15 per cent** compared with UK typical figure of 5.71 gha

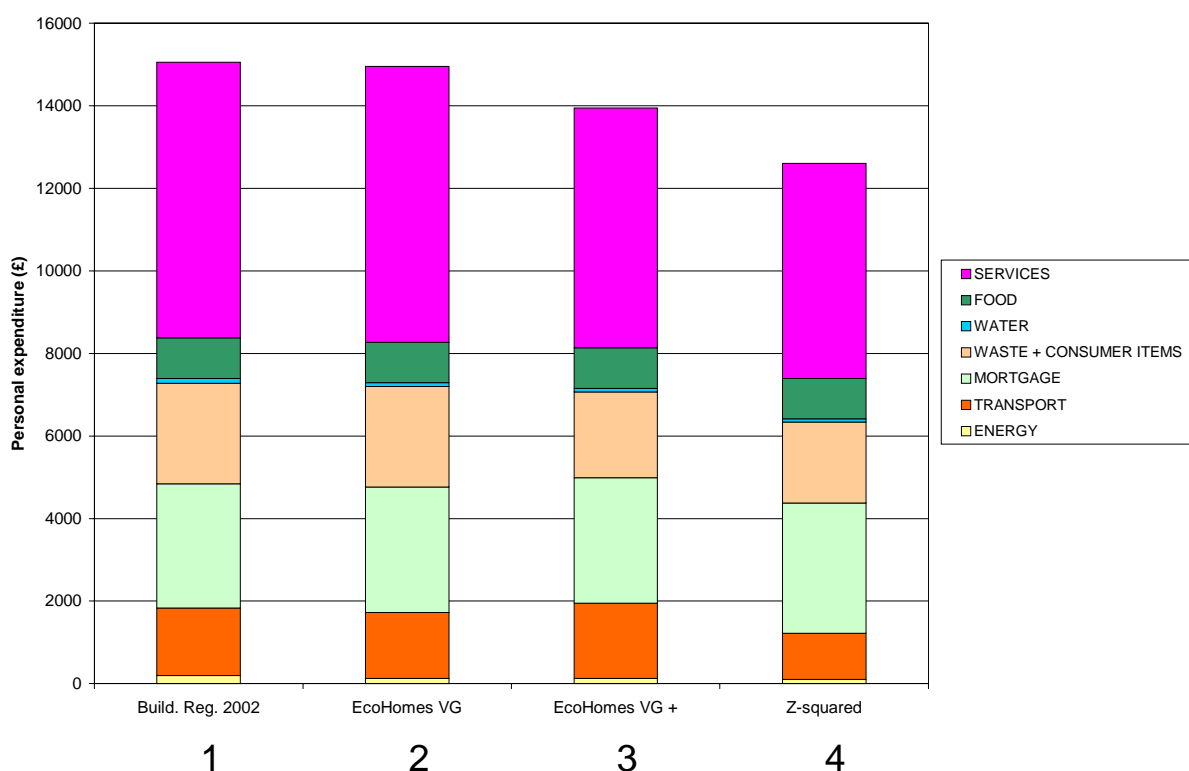
**Scenario 4:**  
 Compared with Scenario 1, **Scenario 4** reduces the Ecological Footprint of a resident by around **38 per cent**, or approximately **40 per cent** compared with UK typical figure of 5.71 gha

The Ecological Footprinting analysis has suggested that Thames Gateway residents could reduce their ‘three planet’ lifestyle by approximately one planet through their choice of a sustainable home and lifestyle. To save the second planet and live sustainably within our planet’s resources, the impact of our ‘Shared Services’ and ‘Shared Infrastructure’ must be reduced.

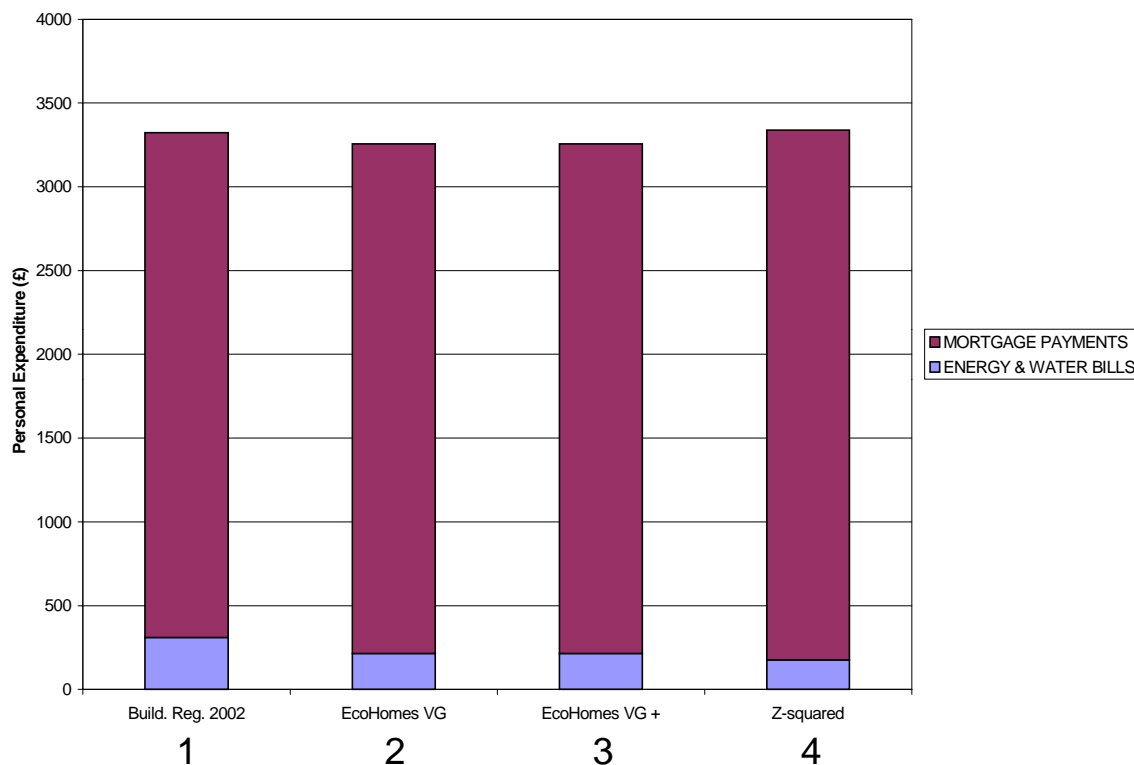
The two sections are intrinsically linked to the services and facilities provided at the community, neighbourhood, regional and national levels, so it is difficult for an individual to influence the associated environmental impact. To save the second planet and achieve sustainable one planet living, choices and strategies need to be implemented by the government, with particular regard to our shared facilities and infrastructure.

**Capital Costs and Personal Expenditure**

ISSUE	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Capital costs	Personal expenditure	Capital costs	Personal expenditure	Capital costs	Personal expenditure	Capital costs	Personal expenditure
Energy use in the home	-	197	-	127	-	127	-	103
Transport	172	1636	172	1595	172	1665	172	1007
House Infra-structure	100k	3013	101k	3043	101k	3043	105k	3162
Shared Infra-structure	2575	-	2524	-	2446	-	2138	-
Waste & consumer items	-	2432	-	2435	-	2077	-	1962
Water	-	113	-	87	-	87	-	74
Built land	-	-	-	-	-	-	-	-
Services	-	6682	-	6682	-	5813	-	5212
Food	-	984	-	984	-	984	-	984
<b>TOTAL</b>	<b>-</b>	<b>15,056</b> £	<b>-</b>	<b>14,953</b> £		<b>13,948</b> £	<b>-</b>	<b>12,610</b> £



**Chart 11:** Personal expenditure per resident living in each of the Scenarios



**Chart 12:** *Personal expenditure per resident living in each of the Scenarios illustrating that the costs associated with running a home (energy and water bills and mortgage repayments) are effectively equal under the four Scenarios (within +/- 1% of Scenario 1).*

It has been calculated that residents living in sustainable communities in the Thames Gateway may enjoy lower household expenditure in addition to higher environmental standards and quality of life. They will have broadly the same household expenditure, but will simply spend their money differently to achieve environmental benefits for themselves and future generations.

It is also believed that capital costs will be comparable. It is clear that to provide the new and upgraded levels of infrastructure to facilitate the development of the Thames Gateway will require substantial investment. By spending the same money differently, it is believed that significant environmental savings can be made for the same costs. For example, investing in public transport, cycle networks and car clubs, will reduce the reliance on private fossil fuel miles and result in fewer roads and infrastructure being required.

## Conclusions

This study has investigated the implications of building the planned 200,000 new homes in the Thames Gateway to four different environmental standards:

- Scenario 1** Current Building Regulations with 'average' UK residents;
- Scenario 2** Building Research Establishment's (BRE) EcoHomes 'Very Good' standard with 'average' UK residents;
- Scenario 3** BRE's EcoHomes 'Very Good' standard with environmentally aware residents; and
- Scenario 4** 'Z<sup>2</sup>' standard (Zero fossil Energy, Zero Waste) with environmentally aware residents.

The environmental impacts of the various scenarios have been measured in terms of specific issues such as carbon dioxide emissions, water use and waste, as well as in terms of overall ecological footprint. The study has also assessed the impacts on the costs of house building and associated infrastructure and household expenditure of the four different scenarios.

### ***Environmental Impacts***

The research undertaken in this study has shown that significant environmental savings can be made through developing sustainable homes and communities which enable residents to live sustainable lifestyles.

The following figures are compared to Scenario 1, which estimates the impacts of homes developed to current Building Regulations. (It is important to remember that current Building Regulations represent much higher standards in terms of energy efficiency than most existing UK housing.)

### **Scenarios 2 and 3: EcoHomes Very Good**

The study has shown that by developing 200,000 new homes in Thames Gateway to a minimum of BRE's EcoHomes 'Very Good' standard, significant savings could be made per home per year:

- a **32 per cent reduction in CO<sub>2</sub> emissions from energy use in the home;**
- a **39 per cent reduction in water use;**
- a **4 per cent reduction in the amount of household waste sent to landfill for Scenario 2; and**
- a **25 per cent reduction in the amount of household waste sent to landfill for Scenario 3.**

The study has assumed that the carbon dioxide emissions resulting from energy use in the home and the amount of water used will remain about the same for both Scenario 2 and 3 (i.e. regardless of the kind of resident living in the home). This is because these homes are designed for efficiency, and therefore facilitate efficient use of energy and water.

This figure for carbon dioxide reduction per home can be used to estimate the potential CO<sub>2</sub> savings of developing 200,000 homes in the Thames Gateway to EcoHomes 'Very Good' standard compared with current Building Regulations. The saving of 0.993 tonnes of CO<sub>2</sub>/home/year, equates to 198,840 tonnes of CO<sub>2</sub> or 54,220 tonnes of carbon for the 200,000 homes.

### **Scenario 4: Z<sup>2</sup>**

The study illustrates that if all new homes in the Thames Gateway were built to 'Z<sup>2</sup>' standards, the savings per home per year could be:

- **a 99 per cent reduction in CO<sub>2</sub> emissions from energy use in the home;**
- **a 65 per cent reduction in water use; and**
- **a 76 per cent reduction in the amount of household waste sent to landfill.**

Building the 200,000 homes in the Thames Gateway to Z<sup>2</sup> standards saves an estimated 3.052 tonnes of CO<sub>2</sub>/home/year compared with dwellings built to current Building Regulations. This equates to 610,640 tonnes of CO<sub>2</sub> or 166,540 tonnes of carbon for the 200,000 homes.

However, the carbon dioxide emissions resulting from powering and heating our homes accounts for only part of the total emissions attributable to our lifestyles. The carbon dioxide emissions associated with the transport of people and goods, the energy embodied in our construction materials, consumer goods and our food, and how we deal with our waste, should all be considered in order to assess our full 'carbon footprint'.

This study demonstrates that for a typical UK citizen living in an average UK home, the carbon dioxide emission levels associated with their food and those associated with their transport demands are both comparable to the amount of CO<sub>2</sub> attributable to energy use in the home.

In the study, the total carbon dioxide emissions associated with our lifestyles have been calculated for each of the scenarios. This includes the energy used in our homes, for transporting ourselves and our goods, the farming, packaging and delivery of our food and the disposal of our waste. Also considered are the CO<sub>2</sub> emissions arising from the energy embodied in the materials used to build our homes and infrastructure. These figures provide a comprehensive picture of the full carbon footprint of residents in the different scenarios.

The total carbon dioxide emissions reduction attributable to the lifestyle described in scenario 2 would save 316,880 tonnes of CO<sub>2</sub> per year if applied to the 200,000 homes in the Thames Gateway (based on 2.33 residents per household). This equates to 86,420 tonnes of carbon.

A resident occupying an EcoHomes 'Very Good' home who had made lifestyle choices to reduce their environmental impact (Scenario 3), could increase their total CO<sub>2</sub> savings, with each of the 200,000 homes saving 3.379 tonnes of CO<sub>2</sub> per year (based on 2.33 residents per household), totalling 675,700 tonnes of CO<sub>2</sub> per year for the Thames Gateway. This equates to 184,280 tonnes of carbon.

Scenario 4 is based on a resident living in a very efficient home as part of a compact sustainable community which enables them to make lifestyle choices to minimise their impact on the environment. Total savings across the 200,000 Thames Gateway homes (based on 2.33 residents per household) would be 2,302,500 tonnes of CO<sub>2</sub> per year. This equates to 627,950 tonnes of carbon.

### ***Cost of Homes and Infrastructure***

The study demonstrates that in terms of infrastructure capital costs and personal expenditure related to the purchase and running of a home, the cost of developing 200,000 homes to EcoHomes 'Very Good' and Z<sup>2</sup> standards would be comparable to developing to current

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Building Regulations. This is because any additional build costs for Scenarios 2, 3 and 4 could be offset by savings in other areas. The additional build costs are estimated to be:

- **2 per cent for EcoHomes**
- **10 per cent for Z<sup>2</sup>**

Half of these additional costs could be offset by planning gain (this is a mechanism under which a developer is permitted to increase development by the local authority in exchange for meeting agreed environmental targets.) The other half could be paid for by consumers through slightly higher cost homes. However, the increased mortgage repayments would be compensated for by the savings resulting from lower utility bills. If the household expenditure estimates are broadened to include transport, waste and the purchase of consumer goods, the average personal expenditure (on the elements considered in this study) per annum for residents living in the 4 scenarios will be:

- **Scenario 1           £ 15,056**
- **Scenario 2           £ 14,953**
- **Scenario 3           £ 13,948**
- **Scenario 4           £ 12,620**

In other words, the findings indicate that increased spending on public transport and mortgage costs are offset by the savings returned from lower energy and water bills, and not keeping a car on the road. This suggests that sustainable living in the Thames Gateway would result in lower household expenditure for residents in addition to the environmental benefits.

The study suggests that the infrastructure costs for all four scenarios would be comparable. The government already recognises that it must provide the necessary investment to facilitate the development of the Thames Gateway. Taking into account private sector expenditure, this study estimates that public sector investment of approximately £1.2 billion per annum for 20 years will be necessary for the development of 200,000 homes in the Thames Gateway, including infrastructure costs such as transport and flood prevention. Based on the estimated reduced infrastructure materials needed for Scenarios 2, 3 and 4, this study suggests that the infrastructure costs could in fact be less than for Scenario 1:

- **Scenario 2 suggests a 2 per cent reduction;**
- **Scenario 3 suggests a 5 per cent reduction; and**
- **Scenario 4 suggests a 10 per cent reduction.**

The aim of this study is not primarily to demonstrate how the government could make savings in its expenditure on developing Thames Gateway (although this may indeed prove to be the case), but to illustrate how environmental and social benefits and government sustainable development targets could be met using the same budget. Provision of the new and upgraded levels of infrastructure to facilitate the development of the Thames Gateway will require substantial investment, but by spending the money differently, it is believed that significant environmental savings can be made for the same capital costs. For example, investing in public transport, cycle networks and car clubs will reduce the reliance on private fossil fuel miles and result in fewer roads being required.

### ***Ecological footprint***

Ecological footprinting (EF) is a comprehensive methodology which considers the environmental impact of our lifestyles. It informs us that the average UK citizen is currently significantly

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exceeding their fair share of the Earth's resources. In fact, if everyone on the planet were to live as UK citizens currently do, we would need three planets to support us!

This study demonstrates that even with significant savings in terms of carbon dioxide, water use and waste in Scenarios 2 and 3, the overall savings in terms of an individual's ecological footprint when compared with Scenario 1 are limited:

- **4 per cent for Scenario 2 (or 8 per cent compared with UK average)**
- **11 per cent for Scenario 3 (15 per cent compared with UK average)**

This is because the ecological footprinting methodology considers a comprehensive range of the impacts associated with an individual's lifestyle, from the food miles they create by purchasing imported food to the energy needed to dispose of their waste. This study has shown that a considerable component of an individual's ecological footprint is attributable to their share of infrastructure and services. These are beyond the scope of the EcoHomes standard.

The figures in Scenario 4 show that an individual can reduce his/her footprint by 38 per cent (or 40 per cent compared with UK average). This is because Scenario 4 facilitates more sustainable lifestyle decisions, (e.g. by providing car clubs to minimise personal car use, and by enabling deliveries of locally produced organic food). This study shows that while Scenario 4 goes a long way in reducing an individual's ecological footprint, it would still not be enough to enable an individual to live a truly 'one planet' lifestyle.

### ***Living on One Planet***

If the ecological footprints of residents in each of the four scenarios are compared to an average UK citizen, the relative importance of each of the nine contributory lifestyle elements can be seen. It is clear (particularly in Scenario 4) that there are four components which make up the majority of our ecological footprints: food, waste, services and shared infrastructure. Developing strategies to tackle the environmental impact associated with these would represent a big step on the route to truly sustainable living.

As discussed in the main body of this report, our Food EF is a product of the physical area required to grow the food, the energy required to grow (excluding free energy from the sun), harvest, process and transport it. The energy associated with any fertilisers used is also added whereas the EF of the packaging is considered under the 'Materials and Waste' section. Meat and dairy products have a high EF because of the cumulative effects of the EF due to raising and farming the animal in addition to the EF of the food it eats.

The data-set for scenario 4 assumes that a resident enjoys a low meat and low dairy diet with increased amounts of fresh fruit and vegetables, as well as eating mostly local and organic produce. A resident who chooses to become a vegan or low dairy vegetarian and source the vast majority of food locally or grow food themselves (in individual or neighbourhood plots) could reduce their EF further.

The waste and materials strategy developed for scenario 4 is based on a consumption rate reduction of 25 per cent (and an equivalent waste output saving). Of the waste produced, 25 per cent is recycled, 25 per cent is composted, 25 per cent is converted cleanly to energy and 25 per cent is sent to landfill. It is anticipated that any further EF savings could be achieved by a combination of reducing the amount of domestic waste produced and increasing the amount recycled and minimising the amount landfilled. To facilitate this, it is believed that the government would need to provide incentives to individuals and industry.

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The remaining two sections, 'Shared Services' and 'Shared Infrastructure', are both intrinsically linked to the services and facilities provided at the community, neighbourhood, regional and national levels. The EF of these two sections makes up more than 40 per cent of the total EF for scenario 4, but it is difficult for an individual to influence the associated environmental impact.

Under scenario 4, some of these shared aspects are addressed as part of the Z<sup>2</sup>- zero fossil energy, zero waste community. For example, it has been assumed that the compact urban form would deliver shared infrastructure savings and that reduced demand for consumer goods would translate into some savings with regards to the retail sector. The EF and CO<sub>2</sub> figures have been calculated accordingly using informed estimates, but it is clear that more research is required to clarify the extent of reductions achievable.

It is also apparent from this report that an individual resident living in any of the scenarios is limited in the scope of the environmental savings they can realise through their choice of home and lifestyle alone. It would be reasonable to state that an environmentally-aware Z<sup>2</sup> resident could reduce their environmental impact by one planet from the UK's three-planet to a two-planet level.

It is evident that construction standards play a significant role in reducing environmental impacts, and that individuals can make very significant contributions to reducing their impact through the lifestyle choices they make. However, the study also demonstrates the vital importance of shared infrastructure and services. The ecological footprinting analysis suggests that a UK resident can reduce their 'three planet lifestyle' by approximately one planet through living in a Z<sup>2</sup> home and through their lifestyle choices. To save the second planet and live within our fair share of the Earth's resources, we must also reduce the impact of our shared infrastructure and services.

### **Next Steps**

If the government wishes to meet its own sustainable development targets and realise the aspirations set out in the Sustainable Communities Plan, it must set minimum sustainable construction standards and create the necessary infrastructure and services to enable people to live within their fair share of the Earth's resources. Provision of the new and upgraded levels of infrastructure to facilitate development in the Thames Gateway will require substantial investment. By spending this money differently, significant environmental savings could be made for the same costs.

Key decisions about the Thames Gateway and the other growth areas will be made before the reforms of the planning and building regulations are implemented. In the absence of a reformed regulatory framework, WWF believes the government must intervene to ensure that development throughout the Thames Gateway and the other growth areas meets the highest possible sustainable development standards. New communities should be developed to Z<sup>2</sup> standards to enable residents to live sustainably and achieve 'one planet living'. As an absolute minimum, the government should require that homes be built to the highest BRE EcoHomes standards of 'Very Good' or 'Excellent'.

If the government is serious about ensuring that new communities are truly sustainable and about meeting its other sustainable development targets, it must take a lead. To enable us to live sustainably within the resources of one planet, the government must tackle construction standards and how it provides shared infrastructure and services, and we must tackle our travel demands and our individual consumption of goods and food.

## Appendix 1: The health benefits of a compact environmentally friendly city

*Dr Robin Stott. 05.05.03*

Good health is based on a number of well recognised determinants, most of which are affected by the built environment. These determinants have been grouped together as social, environmental and economic. For the best possible individual and societal health all the determinants have to be in place. A society in which these determinants are in place would be suffused with social, environmental and economic justice, and so would not only be healthy, but sustainable.

A compact, eco-friendly city as defined in the Z<sup>2</sup> Scenario can beneficially impact on many determinants. We discuss these under three headings:

1. direct benefit to individual inhabitants;
2. indirect benefit to individual inhabitants; and
3. benefit to the wider and global community.

### Direct benefits

- a) **Exercise.** The reliance in a compact city on bicycles, walking and public transport will increase exercise levels. This will improve people's present health, and also on average give individuals years of healthy added life. A good comparator is Amsterdam, where 25 per cent of all journeys are by bicycle, and levels of obesity are much lower than in London.
- b) **Enhanced sense of community.** The public spaces in compact cities will be people friendly, and the increase in walking and bicycling will increase the street life. Contact between individuals in a community is helpful in increasing trust and promoting good neighbourly behaviour. These are important in the nurturing of social capital, in its turn beneficial to health.
- c) **Reduction in ambient noise and dislocation of community.** Motor cars are noisy, and streets dominated by motor traffic are disruptive to interactions between neighbours. The number of neighbourly contacts is inversely related to traffic density. The reduction in traffic will help enhance the sense of community. There would also be a reduction in traffic accidents, a major cause of death in many 'traditional' neighbourhoods.
- d) **Availability of locally produced, organically grown food,** and elimination of food deserts

### Indirect benefits

- a) **Reduction in respiratory disease** consistent with a fall in the level of air pollution. Respiratory diseases, including provocation of attacks of asthma, are more prevalent when air pollution levels are high. There are 20,000 deaths each year in the UK attributable to air pollution. Reducing levels will contribute to a reduction in these deaths.
- b) **The enhanced sense of trust** which comes with interactive communities diminishes the perception of dangerous streets because of antisocial behaviour and crime. Anxieties about the danger people face on streets is an oft-cited cause of ill health.
- c) **Elimination of fuel poverty** would be a part of all the scenarios, but in the compact city this would be accompanied by a lowering of CO<sub>2</sub> production, and thus link the social and economic benefits of relief of fuel poverty with the environmental benefits of CO<sub>2</sub> reduction. Networked CHP plants could be a feature of any of the scenarios. A fuel poor household is

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defined as one which cannot sustain reasonable health (21°C in the living room, 18°C in the rest of the house) at a reasonable cost (< 10 per cent of income). In 1999 there were 4.5 million fuel poor homes in the UK, 50 per cent of which housed people over 60 years and 20 per cent of which housed children. There are estimated to be 20-50,000 excess deaths in the UK between December and March each year, and a significant proportion of these relate to fuel poverty. Respiratory disease, heart disease, domestic accidents, problems of immobility and social isolation are all contributory causes.

- d) Compact environmentally-friendly communities are an example of a **virtuous cycle of activity**, in which social, economic and environmental determinants of health are promoted in synergy. These virtuous cycles are important, as in conventional cities, the wax of one set of determinants may be the wane of others, a situation which cannot in the medium and long term sustain health.
- e) **Benefits of exemplary public buildings.** Health premises and other public service buildings which encouraged local employment, sustained local production and consumption cycles, and were zero emission buildings would not only provide the relevant public service, but act as inspirational models for the rest of the community.
- f) **Local production and consumption cycles**, while not impossible in conventional cities, will be facilitated by compact cities. Many such cycles of consumption create virtuous cycles of activity which are of crucial importance in promoting health and sustainability. Local production of organic food is an example of such a virtuous cycle. Organic food grown in allotments and roof or other gardens produces readily available fresh food, reduces pesticide residues in food, reduces food miles, supports local traders, and gives employment to local people.
- g) **Compact cities will thus in many ways promote a greater sense of community and a greater degree of control over one's own destiny.** This is likely to increase the participation level of citizens in all aspects of their lives. Such participation is the bedrock of sustainability and health.

## Global benefits

The footprint of compact, eco-friendly cities will be substantially lower than the norm, and will contribute to the amelioration of climate change. Climate change is associated with many adverse health consequences, although most of these relate to people living in the poorer areas of the world. Samples of these are:

- a) The rise in sea levels will lead to the flooding of many densely populated areas, such as the Delta of the Brahmaputra in Bangladesh. This will have devastating consequences for the health and wellbeing of the population.
- b) The warming of present temperate climates will lead to the spread of vectors of many diseases, including malaria. There are 500 million cases of malaria each year, with a million deaths. Young children and pregnant mothers are most affected, and every 30 seconds a child dies of malaria. Each episode causes an average 12 days loss of productive work, and as malaria is most common in the agricultural season, this is doubly incapacitating. It is estimated that malaria destroys 35 million years of productive human life each year. Climate change is one significant cause of the re-emergence and spread of malaria.
- c) Climate change is predicted to increase the extremes of weather worldwide, so droughts, hurricanes and other 'natural' disasters will become more common. The resultant disruption of agriculture in many marginal areas of the world will lead to starvation and social unrest and mass migration in these areas.

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The organisation Global Environmental Change estimates that climate change will cause losses of up to 10 million tonnes of maize, affecting more than 140 million people in the developing world. There are already one billion people living at starvation level and this loss of the staple diet of sub-Saharan Africa will seriously exacerbate this problem.

Starvation, through reduction in both total calories and essential nutrients such as iron, causes many disease syndromes and chronic ill health, as well as leading to premature death. Children and pregnant mothers are always worst affected. For instance, in Bihar (India) 60 per cent of pregnant women have significant Iron Deficiency Anaemia.

Clearly, even a large eco-friendly city will only have a small impact on these global problems, but it will be exemplary, and thousands of compact eco-friendly cities will make a substantial difference.

## Appendix 2: Scenario Data-sets

ISSUE	Scenario 1 Typical UK resident in typical new UK home to 2002 Building Regulations	Scenario 2 Typical UK resident in typical new UK home to EcoHomes 'Very Good'	Scenario 3 Environmentally-aware resident In typical new UK home to EcoHomes 'Very Good'	Scenario 4 Z <sup>2</sup> : Zero fossil energy, zero waste community
Energy use in the home	<ul style="list-style-type: none"> <li>Typical UK energy demand</li> <li>UK new insulation levels</li> <li>'C'-rated white goods</li> <li>Non-condensing boiler</li> <li>Space heating = 5278 kWh</li> <li>Hot water = 3900 kWh</li> <li>Cooking = 614 kWh</li> <li>Lights and appliances = 2859kWh</li> <li>(Per household/year BRE 2002)</li> <li>Bill costs based on DTI unit costs of 1.64p/kwh for gas, 7.23p/kwh for electricity (inclusive of standing charge and averaged for credit/direct debit)</li> <li>Based on space heating and water demands being met by gas (85%) and electricity (15%). Energy for cooking assumed 50:50.</li> <li>National Statistics data indicates average London expenditure of £234 /person/year if average national household size figure (2.33) applied</li> </ul>	<ul style="list-style-type: none"> <li>Lower energy demand</li> <li>Better insulation levels</li> <li>'A'-rated white goods</li> <li>Condensing boiler.</li> <li>Space heating = 3333 kWh</li> <li>Hot water = 3055 kWh</li> <li>Cooking = 614 kWh</li> <li>Lights &amp; app. =1536 kWh</li> <li>(BDG estimated for SAP 105 using energy efficient lights, appliances, good insulation &amp; condensing boiler)</li> <li>Bill costs based on DTI unit costs (see Scenario 1)</li> <li>Based on same gas/electricity mix as Scenario 1</li> </ul>	<ul style="list-style-type: none"> <li>As Scenario 2</li> </ul>	<ul style="list-style-type: none"> <li>Zero (fossil) Energy</li> <li>Very low UK energy demand</li> <li>UK better insulation levels</li> <li>'A'-rated white goods</li> <li>On-site waste CHP/pyrolysis plant</li> <li>Space heating = 333 kWh (90% reduction)</li> <li>Hot water = 3055 kWh (as UK average)</li> <li>Cooking = 614 kWh (as UK average)</li> <li>Lights &amp; appliances = 1430 kWh (50% reduction)</li> <li>(BDG estimate based on BedZED design criteria)</li> <li>Bill costs based on design data and unit charges</li> </ul>
Transport	<ul style="list-style-type: none"> <li>Average UK travel pattern</li> <li>No home office</li> <li>Travel Pattern (miles per person per year)</li> <li>Walk = 189 miles</li> <li>Pedal cycle = 39 miles</li> <li>Cars/private road vehicles = 5713 miles</li> <li>Bus = 245 miles</li> <li>Rail = 425 miles</li> <li>Taxi = 205 miles</li> <li>TOTAL = 6815 miles</li> <li>(DTI, 2001 Travel survey)</li> <li>National Statistics data suggested average South East expenditure.</li> <li>£ 1700 / £ 730 Purchase of vehicles</li> <li>£ 1622 / £ 696 Operation of personal transport</li> <li>£ 489 / £ 210 Transport services</li> <li>(£ 166 / £ 71 Rail/tube)</li> <li>(£ 52 / £ 22 bus/coach)</li> <li>(£ ? / £ 103 taxi (assumed))</li> <li>(£ ? / £ 14 other (calculates as 1.6%))</li> <li>£ 3811 / £ 1635 Total per HH / per person</li> </ul>	<ul style="list-style-type: none"> <li>Lower private car use</li> <li>Home office</li> <li>5% overall journey reduction</li> <li>10% reduction in private car use</li> <li>Travel Pattern (miles per person per year)</li> <li>Walk = 270 miles</li> <li>Pedal cycle = 60 miles</li> <li>Private road vehicles = 5140 miles</li> <li>Public trans = 1000 miles</li> <li>(Bus = 280 miles)</li> <li>(Rail = 486 miles)</li> <li>(Taxi = 234 miles)</li> <li>TOTAL = 6470 miles</li> <li>(BDG estimate)</li> <li>£ 730 Purchase of vehicles</li> <li>£ 626 Operation of personal transport</li> <li>£ 239 Transport services</li> <li>(£ 81 Rail/tube)</li> <li>(£ 25 bus/coach)</li> <li>(£ 117 taxi (assumed))</li> <li>(£ 16 other (assumed @1.6% of public transport))</li> <li>£ 1595 per person / annum TOTAL</li> </ul>	<ul style="list-style-type: none"> <li>Resident is a member of a car club</li> <li>Sometimes works from home</li> <li>20% overall journey reduction</li> <li>40% reduction in car use</li> <li>Travel Pattern (miles per person per year)</li> <li>Walk = 280 miles</li> <li>Pedal cycle = 239 miles</li> <li>Private road vehicles = 2584miles</li> <li>Car club miles = 500 miles</li> <li>Public trans = 1573 miles</li> <li>(Bus = 489 miles)</li> <li>(Rail = 850 miles)</li> <li>(Taxi = 234 miles)</li> <li>TOTAL = 5176 miles</li> <li>(BDG estimate)</li> <li>£ 730 Purchase of vehicles</li> <li>£ 315 Operation of personal transport</li> <li>£302 Car club</li> <li>£ 328 Transport services</li> <li>(£ 142 Rail/tube)</li> <li>(£ 44 bus/coach)</li> <li>(£ 117 taxi (assumed))</li> <li>(£ 25 other (assumed @1.6% of public transport))</li> <li>£ 1817 per person / annum TOTAL</li> </ul>	<ul style="list-style-type: none"> <li>40% overall journey reduction</li> <li>Majority of journeys by foot/cycle</li> <li>85% reduction in car miles, no private fossil fuel miles, all via car club</li> <li>Home office &amp; local employment</li> <li>Travel Pattern (miles per person per year)</li> <li>Walk = 305 miles</li> <li>Pedal cycle = 505 miles</li> <li>Car club = 840 miles</li> <li>Public trans = 2430 miles</li> <li>(Bus = 803 miles)</li> <li>(Rail = 1393 miles)</li> <li>(Taxi = 234 miles)</li> <li>TOTAL = 4080 miles</li> <li>(BDG estimate)</li> <li>Car club total miles, average journey length (15 miles / 3 hours) and costs (£2.30 per hour and £0.15 per mile) based on Smart Moves data</li> <li>£ 140 Car club membership</li> <li>£ 512 Operation of personal transport</li> <li>£ 458 Transport services</li> <li>(£ 232 Rail/tube)</li> <li>(£ 72 bus/coach)</li> <li>(£ 117 taxi (assumed 50p / mile))</li> <li>(£ 37 other (assumed @1.6% of public transport))</li> <li>£ 1113 per person / annum TOTAL</li> </ul>

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<b>House</b>	<ul style="list-style-type: none"> <li>Typical UK home construction</li> <li>Typical UK new residential build costs, extrapolate into sales cost and hence mortgage costs</li> <li>average UK mortgage is £94,200 (moneynet.co.uk September 2002)</li> <li>Suggests monthly payments of <b>£585</b> over 25 years @ 5.5%</li> </ul>	<ul style="list-style-type: none"> <li>Typical UK home construction, with more insulation and materials with lower environmental impacts</li> <li>(Sustainable Homes suggests approx. 4% higher cost compared with HA usual spec.)</li> <li>If mortgage if 4% higher then suggests £97,968. Equates to monthly payments of <b>£608</b> over 25 years @ 5.5%</li> </ul>	As Scenario 2	<ul style="list-style-type: none"> <li>Similar embodied energy to typical UK new home construction, but with much more insulation and more inert materials. Reclaimed, recycled and locally sourced materials extensively used</li> <li>If mortgage is 20% higher then suggests borrowing of £113,040. Equates to monthly repayments of <b>£702</b> over 25 years @ 5.5%</li> <li>Higher build costs, extrapolate into sales cost and hence mortgage costs</li> </ul>
<b>Shared Infrastructure</b>	<ul style="list-style-type: none"> <li>Current levels of infrastructure shared equally</li> <li>No. of power stations of what type and size, plus infrastructure?</li> <li>Amount of roads, garages, petrol stations, bridges, car parks, airports, footpaths and cycle ways etc</li> <li>No. of food RDC and processing facilities of what size?</li> <li>No. of goods RDC and processing facilities of what size?</li> <li>No. of water purification and sewage plants of what size, plus infrastructure?</li> <li>Amount of rainwater infrastructure?</li> <li>No. and size of recycling facilities and incinerators?</li> <li>Amount of landfill space?</li> </ul>	<ul style="list-style-type: none"> <li>Reduced transport and energy infrastructure</li> <li>Less waste landfill, but some more waste processing infrastructure</li> <li>Reduced water processing infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>Reduced transport infrastructure</li> <li>Less waste landfill, but some more waste processing infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>Further reduced transport and energy infrastructure</li> <li>Even less waste landfill, with some more waste processing infrastructure</li> <li>Further reduced water processing infrastructure</li> <li>Reduced material extraction and transport infrastructure, increased material recycling and reclaiming facilities</li> <li>Fewer airports and infrastructure associated with air-freighted imported goods</li> </ul>
<b>Waste &amp; Consumer items</b>	<ul style="list-style-type: none"> <li>Average UK consumption of goods</li> <li>National Statistics data suggested average South-east expenditure for sections 3, 5, 9.1, 9.2, 9.3, 9.5, 12.1 and 12.2.</li> <li>£108/household/week or</li> <li>£2410/person/year</li> <li>Average UK domestic waste production of 520 kg/person/year</li> <li>Typical recycling rate of 12%</li> <li>79% landfill and 9% incineration</li> <li>Average cost countywide for the kerbside collection of municipal waste was £32.08 per tonne during 2000/01.</li> <li>Average cost countywide for the disposal of municipal waste to landfill was £31.80 per tonne of municipal waste during 2000/01.</li> <li>Biffa estimates strategy would cost £50/tonne</li> </ul>	<ul style="list-style-type: none"> <li>Average UK consumption of goods</li> <li>Average UK waste production of 520 kg/person/year</li> <li>25% higher recycling levels of 15.5%</li> <li>As Scenario 1</li> </ul>	<ul style="list-style-type: none"> <li>Consumption reduced by 15% through lifestyle choices</li> <li>Waste levels reduced by 15%</li> <li>25% of domestic waste recycled or composted</li> <li>70% landfill and 5% incinerated</li> </ul>	<ul style="list-style-type: none"> <li>Promotion of reclaimed and recycled goods.</li> <li>25% reduced consumption</li> <li>25% reduced packaging levels</li> <li>25% less waste than UK average</li> <li>25% of which is recycled</li> <li>25% of which is composted</li> <li>25% of which is gasified in a CHP</li> <li>25% of which is landfilled</li> <li>Waste-to-energy solutions</li> <li>Biffa estimates strategy would cost £80/tonne, cheaper to recycle than landfill in the future.</li> </ul>
<b>Water</b>	<ul style="list-style-type: none"> <li>Average UK water consumption</li> <li>134 litres/person/day metered water (OFWAT)</li> <li>BRE estimates 1.95m3 used externally per person per annum</li> <li>Hence, 128 litres/person/day sewerage</li> <li>(If new UK home with power shower then water demand up to 230 litres/day)</li> <li>In = (48.91m3 x 0.7243)+17.58=£53</li> <li>Out = (46.72m3x0.6542)+29.35=£60</li> <li>2001-02 Expenditure and Food Survey suggests average annual cost per person in SE of 'water supply and misc. services relating to the dwelling' = £118 approx.</li> </ul>	<ul style="list-style-type: none"> <li>low water consumption</li> <li>82 litres/person/day</li> <li>BRE estimates 1.95m3 used externally per person per annum (EcoHomes)</li> <li>Hence, 76 litres/person/day sewerage</li> <li>In = (29.93m3 x 0.7243) + 17.58 = £39</li> <li>Out = (27.74m3 x 0.6542) + 29.35 = £48</li> <li>Calculate as cost per m3 of domestic water consumer and sewage produced</li> </ul>	As Scenario 2	<ul style="list-style-type: none"> <li>Very low water consumption 47 litres/person/day</li> <li>BedZED average over all dwellings = 72 lpppd</li> <li>On-site grey water processing</li> <li>Rainwater harvesting meets external water demand</li> <li>If 47 litres/day and water recycling= £74</li> <li>In(32l)=(11.68m3x0.586)+19=£26</li> <li>Ingreen(15l)=(5.475m3x0.527)=£3</li> <li>Out (47 litres) = (17.16m3 x 0.4325) + 38.00 = £45</li> <li>If 47 l/day with no water recy= £71</li> <li>In =(17.16m3x0.7243)+17.58= £30</li> <li>Out=(17.16m3x0.654)+29.35=£41</li> </ul>

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Built land	<ul style="list-style-type: none"> <li>40 homes/hectare in core</li> <li>2-storey development average</li> </ul>	<ul style="list-style-type: none"> <li>40 homes/hectare in core</li> <li>2.5-storey development average</li> </ul>	As Scenario 2	<ul style="list-style-type: none"> <li>80 homes/hectare in core</li> <li>3-storey development average</li> </ul>
Services	<ul style="list-style-type: none"> <li>Retail, recreation, healthcare, hotel and catering, communications, banking and finance</li> <li>National Statistics data suggested average South-east expenditure</li> <li>Health £6.20/hh/week or £138/person/year</li> <li>Communications £11.30/hh/week or £252/person/year</li> <li>Restaurants and hotels £35.30/hh/week or £788/person/year</li> <li>Insurance, care &amp; legal fees £24/hh/week or £536/person/year</li> <li>Licences and fines £3.40/hh/week or £76/person/year</li> <li>Money transfers and credit £19.50/hh/week or £435/person/year</li> <li>Life assurance and pensions £29.60/hh/week or £660/person/year</li> <li>Income tax £111.10/hh/week or £2480/person/year</li> <li>National Insurance £23.70/hh/week or £529/person/year</li> <li>Savings and investments £9.50/hh/week or £212/person/year</li> <li>Paying off loans £3.40/hh/week or £76/person/year</li> <li>Windfall from receipts £1.20/hh/week or £27/person/year</li> <li>Average bill for Band D (England) 2003/04</li> <li>Council tax £1102/hh/year or £473/person/year</li> </ul>	As Scenario 1	Fewer commercial services used due to reduced consumption	<ul style="list-style-type: none"> <li>10% fewer 'services' resources used</li> <li>Less healthcare needed</li> <li>Less consumption</li> <li>Less travel</li> </ul>
Food	<ul style="list-style-type: none"> <li>Average UK consumption</li> <li>Food and non-alcoholic drinks £44.10/hh/week or £984/person/year</li> <li>Alcoholic drinks, tobacco £11.20/hh/week or £250/person/year</li> <li>National Statistics data suggested average South-east expenditure</li> </ul>	<ul style="list-style-type: none"> <li>Average UK consumption</li> <li>As Scenario 1</li> </ul>	Increased consumption of local and organic food	<ul style="list-style-type: none"> <li>Low meat/dairy or vegetarian lifestyle</li> <li>Increased fruit and veg. intake</li> <li>Promotion of local and organic food.</li> <li>Less packaging</li> <li>Organic food is currently about 25% more expensive on average than intensively-farmed food (<a href="http://www.organicfood.co.uk">www.organicfood.co.uk</a>)</li> <li>South West local food partnership research found that produce sold at farmers markets was between 30-40% cheaper than that sold in supermarkets. Much of the produce is also organic. (<a href="http://www.localfood.org.uk">www.localfood.org.uk</a>)</li> <li>Perhaps therefore assume same costs overall?</li> </ul>

Assumes 200k households planned and occupancy of 2.33 pphh (persons per household)

The mission of WWF, the global environment network – is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by:

- conserving the world's biological diversity
- ensuring that the use of renewable resources is sustainable
- promoting the reduction of pollution and wasteful consumption

**[www.wwf.org.uk](http://www.wwf.org.uk)**



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**Taking action for a living planet**