Z SQUARED ONE PLANET LIVING COMMUNITY

Enabling One Planet Living in the Thames Gateway

A report from BioRegional

Jane Durney and Pooran Desai, BioRegional Development Group, November 2004

Design team:

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ONE PLANET LIVING

a joint initiative: BioRegional | WWF

The Design Team

BioRegional

Sustainability Specialists:
BioRegional Development Group is an independent environmental organisation working cross-industry in farming, forestry, recycling and eco-homes. They work with industry partners to implement real-life, commercially viable solutions for sustainable living – bringing local sustainability into the mainstream.

BioRegional was involved in initiating, designing and constructing the award-winning BedZED eco-village in South London. The project was designed with architect Bill Dunster and developed in partnership with the Peabody Trust.

BioRegional has launched a joint initiative with WWF – One Planet Living – and also provides consultancy services to Local Authorities, developers and other parties with an interest in sustainable living.

www.bioregional.com

KBR

Infrastructure Engineers:
KBR is a global engineering, construction, technology and services company and provides a wide range of engineering, construction, operations and maintenance, logistics and project management services for government and infrastructure projects around the world.

The company operates in the buildings, defence, highways, aviation, water, renewable energy and telecommunication market sectors and is a world leader in the successful delivery of major infrastructure projects. It provides planning, engineering, design, project management, programme management and technical services.

Current projects in the UK include the design and construction of circa 400 new buildings to BREEAM / EcoHomes Excellent Standard, design and construction of offshore wind farms, term appointment with the Environment Agency, design of landside infrastructure for Heathrow Passenger Terminal T5 and multi-modal transportation studies for London and the SE of England.

KBR operates in the Europe & Africa, USA and Asia Pacific regions and employs 83,000 people in 43 countries. KBR is the engineering, construction and services subsidiary of Halliburton.

www.halliburton.com/kbr

Foster and Partners
architects and designers

Architects:
Foster and Partners is an international studio for architecture, planning and design led by Norman Foster and a group of Senior Partners. The practice's work ranges in scale from Beijing Capital International airport to its smallest commission, a range of door furniture. The scope of its work includes masterplans for cities, the design of buildings, interior and product design, graphics and exhibitions. These can be found throughout the world.

www.fosterandpartners.com

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Cost Consultants:
Cyril Sweett is a leading UK construction consultant that has been delivering effective solutions to clients' businesses since 1928. They offer expertise in cost consultancy and project management, together with a diverse range of specialist consulting services.

www.cyrilsweett.co.uk

FULCRUM CONSULTING

Environmental, Energy and Water Infrastructure Engineers:
Fulcrum Consulting is a leading international practice of consulting engineers specialising in the built environment. Their primary areas of activity are the following:

- Mechanical and electrical services engineering
- Building physics and passive environmental control systems
- Public Health
- Daylighting and specialist artificial lighting design
- Sustainability
- Acoustics

www.fulcrumfirst.com

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Cover image: Z-squared concept courtesy of Foster and Partners

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1. Executive summary

If everyone on earth consumed natural resources and polluted the environment as we currently do in the UK, we would need at least three planets to support us. Reducing our ecological footprint to one planet is crucial in terms of ensuring long term sustainability. To help communicate the challenge we all face in reducing our environmental impact, and to facilitate change at local and global levels, BioRegional and WWF have launched a joint initiative "One Planet Living" (OPL) which aims to develop a global network of One Planet Living Communities to enable people to live within a fair share of the earth's resources.

According to South East England Development Agency (SEEDA)'s Taking Stock report, shared services and infrastructure together are the largest component of our ecological footprint, followed by food, transport, energy and water, and waste. Therefore we need to address the impact of each of these, in order to reduce their ecological footprint and to develop truly sustainable communities.

The Z-squared project has produced an infrastructure-led concept design for a 2,000 home mixed-use, and mixed-tenure development which takes tried and tested technologies and integrates them to achieve zero carbon emissions from the energy required for heating, cooling and electricity and close to zero waste to landfill.

The starting point for the project was to estimate the amounts of waste that would be generated by the homes, businesses and community facilities within the community, their energy demands for heating, cooling, lighting and appliances and their water consumption, in effect looking at the metabolism for the community. Working with a team comprising KBR building / infrastructure engineers and transportation planners, Fulcrum Consulting environmental energy and water engineers, a series of options were appraised. Cost estimates were produced by Cyril Sweett and an indicative masterplan was developed by Foster and Partners.

This report, Z-squared: Enabling One Planet Living in the Thames Gateway, is the culmination of the first phase of work to justify development of a One Planet Community in the Thames Gateway. It outlines scenarios for on-site infrastructure required to deliver zero carbon and zero waste and sustainable water use and treatment. It suggests the approach that should be taken to reduce the environmental impact of transport and food within a community. It proposes methods to reduce the environmental impact of construction materials and improve biodiversity. Incorporating strategies to increase equity and fair trade, and acknowledge culture and heritage, it offers a means by which people who live, learn and work in Z-squared can have happy and healthy lifestyles whilst living within a fair share of the earth's resources.

Our research, including economic appraisals by KBR and Cyril Sweett, demonstrates that it is commercially viable to build to Z-squared standards when taking into account lifetime costs, but by taking this approach, a lead developer takes on more than would be required of him in a conventional development. This report highlights the next steps that should happen to see Z-squared developed. This includes recognition of the benefits compared with a conventional development delivered by Z-squared, in terms of carbon emission savings, reduced pressure on mains water and water treatment infrastructure, off-site generation and distribution capacity and landfill capacity. There is a need for a new approach to owning and operating infrastructure in such a development with waste, water and energy services integrated to optimise performance.

Central government, the Office of the Deputy Prime Minister, the Greater London Assembly, Regional Development Agencies, Local Authorities as well as Registered Social Landlords and developers all have a role to play in supporting development to Z-squared standards and thus delivering truly sustainable communities.

Section A: Context

2. Introduction

"Unless we are guided by a conscious vision of the kind of future we want, we will be guided by an unconscious vision of the kind of present we already have."
(The Edge magazine 1995)

If everyone on this 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[1]. Reducing our ecological footprint to one planet through One Planet Living is crucial in terms of ensuring long term sustainability.

BioRegional initiated the award-winning Beddington Zero (fossil) Energy Development (BedZED), designed by Bill Dunster architects and developed by the Peabody Trust. In June 2003, BioRegional, with WWF, published *One Planet Living in the Thames Gateway*[2]. The study focussed on the Thames Gateway region and investigated the implications of building 200,000 new homes to different environmental standards. It found, through ecological footprinting analysis, that UK residents could reduce their "three planet lifestyle" by approximately one planet through their lifestyle choices and living in a sustainable home. 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.

The Z-squared project aimed to produce an infrastructure-led concept design for a zero carbon and zero waste (Z-squared) settlement for up to 5,000 people (2,000 homes), taking existing knowledge of waste management and renewable energy technologies and integrating them to develop a community that will make it easier for people to live a one planet lifestyle. Since the beginning of 2004, BioRegional Development Group has been working with engineers KBR, Fulcrum Consulting, cost consultants Cyril Sweett and architects Foster and Partners, first to map the energy, water and material flows through the Z-squared community, then to assess the options to achieve zero carbon and zero waste, leading to an indicative masterplan for the community and development of preliminary costs plans and development appraisals. KBR demonstrated the impact of the proposals on the main developer, the need to focus on energy rather than enhanced building fabric and then produced economic justification for the adoption of Z-squared, based on estimates of both capital and annual costs avoided.

This report first sets the context for Z-squared, outlining the drivers for change – resource depletion, climate change, waste – before introducing the One Planet Living initiative and Z-squared as a response to these challenges. Waste, energy, water and transport infrastructure have been considered, together with other aspects such as lifestyles, cultural heritage and biodiversity. Preliminary costs have been developed for a business-as-usual base case based on current building regulations, and has been compared to a number of low carbon and zero carbon options. The costs for the preferred option have then been compared with the costs avoided by not adopting the base case, both on- and off-site. It is clear from this comparison that Z-squared is commercially viable and merely needs appropriate recognition and facilitation to become a reality. Finally, the next steps to see Z-squared developed as a real community are outlined.

This concept design shows the extent to which zero carbon and zero waste can be achieved using existing technologies and highlights the political and technological changes required to make it become a reality. Undoubtedly, technology will allow greater environmental savings as we move into the future; Z-squared will build on the achievements of BedZED and is a stepping stone along that path.

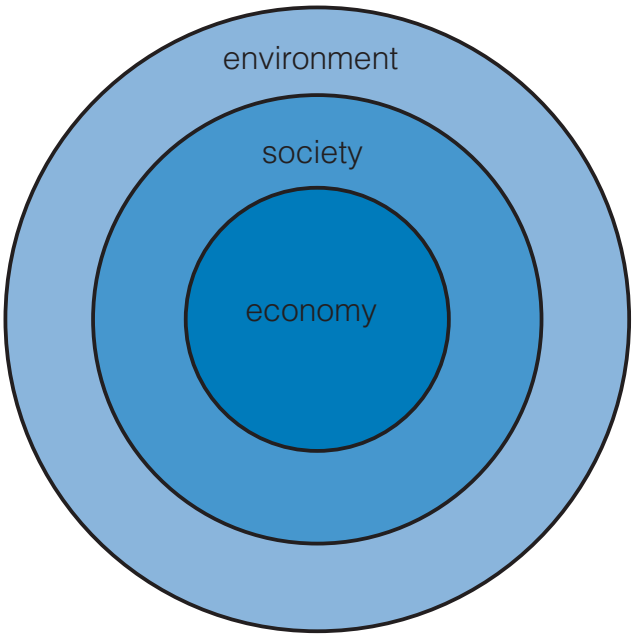
3. Sustainability

We live in a society where our consumption of energy, goods (and therefore natural resources) and production of waste is ever-increasing and is beyond our fair share of the earth's resources. Increasing levels of carbon dioxide (CO_2) and other greenhouse gases in the atmosphere are causing climate change. European Union (EU) legislation and government targets in relation to energy and waste are leading to a greater emphasis on renewable energy generation and more efficient use of resources, with increased reuse, recycling, composting, and recovery of value from residual waste. We rely on the earth for the resources we need to sustain our lives and to absorb our waste. Living unsustainably beyond the carrying capacity of the earth is resulting in the degradation of our environment, diminished human wellbeing and may ultimately leave future generations a planet that is unable to sustain life.

What is sustainability?

There are numerous definitions of sustainability, the best known of which is: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (World Commission on Environment and Development – The Brundtland Commission). It is also commonly represented as three inter-related factors: economy, environment and society, often portrayed as a "triple bottom line" or three pillars. BioRegional subscribes to a model that places environmental sustainability as the real bottom line. This is based on two fundamental tenets, that commerce cannot exist outside society and that our society cannot exist outside the environment.

Figure 1: Nested model representing inter-relationships between environment, society and economy



The UK government has made commitments on a wide range of social, economic and environmental targets. It is committed to a series of Headline Sustainable Development Indicators (Figure 2) to measure progress with respect to sustainable development, and has set out its aims of achieving a sustainable future through the Waste Strategy 2000, the Energy White Paper 2003 and the Sustainable Communities Plan.

However, as the UK Sustainable Development Commission stated in April 2004, this "shows promise. But must try harder" to meet the challenge of integrating social environmental and economic factors. The report states, "the UK has failed to get a grip on consumption of environmental resources. There is insufficient grasp of the severity of the threat from climate change and the urgency of the need to reduce greenhouse gas emissions." We still have a society and government whose primary goal is economic growth, with social justice and environmental protection reconciled where possible.

Up to 3.8 million[i] new homes will be required in England and Wales by 2021, mostly in the South East, which conflicts with the sustainable development targets unless they are built to strict standards for sustainability.

[i] Environment Agency

Figure 2: UK Headline Sustainable Development Indicators

- **Economic growth**
  - Economic output – our economy must continue to grow
  - Investment – investment (in modern plant and machinery as well as research and development) is vital to our future prosperity
  - Employment – maintain high and stable levels of employment so everyone can share greater job opportunities
- **Social progress**
  - Poverty & social exclusion – tackle poverty and social exclusion
  - Education – equip people with the skills to fulfil their potential
  - Health – improve health of the population overall
  - Housing – improve the condition of housing stock
  - Crime – reduce both crime and fear of crime
- **Environmental protection**
  - Climate change – continue to reduce our emissions of greenhouse gases now, and plan for greater reductions in the longer term
  - Air quality – reduce air pollution and ensure air quality continues to improve through the longer term
  - Road traffic – improve choice in transport; improve access to education, jobs, leisure and services; and reduce the need to travel
  - River water quality – improve river quality
  - Wildlife – reverse long-term decline in populations of farmland and woodland birds
  - Land use – reuse previously developed land, in order to protect the countryside and encourage urban regeneration
  - Waste – move away from disposal of waste towards waste reduction, reuse, recycling and recovery

Source: www.sustainable-development.gov.uk

Measuring our environmental impact

One way of measuring the environmental impacts of a process, product, community, organisation or an individual's lifestyle is to use ecological footprinting analysis. The methodology provides an accounting tool that measures environmental impact in terms of biologically productive land required to produce a particular natural resource, absorb waste materials arising from consumption and sequester the CO_2 emissions associated with energy demands.

This methodology can be used to compare the calculated "footprint" with available bio-productive land to see whether we are living within the regenerative capacity of the Earth; whether we are living off the earth's interest, or eating into its capital.

Ecological footprinting provides an effective communication tool for representing whether we are living sustainably or not. According to WWF's *Living Planet Report 2004*[3], it takes around 5.4 global hectares of biologically productive land to support each person in the UK compared to the available area of 1.8 global hectares per person (global bio-productive land divided by global population). If everyone in the world lived as we do in the UK, we would need three planets to support us. We therefore need to reduce our impact, our "ecological footprint", by two-thirds to a sustainable and globally equitable level.

Figure 3: the UK's three planet challenge

BioRegional

Different countries have different levels of consumption. In the USA, five planets would be needed, whilst in China, although currently living within their fair share of the earth's resources, rapid development will lead to a massive environmental impact.

Table 1: Ecological footprint for several countries

	EF (ha / person)	**How many planets?**
USA	9.5	
Australia	7.7	
UK	**5.4**	
South Africa	2.8	
China	1.5	
Somalia	0.4	

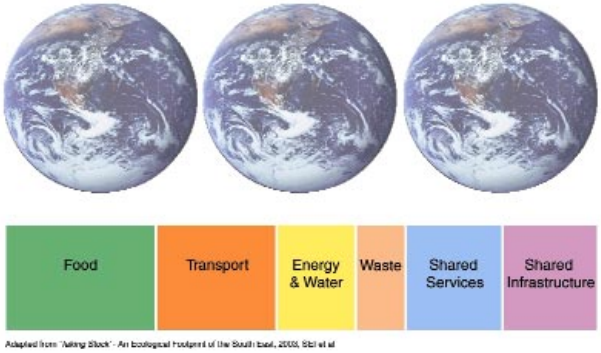
Source: WWF Living Planet Report 2004[4]

Within the UK, there is variation in levels of consumption and hence ecological footprint. A number of regions are undertaking ecological footprint studies to enable them to understand the resource flows and energy consumption arising from activities in their area and to help them when making decisions about options for the future.

An individual's ecological footprint comprises the footprints of all their work and leisure activities, food and products consumed and waste produced. It also includes the area of forest required to sequester CO_2 emissions associated with that individual's energy use, together with a share of the footprint of shared infrastructure and services such as airports, roads, financial services, hospitals, schools and other public services. Figure 4 illustrates one way of dividing up the footprint of a UK individual into the component aspects of their lifestyle. The diagram highlights the relative importance of lifestyle choices compared with the impact of our buildings (i.e. our footprint associated with food consumption compared with the impact of materials used in our home). It also shows the importance of our shared infrastructure, which is difficult to address as an individual but can be addressed at the community level.

We need to rise to the challenge of One Planet Living and reduce our ecological footprint to the one planet level in order to live within our fair share of the earth's resources. The Z-squared project aims to build the infrastructure, and offer residents choices, that will enable them to have a high-quality lifestyle that reduces their impact on the environment.

Figure 4: Components of the average UK individual's ecological footprint



Climate change

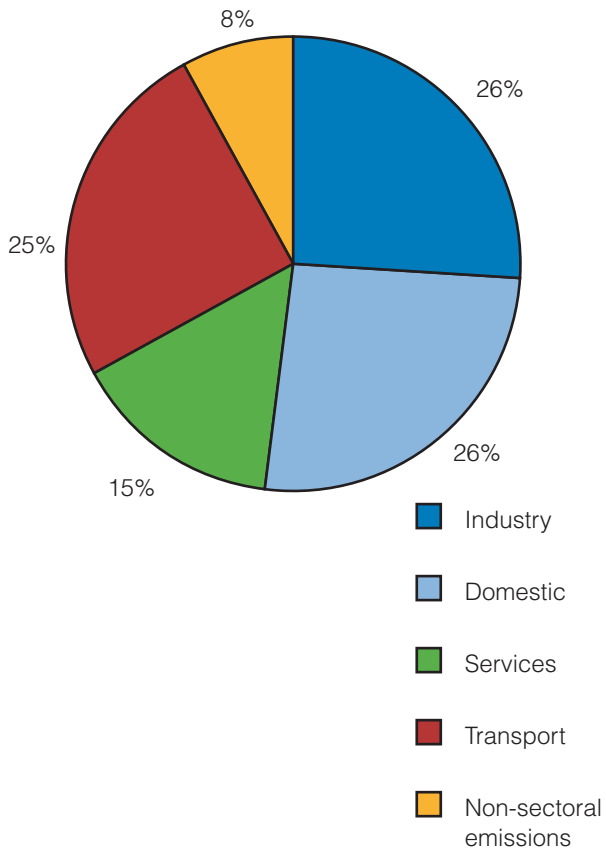
It is widely accepted by the international scientific community that climate change is occurring, caused in part by excessive greenhouse gas emissions generated by humans burning fossil fuels and deforestation. The UK Government's Chief Scientist[5] has asserted that climate change represents a greater threat than terrorism, a view endorsed by a recent Pentagon report. In the UK, the effects of climate change are likely to include a warmer climate with hotter and drier summers and milder winters, and changing rainfall patterns resulting in wetter winters and increased flooding risk. Sea levels will rise and storm surges will increase in intensity and become more frequent. In the longer term, the UK may return to Siberian conditions if the ocean's circulation system shifts or switches off in response to the effects of global warming.

Under its obligations to the Kyoto Protocol, the UK government has committed to a 12.5% reduction in greenhouse gas emissions against 1990 levels over the period 2008 to 2012. The government's energy white paper[6] sets a long term aspiration for a 60% reduction in CO_2 emissions by 2050, in line with the Royal Commission on the Environment and Pollution recommendations[7]. In relation to the energy supply mix, the white paper confirms a target of 10% electricity demand to be provided by renewables by 2010 together with an aspiration of doubling this share by 2020. In the white paper, there are additional statements relating to combined heat and power (CHP), energy efficiency and fuel poverty.

Statistics published by Department for Environment Food and Rural Affairs (DEFRA) in 2004 indicate that UK CO_2 emissions increased by 1.5% during 2003, partly reversing a 3.5% reduction the previous year, although 2003 emissions were approximately 14% below the 1990 baseline. However, globally, CO_2 (and other greenhouse gas) emissions are increasing through increased use of fossil fuels and deforestation. In order to stabilise concentrations of CO_2 in the atmosphere, we need to reduce CO_2 emissions and converge on an equitable global per capita CO_2 "allowance". This "Contraction and Convergence" greenhouse gas abatement methodology proposed by the Global Commons Institute[8] is widely recognised as the only equitable approach that will stabilise greenhouse gas levels. It is supported by the UK's Royal Commission on Environmental Pollution, the UN Environment Programme, the European Parliament and the German Advisory Council on Global Change, as well as many developing countries.

Figure 5 shows the proportions of carbon emissions attributable to each sector in the UK. All future developments must mitigate their contribution to climate change by reducing carbon emissions through a combination of reducing demand for energy and supplying it, as far as possible, by renewable means. Work carried out by the London Sustainable Development Commission to inform the Mayor of London's Energy Strategy showed that if London is to meet the target of a 60% cut in CO_2 emissions by 2050, all new buildings must be carbon neutral. With the inevitability of climate change, future developments must also be able to adapt to its consequences by being able to withstand warmer temperatures and being flood resilient.

Figure 5: UK Carbon Emissions



Source: Department of Trade and Industry (DTI) 2002

The carbon footprint for the average person in the UK is 12 tonnes[9] of CO_2 per year (including direct emissions and carbon emissions associated with imported food and goods). Table 2 outlines where these emissions arise. The primary focus to date has been to improve building standards; however, Table 2 demonstrates the need to focus more on food, transport and infrastructure if the UK Government is to achieve its longer-term carbon reduction targets. Indeed, the highest individual carbon impact is currently food due to long-distance haulage and air freight imports, as well as increased use of fertilisers and pesticides. Transportation is the fastest growing element of our carbon footprint, with increasing car use and the rise in aviation, particularly short-haul flights.

Table 2: Carbon footprint for the average UK lifestyle

	UK average %
Space heating in the home	4%
Hot water	4%
Appliances in the home	3%
Personal transport	18%
Embodied energy in home infrastructure	3%
Waste and consumer items	13%
Food	23%
Shared services (share of total energy for running schools, hospitals, financial services, etc.)	12%
Shared infrastructure (share of energy for constructing schools, hospitals, roads, airports, etc.)	20%
Total	**100% (12 tonnes CO_2)**

Source: BioRegional Development Group

BioRegional has undertaken analysis of the carbon savings achieved by residents at BedZED, the award-winning eco-village designed to be carbon neutral in the supply of energy to the buildings. The research is based on both monitored consumption figures and consultation with residents. The findings suggest a 41% carbon saving against the average for the South East of England with the greatest savings being delivered by the wood-fired CHP, together with the Green Transport Plan and car club.

Waste

Municipal Solid Waste (MSW) arisings in the UK are growing at 3% per annum[10] and are inextricably linked to growth in Gross Domestic Product (GDP). Over 75% of MSW is sent to landfill and only around 12% recycled[ii]. The Environment Agency estimates that the UK has approximately six years landfill capacity remaining at current rates of waste generation. The Institute of Civil Engineers suggests that up to 2,300 new waste treatment facilities must be operational by 2020 to avoid a waste crisis.

A significant component of MSW is Biodegradable Municipal Waste (BMW) which decomposes in landfill to produce methane, a more potent greenhouse gas than CO_2, which escapes to the atmosphere. Due to concerns about greenhouse gas emissions, the European Commission (EC) Landfill Directive has set targets for diversion of BMW from landfill (see Table 3). If the UK fails to meet the EC Landfill Directive targets, it will face fines of up to £180 million per year (£500,000 per day). These are challenging targets, made more difficult to achieve because of the UK's reliance on landfill as a waste management option, and the year-on-year increase in waste arisings[11].

Table 3: EC Landfill Directive

BMW levels allowed to landfill	**Target year for UK**
75% of 1995 quantities	2010
50% of 1995 quantities	2013
35% of 1995 quantities	2020

Note: this includes a 4 year derogation open to the UK as a Member State landfilling more than 80% of MSW in 1995.

In response to the EC Landfill Directive, in Waste Strategy 2000, the UK government established a series of national targets (see Table 4). The latest waste surveys for 2003-2004 suggest that, while some local authorities (LAs) are achieving relatively high diversion from landfill, overall, they are some way off meeting next years target of 25% of household waste being recycled or composted.

Table 4: Waste Strategy 2000

Target year	**Percentage of household waste recycled and composted (Recovery of value, includes energy recovery)**
2005	25% (40%)
2010	30% (45%)
2015	33% (67%)
2003/4 Actual[iii]	London 13.2% UK 17.7%

ii DEFRA

iii www.capitalwastefacts.com

4. One Planet Living®

ONE PLANET LIVING

To help communicate the challenge we all face in reducing our environmental impact, and to facilitate change at local and global levels by working with partners, BioRegional and WWF have recently launched a new joint initiative "One Planet Living".

The One Planet Living initiative plays to the strengths of both BioRegional's background in providing BioRegional Solutions – products and services that can significantly reduce our ecological footprint – and WWF's global reputation as a leading independent environmental network, to further the achievements of projects such as BedZED, the WWF One Million Sustainable Homes Campaign, the Living Planet Report, and the work of both organisations to promote the concepts of sustainable development and ecological footprinting.

A key aim of the One Planet Living programme is to develop a global network of One Planet Living Communities to enable people to reduce their ecological footprint and demonstrate One Planet Living in action. Each community will have a One Planet Living Centre to provide information and education. The programme also aims to raise awareness of the imperative for One Planet Living and its guiding principles to catalyse change with governments, business and individuals. One Planet Living will work with cities and multinational companies to reduce their footprint and will also develop partnerships with companies to introduce a wide range of sustainable One Planet Living products and services.

The One Planet Living vision moves beyond purely environmental aims and envisages "a world in which people everywhere can live healthy, happy lives within their fair share of the earth's resources", in other words to demonstrate that people living everywhere can enjoy a high quality of life that is sustainable. One Planet Living Communities and organisations will adopt the following guiding principles and deliver them through the adoption of a series of action plans:

1. Zero carbon
– Energy and Carbon Plan (phased over a given period)
2. Zero waste
– Waste Management Plan (phased over a given period)
3. Sustainable transport
– Green Transport Plan
4. Sustainable construction materials
– Materials specification
5. Local and sustainable food
– Local Food Plan
6. Sustainable water
– Water Usage and Treatment Plan
7. Natural habitats and wildlife
– Biodiversity Action Plan
8. Cultural and heritage
– Culture and Heritage Plan
9. Equity and fair trade
– Equity and Fair trade Plan
10. Health and happiness
– Health and Wellbeing Plan

The concept design for Z-squared is presented against each of these 10 principles. Z-squared will be the first One Planet Living Community in the UK and aims to offer residents the opportunity to live a One Planet lifestyle.

The world's first One Planet Living Community has recently been launched in Portugal. The 1 billion project – a sustainable tourism development comprising 6,000 homes – covers 5,300 hectares in Mata de Sesimbra and will be completely powered by renewable energy, reduce waste to landfill to just 5% of the Portuguese national average, and use rainwater and wastewater recycling to achieve savings in domestic water consumption and irrigation. More than half of the food served in the tourist facilities will be sourced locally and there are plans to create a sustainable transport network which will virtually eliminate private cars within the development.

5. Z-squared

BioRegional's vision for Z-squared

In taking on the One Planet Living challenge, a fundamental target of the design team is to maximise the opportunity for developing communities that reduce environmental impact, both during construction and occupation, and offer convenient choices to enable residents and workers to live sustainably.

The aim of the Z-squared project team is to develop a concept design for a zero carbon and zero waste community (hence "Z-squared") for up to 5,000 people for the Thames Gateway regeneration area east of London. Where there are technical or commercial limits to achieving zero carbon and zero waste, this report outlines the gap and identifies what is needed to achieve these targets over a given timescale.

Z-squared, a mixed use, mixed tenure development is intended as a model One Planet Living Community that provides homes, office and light industry workspaces, shops, education, leisure, health and community facilities together with green open space. Z-squared will integrate a variety of residential, commercial and leisure uses, with most facilities within walking distance and efficient public transport and a car club, making it easier to live without owning a car, following the "Compact City" form advocated in *Cities for a Small Planet*[12]. Many young people and key workers are currently struggling to afford housing, car ownership and feed their families. Z-squared aims to ensure that the local infrastructure is in place to enable these people to enjoy a better quality of life, thereby strengthening the fabric of our society.

Modern cities consume resources from all over the globe, with little thought as to where they originate or where the wastes end up. The linear flow of resources through our society sees raw materials extracted and processed into consumer goods which ultimately end up as waste, 75% of which currently ends up in landfill sites; food is imported, consumed and discharged as sewage with little recovery of nutrients. This linear model of production, consumption and discharge is unsustainable. In *Creating Sustainable Cities*[13], Herbert Girardet suggests that in an increasingly urban world, "cities will need to adopt circular metabolic systems to ensure their own long-term viability and that of the rural developments on whose sustained productivity they depend". The metabolism of Z-squared is one that follows the principles of industrial ecology, maximising recycling of glass, paper, plastics and metals, anaerobically digesting organic waste and sewage to produce biogas that can be converted to energy in a CHP plant, nutrient-rich digestate and fibre, and attracting clusters of businesses that maximise resource efficiency and energy use. In addition, a mix of renewable energy technologies will be used to reduce the continually increasing demand on local infrastructure.

The objective is to create a thriving and successful new urban quarter, where people will want to live, work and enjoy leisure time. The delivery of zero carbon and zero waste objectives will work with this vision to produce an outstanding environment that:

- Supports a successful, vibrant and integrated mix of homes, shops, businesses, leisure facilities and other uses and activities;
- Has its own clear and positive identity, that builds on the strengths of its surrounding context;
- Has suitable size, scale, density and layout to support other amenities in the neighbourhood, whilst minimising resource – including land;
- Will contain high quality recreation facilities;
- Is safe, secure and free of the fear of crime;
- Has design features to promote a healthy indoor environment in an urban setting;
- Supports centres of learning and training at all levels;
- Gives priority to pedestrians, public transport and cycling, rather than cars;
- Has direct or close proximity to public transport, linking it to urban, regional and rural centres;
- Has a high quality, attractive and successful public realm of streets and spaces that are well-designed, safe to use and easy to understand;
- Is clean and well-maintained;
- Has an integrated network of high quality green spaces and green lanes that draws people into and through the area, encourages activity and improves the appearance of the area and the quality of life of the people in it;
- Provides for the economical, educational, cultural, social and other needs of a diverse mix of residents;
- Provides a balanced and integrated mix of residential accommodation of different types and tenures to support a range of household sizes, ages and incomes;
- Has easy access to a diverse range of high quality local public facilities and services, including education and training opportunities, health care and community and leisure;
- Has buildings that can accommodate changes in use over time and that minimise resource use in construction and occupation.

This vision reflects the aims of both the Sustainable Communities Strategy[14] and the London Plan[15].

Figure 6: Components of Sustainable Communities

Source: The Egan Review: Skills for Sustainable Communities (2004)[16]

Z-squared and One Planet Living

Issue	OPL Sustainability Principle	Z-squared strategies
Each person in the UK is responsible for nearly 12 tonnes of CO_2 emissions each year. CO_2 contributes towards global warming which is predicted to result in a rise in global temperatures of between 1.4° and 5.8° by 2100	carbon	• Reduced energy demands from the buildings and infrastructure • On-site power generation from low-carbon and renewable sources • Energy Services Company (ESCo) to manage sustainable energy supply in the long term. A Waste Water and Energy Services Company (WWESCo) could maximise linkages between waste, energy and water
Over three-quarters of municipal waste currently goes to landfill. The Environment Agency estimates that there is only landfill capacity for another six years in the South East region	waste	• Strategies for homes and businesses to reduce the amount of waste they produce • Facilities to make recycling and composting easy and recover Energy from Waste (EfW) • Strategy developed for reducing construction waste
Around one-third of a UK resident's carbon emissions are due to their travel habits. More than a half of all journeys taken in the UK are less than two miles in length, but many of these journeys are taken by car although most would be easy to cycle. Overall car traffic has increased almost 15 times in the last 50 years. CO_2 emissions due to transport are growing at roughly 4% each year	transport	• Facilities located within walking distance to reduce the need to travel • Opportunities for internet ordering and coordinated deliveries of food and goods • Public transport provision and promotion of alternatives to private car use, i.e. car clubs, walking and cycling
Of the 420 million tonnes of material resources used for construction each year in the UK, about 10% are recycled materials, approximately 5% are from secondary sources and less than 1% is reclaimed materials. Furthermore, government figures indicate that the transportation of construction materials accounts for 30% of all road freight in the UK	materials	• Materials chosen for construction of buildings and infrastructure to give high performance in use with minimised impact in manufacture and delivery • Local, reclaimed and recycled materials used • "Healthy" low-toxicity materials specified
Around one-third of a UK resident's carbon emissions are due to their food consumption. The average UK meal travels 2,000 miles from farm to fork. Around 80% of the food consumed in London is imported	local food	• Opportunities to grow local food through edible landscaping, in gardens, balconies and on (mini) allotments • Local organic food box schemes and opportunities provided to purchase local and seasonal food in cafes, shops and farmers' markets • Links established with food growers to provide waste treatment digestate as a soil conditioner in part-exchange for supply of local food

Issue	OPL Sustainability Principle	Z-squared strategies
Domestic water consumption in the UK is around 150 litres per person per day. Increased development is resulting in greater demand for drinking water and drainage with parts of the UK experiencing both water shortages and increased risk of flooding.	**water**	• Water demands in buildings reduced and zero or low mains water-reliant infrastructure provided • Wastewater treated and rainwater managed on-site • Bodies of water integrated in masterplan for flood prevention and wastewater treatment and as valuable amenity
Unchecked development can cause natural habitat destruction and result in species loss locally and globally. Over the last 100 years in the UK we have lost over 100 species – WWF's Living Planet Report states that over the last 30 years, we have lost 30% of the species from our planet.	**flora & fauna**	• Z-squared will support a rich biodiversity and a varied landscape • Native planting and landscape strategy to increase biodiversity • Green and brown roofs incorporated where possible
Acknowledging and learning from our past is an important element of understanding how we live in the future. "The physical survivals of our past are to be valued and protected… as a central part of our cultural heritage and our sense of national identity." Government PPG 16	**culture & heritage**	• Z-squared developed with sensitivity and acknowledging the history of the site and the surrounding area • Opportunities for local references and interpretation of history and heritage maximised
Living sustainably is not only about not compromising the quality of life of future generations, but also the present generation living elsewhere in the world	**equity & fairtrade**	• Z-squared designed to provide affordable access to a range of facilities and housing with opportunities for all, including lifelong learning and local employment • Diverse and inclusive community with a sense of identity and of place • Fair trade retailers and goods promoted
There is a proven correlation between the state of our environment and our health; our buildings and our wellbeing. The long term health of the planet is fundamentally related to how we chose to live now; the sustainability of our lifestyles. Living unsustainably can not only lead to poor quality of life today, but may also jeopardise the quality of life of our descendants in the future	**health & happiness**	• Promote healthy lifestyles including exercise, healthy food and community involvement • Engender a sense of community and identity via a community trust and intranet • Buildings designed to provide a healthy indoor environment • Development designed to provide a safe, pleasant and healthy environment • Undertake ongoing monitoring of buildings and support services to measure levels of resident satisfaction and happiness

Overall targets for Z-squared

Z-squared will be the UK flagship One Planet Living Community and as such, will adhere to the 10 One Planet Living Principles. A Sustainability Action Plan will be developed with targets and plans to achieve each of the 10 principles, together with a process for monitoring actual outcomes against targets. Targets for each One Planet Living Principle have been included within the respective chapter headings.

Target

- All dwellings will be designed to achieve a Building Research Establishment (BRE) EcoHomes rating of "Excellent" at both design stage and post-construction review
- All other buildings will be designed to achieve BRE's Environmental Assessment Method (BREEAM) ratings of "Excellent" where applicable
- The development will be designed to achieve "Best Practice" in all sections of the relevant regional Sustainability Checklist for Developments
- Commitment to gather data and measure baseline performance, in the absence of reliable local / national data, to produce benchmark figures for indicators
- Periodic increases in targets during construction phase and beyond to facilitate "future-proofing" and to ensure performance beyond best practice
- Facilities management linked into tracking new, improved sustainable technology
- Ongoing monitoring and reporting against indicators during design, construction and occupancy phases as appropriate to help inform future strategies and developments

Section B: Infrastructure for One Planet Living

6. Energy and Carbon Strategy

Objective

- To meet all non-transport energy needs from renewable energy or clean Energy from Waste (EfW)

Target

- Develop a Zero Carbon Plan and indicators
- Reduce energy consumption due to lights and appliances
- Reduce energy consumption due to space heating / cooling
- Target to achieve maximum credits relating to "energy" under BREEAM and EcoHomes
- Development of energy supply strategy, including generation of energy from on-site renewables, to ensure commitment to zero carbon target in the long-term

Concept design

- Energy demand minimised through:
    - energy-efficient design and construction including maximising natural light and ventilation effectiveness
    - specification of energy-efficient appliances
    - co-location of facilities to minimise heat losses and make maximum use of waste heat
- On-site renewables incorporated into design

This chapter summarises the results of a study by Fulcrum Consulting into the energy infrastructure for a 2,000 home mixed-use community in the Thames Gateway. Behind this overview, a series of Fulcrum Consulting reports covers the main research and bibliography in more depth.

Background

Design of the infrastructure scheme is driven by three principles: firstly, demand side measures to limit consumption, secondly, optimisation of the relationship between supply and demand to reduce CO_2 emissions and, thirdly, reduction of waste and byproducts generated in the community by linking to other local processes.

The study has shown that a low carbon scenario can cut CO_2 emissions by 70% compared to current best practice. This has been achieved by adopting a supply portfolio comprising interseasonal thermal storage (ITS), gas-fired CHP, anaerobic digestion and wind turbines. Use of biomass-fired CHP would reduce carbon emissions to virtually zero. It is anticipated that wind turbines within the Thames Gateway will generally be positioned on low-lying flood plain, or possibly within the Thames Estuary itself, remote from residential development.

On the demand side, the orientation, glazing, shading and fabric of the buildings should be specified to limit heat losses during the winter and reduce overheating during the summer.

On the supply side a portfolio of on-site generation sources is proposed incorporating large, commercial sized wind turbines provided on- or off-site but rejecting photovoltaic technology.

All the systems can be installed in modular form to complement each phase of development at the site.

An ESCo or WWESCo management company must be designed to operate Z-squared in the long-term.

Energy modelling

For a range of scenarios, the expected energy demand for heat and power was estimated using benchmarks, assumptions and daily peak load profiles. The base case, to which all other scenarios are compared, used current good practice heat and electricity demand. All other scenarios assume that energy demand would be reduced at Z-squared through the installation of low-energy fittings and appliances, excellent building fabric performance, visible metering and education. Reduction of demand that is focussed on energy saving and peak shaving can also impact on the cost, design and reinforcement of utilities infrastructure.

Peak demand was modelled over the course of a typical day in winter and in summer while the average energy used over a year allowed annual CO_2 production to be estimated. These energy and carbon estimates distinguished between the demand for hot water and space heating which occur at different times of the day and vary during the year.

On the supply side, a number of established and emerging solutions were considered as part of a mixed energy supply "portfolio". The analysis looked at the classic problems of matching electrical supply and demand and explored the storage of energy as a buffer between efficient supply and fluctuating demand. This included the possibility of using ITS in the ground or ground water as a way to meet the site's space heating and cooling requirements. Such a system would rely on a series of boreholes or ground-coupled coils to pump hot water through underground thermal mass during the summer and extract this stored heat during the winter. The pumps could operate continually drawing on electricity from intermittent, renewable sources, like wind turbines, that cannot be used immediately by the Z-squared community.

A model was set up to test different options: with and without mains connections for natural gas and electricity; with and without EfW; with and without ITS. In the scenarios without an electrical grid connection, CHP plants were used to meet peak electrical demand. This resulted in larger CHP plants operating for shorter periods. When a connection to grid electricity was introduced into the model the CHP plants were sized to meet the hot water demand at the site, resulting in smaller CHP plants running for longer periods. A further scenario without a natural gas connection attempted to meet the community's hot water demand using solar thermal collectors. Figure 7 shows the relationship between the supply portfolio and daily demand. The power output from each supply technology is drawn against time to illustrate the mismatches between peak supply and demand. Conventional grid supplies can be matched very well to changes in demand because the base electrical load is topped up by large-scale power stations embedded in the national grid infrastructure. Other technology, like CHP, is most efficient when it runs constantly at full power while wind turbines fluctuate with wind speed and solar technologies peak during the middle of the day. Optimising each scenario to minimise CO_2 emissions depends on "tuning" the supply portfolio to meet peak electrical demand without producing an electricity or heat surplus.

The concept of a supply portfolio also deals with long-term future proofing. New technologies can be introduced to the mix as they mature or as the market shifts to reflect shortages in certain fuels or changes in taxation and carbon trading arrangements. Rather than replacing thousands of individual boilers, large single items of equipment can be upgraded without disrupting every resident or business. Options for the future portfolio are outlined below.

It has been suggested that biomass CHP will be an important component of embedded generation in the area but to run a biomass plant of a suitable size to generate electricity at this urban location, fuel would have to be imported to the site. A limited supply could be developed from the 10-20 hectares of land set aside for flood prevention but this would only support small-scale biomass CHP, which is not yet a proven technology. BioRegional has undertaken a separate study to look at the possibility of using pallet waste and other urban sources of biomass to run zero carbon CHP. This study suggests that there is sufficient waste wood in the Thames Gateway and plant

commercially available, that biomass CHP could be substituted for gas-fired CHP in Z-squared, thus achieving carbon neutrality. Whilst biomass might supply the needs for a development the size of Z-squared, it would not overcome wider future demand and sustainability issues.

Hydrogen energy storage and fuel cells are likely to be part of the long-term move towards a low carbon economy. Fuel cells take a hydrogen-based fuel source to generate electricity and heat. The technology stems from the idea that the electrolysis of water (applying a voltage across water) separates water into hydrogen and oxygen and when these elements recombine, the energy used in originally separating them is released. Fuel cells are designed to control and harness this reaction to recover the energy in the form of electricity.

The fuel cell technology currently available does not actually take hydrogen directly from the electrolysis of water but instead re-forms fuels such as methane, liquid petroleum gas, ethanol or biogas to produce hydrogen. A byproduct of reforming these hydrocarbon fuels is CO_2 and unless this can be sequestered there will still be CO_2 emissions from the process. However, because some fuel cells respond rapidly to demand, operate efficiently at a range of different power outputs and offer a useful ratio of heat to electricity output, the overall CO_2 emissions from the supply system could be reduced, as less flexible equipment is replaced. Recent research suggests that plasma torch technology may be utilised in conjunction with fuel cells to generate electricity while cleanly disposing of residual waste.

With the exception of the conversion of organic waste arising from the site (sewage sludge and kitchen waste) EfW at Z-squared has been ruled out of this analysis. Although an EfW plant would deal with non-recyclable, inorganic waste and generate heat and electricity, small EfW plants, suitable for the amounts of waste produced by Z-squared, are not yet commercially available. There are demonstration projects using small scale equipment which could be adopted later when the costs of transporting waste to landfill rise and encourage the local treatment of waste. Alternatively, the smallest EfW plant available on the market could be installed on the site and Z-squared would import waste from the surrounding communities. On-site storage and sorting would feature under such a scheme and grid connections to the local distribution network would be necessary to share energy output with the communities that have contributed waste to the system. Taking this strategy to the next scale, a large municipal EfW plant would achieve the greatest economies and efficiencies of scale and could be used to treat inorganic, non-recyclable waste from across the Thames Gateway. Management of such a large facility would have to take place at municipal level with representation from Z-squared and other sustainable communities in the Thames Gateway. Cost, planning and emission control issues are likely barriers to any EfW option but, by commissioning a large, central clean EfW plant and distributing heat and electricity across many interconnected local energy networks, low value waste would be re-processed into a useful energy instead of landfill.

Results

By adopting strategies to reduce energy consumption, we estimate that the annual electricity consumption for Z-squared would be nearly 15% lower than the best current practice base case, from 14,610 megawatt hours electricity (MWhe) to 12,480 MWhe. Hot water demand would drop by 20% from 9,700 megawatt hours thermal (MWhth) to 7,900 MWhth and the space heating load would fall by 17% from 21,015 MWhth to 17,455 MWhth. Shaving of the electrical demand peaks could also be achieved through the use of A-rated appliances, low-energy light fittings and reduced airconditioning loads in office and retail space. At this stage, we estimate a fall from 7 megawatts electrical (MWe) to 5MWe.

Two supply portfolios are compared here: the base case and a low carbon scenario. The low carbon scenario, one of several modelled for this study, uses ITS, natural gas and biogas fired CHP and wind turbines to meet demand. An electrical connection to the national grid has been included to allow the export of wind-derived electricity and import of grid electricity to meet peaks. A mains natural gas connection is used to feed a CHP plant, although, it is theoretically possible to substitute gas-fired equipment for large areas of solar thermal collectors and reduce CO_2 emissions further.

The combination of demand- and supply-side management results in a 70% saving in CO_2 emissions compared to the base case. The schematic diagrams (Figure 7 and Figure 8) show the energy demand for each building type, incoming supplies and carbon emissions for both scenarios. CO_2 emissions that are shown as negative in the low carbon scenario represent the wind-generated electricity exported to the national grid.

Figure 7: Base case energy demand with mains electricity and gas to meet loads

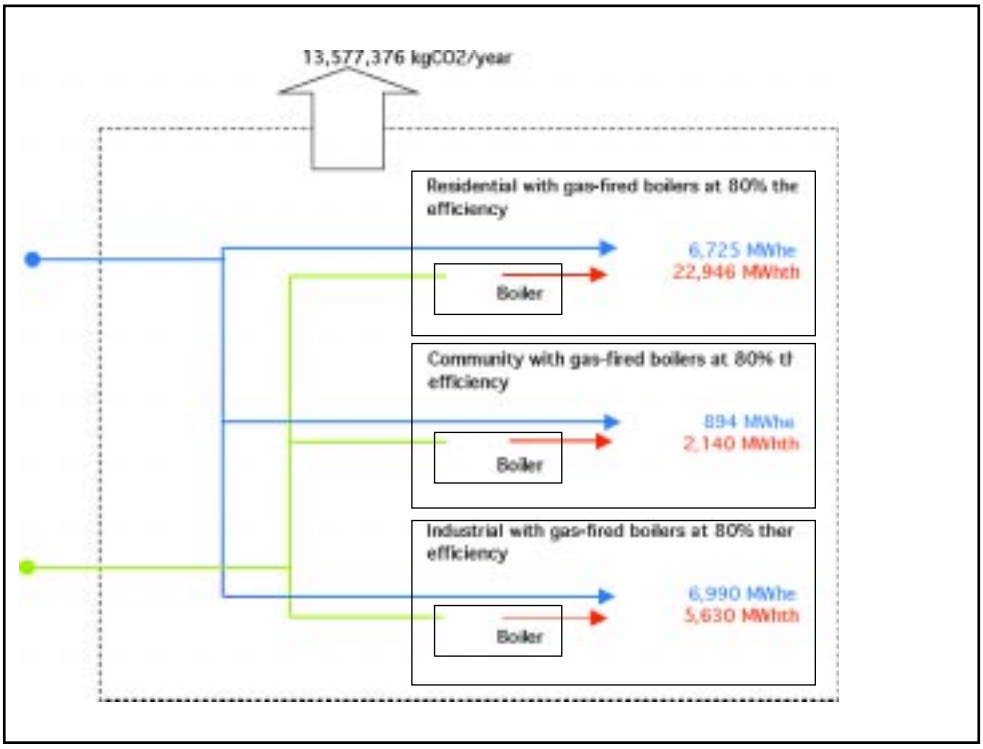
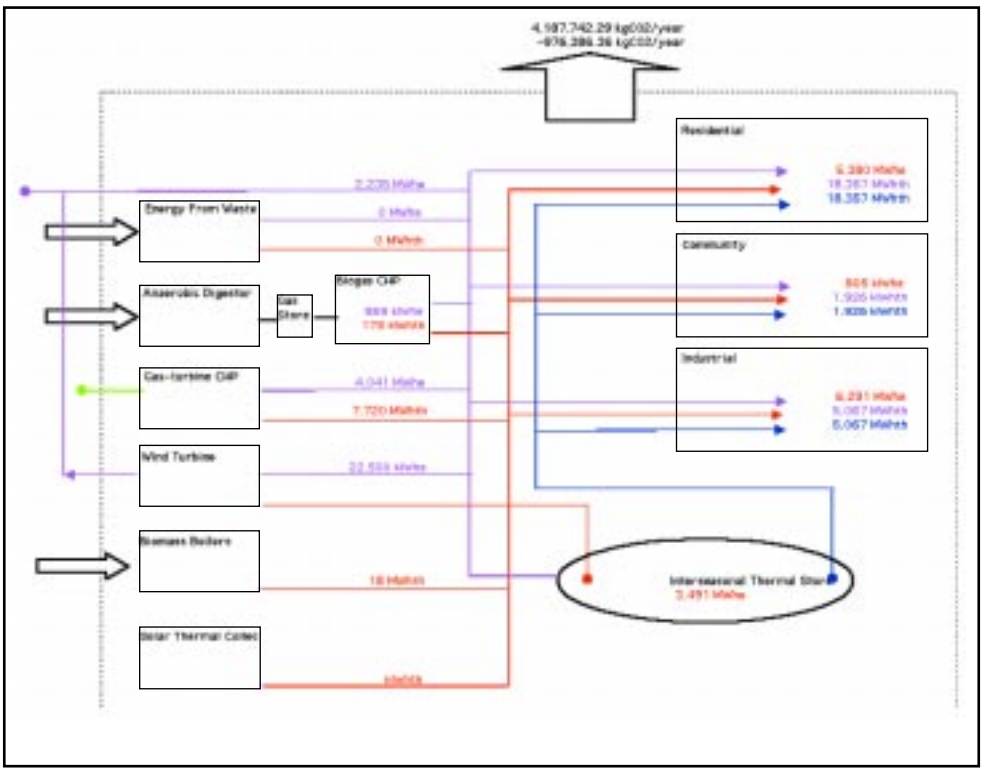


Figure 8: Low carbon scenario using a mixed supply portfolio



Building form and function

The energy supply portfolio is not independent of building design. The orientation, glazing, shading and fabric of a building can all be specified to limit heat losses during the winter and reduce overheating during the summer. We should aim for buildings with a low demand for heating and cooling but, if ITS is adopted, we must also aim for thermal balance where annual heating loads are equal to annual cooling loads. The effect of climate change will be to alter the balance point and the mix of technologies will change with time.

At this stage, it is important to permit a wide range of architectural or developer-led preferences, including lightweight construction and large areas of glazing to some of the buildings. To minimise the sizing of the ITS, it would be preferable for buildings to be designed to remain cooler in summer and warmer in winter than buildings constructed in line with current practice, as this would also provide a degree of futureproofing against climate change. However, it is possible to accommodate any building constructed in line with current building regulations, without incurring a significant carbon penalty through utilising night-time wind-generated electricity to operate the ITS. The key point is to understand the relationship between design and demand and to use an appropriate supply portfolio.

To eliminate the need (and cost) of perimeter heating and to maintain exemplary radiative thermal comfort conditions, minimum u-value requirements for glazing and the building envelope should comply with document TM29 published by the Chartered Institution of Building Services Engineers (CIBSE). The thermal balance concept of ITS indicates that there may be no advantage in increasing insulation levels from these. Where u-values are known to deteriorate with time, the long-term performance u-values must not compromise the design or energy portfolio.

Cooling is an inherent requirement in most commercial buildings, is an increasing requirement in educational buildings and is of concern regarding dwellings as the warmer summers are causing a considerable increase in sales of the less-efficient comfort cooling units designed for the domestic market. ITS systems provide cooling as a byproduct of collecting heat in the summer and storing it for use in winter, thus removing any need for these energy-hungry technologies.

Development phasing

An understanding of the construction phases is essential to the infrastructure masterplan. All the systems we have opted for can be installed in modular form, with discrete pieces of equipment to serve each phase. An ITS that relies on a cluster or field of boreholes can also be constructed in phases.

Each modular energy source will eventually be linked into a distribution network for heating, cooling, electricity and water. Phasing of the network installation will depend on the site layout and construction programme but the design should allow all buildings and energy sources to be linked up eventually without loading the cost of the entire distribution network on to the earliest phases.

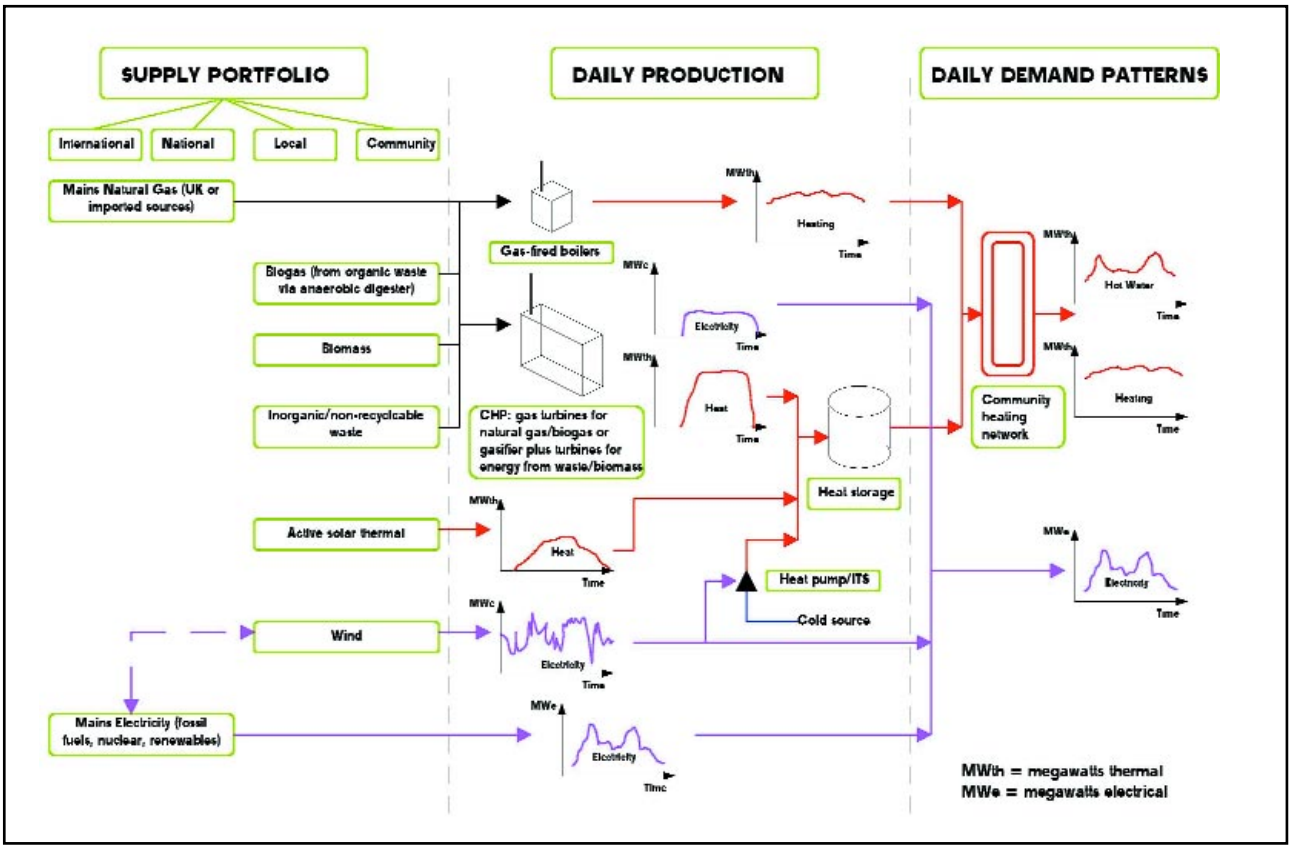
Facilities management and infrastructure ownership

Throughout the life of Z-squared, the systems must be operated to ensure that waste going to landfill, CO_2 emissions and the cost to the community are minimised. This may mean responding to changes in energy consumption, demography, waste streams, fuel sources and prices. The design of an organisation with the capacity to manage the site long-term is as important as any of the technical, architectural and ecological aspects of Z-squared. Several organisational models exist based on the concept of an ESCo.

The ESCo model has been developed to allow a route for (often incumbent) utility suppliers to provide a value-added service rather than a unit-based product. To operate successfully, ESCos must be involved in demand side management, engage in long term contracts and respond quickly to funding opportunities which support energy and CO_2 savings. Management models for ESCos can be based on community ownership, not-for-profit companies or private utilities. Ideally, the arrangement should encourage a relationship between the Distribution Network Operator, the Supplier and the Customer but should ensure that risks and costs are shared fairly. The degree to which cost and risk are shared will depend on design of the ESCo but should be carefully considered especially where customers can be classed as "fuel poor".

Once ESCos are in operation, the possibility of competition is limited but consumers benefit from low energy costs, CO_2 reductions, savings on infrastructure reinforcement and system reliability.

Figure 9: Energy flows



Credit: Fulcrum Consulting

7. Waste Strategy

Objective

- To adopt a resource-based approach to waste management and development of a waste management strategy that enables high levels of waste separation, commits to ongoing facilities management and a long term target of zero waste to landfill
- Low levels of packaging and majority of products and packaging made from recycled materials

Target

- Zero Waste Plan and indicators developed
- Zero waste to landfill set as a long term target for occupation with waste minimised and all waste reused, recycled, composted or cleanly converted to energy
- Achieve maximum credits relating to “waste and recycling” under BREEAM and EcoHomes
- Waste minimised during construction

Concept design

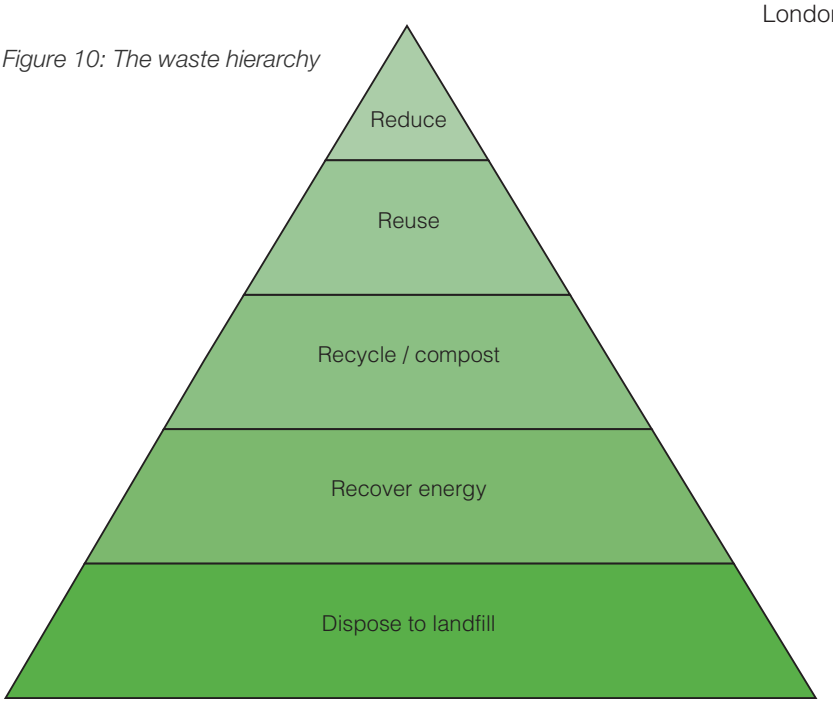
- Incorporate space for source separation in homes and other spaces
- Develop effective waste management facilities and infrastructure to enable high levels of waste stream separation
- Clean EfW technologies explored

This chapter summarises the results of a study by KBR into municipal waste infrastructure for a 2,000 home community in the Thames Gateway. Behind this overview, another KBR report covers the main research and bibliography in more depth.

The impacts of landfill disposal of waste are felt both by human society and throughout the natural habitat in which we live. Precious land and habitats in the UK are under pressure from expanding landfill disposal requirements creating pollution risk to aquifers, surrounding land, the air we breathe and contributing to climate change.

The Z-squared concept was developed around a vision to build a community which achieves zero waste to landfill and zero fossil-fuel energy usage. This report aims to establish the most sustainable strategy for waste management for the Z-squared concept in the Thames Gateway that strives towards zero waste to landfill. The analysis estimates the potential commercial, industrial and domestic waste quantities arising from a community of 5,000 inhabitants, and reviews various options to manage the waste in the most sustainable manner, in accordance with the waste hierarchy (Figure 10).

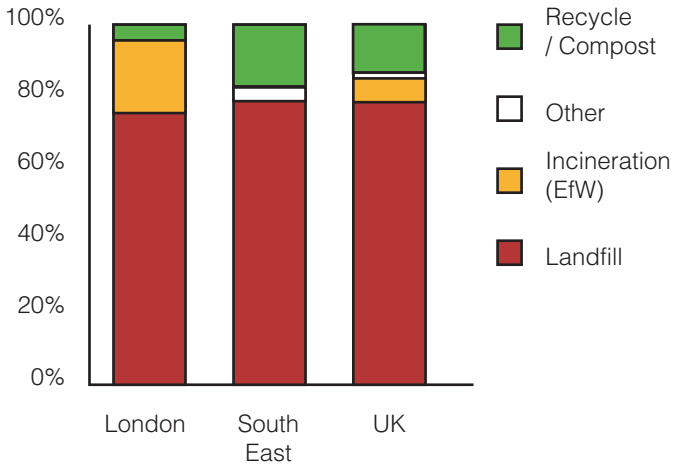
Figure 10: The waste hierarchy



Background

Using government statistics for the UK and London to represent common practice rather than best practice, it is possible to ascertain a base case benchmark to use as a comparator for various waste management strategy options. Total waste produced in the UK averages around 430 million tonnes per year. Of this, 250 million tonnes is controlled waste (household, commercial, industrial, construction and demolition), the rest comprising mining and quarrying, agriculture, dredged materials and sewage sludge.

Figure 11: Municipal Waste Management by region, 2001/2



In 2000, London generated over 26 million tonnes of waste (3.56 tonnes per capita) of which 14.9 million tonnes were generated by the construction and demolition sector, 7.9 million tonnes by the commercial and industrial sector, and 3.4 million tonnes by households[17]. Of this total waste, London disposed of 72% to landfill, 19% was incinerated with some energy recovery, and 9% was either composted or recycled.

The drivers to find an alternative solution to landfill waste disposal in the Thames Gateway are substantial:

1. Land in London and the South East is valued more for residential and commercial development, and environmental protection, than for landfill.
2. Health and safety risks to society from landfill disposal.
3. Ecological damage resulting from contaminating landfill sites.
4. The costs incurred from the Landfill Tax (currently £15 per tonne but due to escalate by £3 per tonne per annum up to £35).
5. Pressure to increase natural resource productivity from the Waste Electrical and Electronic Equipment (WEEE), End-of-Life Vehicles and Packaging Directives and waste recycling targets set by the EU.

Compounding this are the escalating volumes of waste year on year; domestic waste alone increases by 2-3% each year, neutralising the benefits from current recycling initiatives.

A step change in waste management is required to divert as much material away from landfill as possible. The Z-squared strategy outlines how this step change can be achieved in the Thames Gateway, by re-focusing on reuse and recycling of material to a practical and cost-effective maximum, then recovering energy from the remainder. The amount of waste disposed to landfill will be minimal.

Waste arising

Using data from a number of London Boroughs and the Environment Agency National Industrial and Commercial Waste Survey, a profile of the waste composition for the Z-squared community was derived. No allowance has been made in the following figures for future changes to the currently expected waste streams, as these are dependent upon lifestyle, innovation, response to manufacturing, processing and waste strategies, and changes in legislation. For the 2,000 household community containing 5,000 inhabitants and a pre-determined number of workplaces and community facilities, the expected total waste arising is shown in Table 5.

Table 5: Total waste arisings expected from the Z-squared community

	Tonnes per annum	
Domestic	2,168	30%
Commercial & industrial	5,051	70%
TOTAL	**7,219**	**100%**

The composition profile for the total waste arising is shown in Table 6. A more detailed breakdown of the waste profile of the separate streams is described in the main report.

Table 6: Expected total waste composition profile

	Tonnes per annum	
Organic	1,689	23.4%
Paper & card	1,487	20.6%
Glass	197	2.7%
Metals	253	3.5%
Textiles	76	1.0%
Plastic	993	13.7%
Nappies	130	1.8%
Mixed & inseparable	2,394	33.2%
TOTAL	**7,219**	**100.0%**

Collection and sorting

The principle of the collection strategy is to cost-effectively enable the priorities of the waste management approach – to reuse and recycle to a viable maximum, then recover energy from the remainder. To facilitate this, collection and sorting need to be an integrated process combining the benefits of source-segregation with the economies of scale from dealing with waste types in large quantities. Health, safety and environmental considerations, particularly those relating to the handling, sorting and disposal of waste also influence the proposed strategy.

The following waste strategy is proposed to optimise the separation of recyclable and reusable material, and provide the remainder for EfW gasification or pyrolysis processes. The identified recyclable and reusable materials are:

- Glass – separated into clear, green and brown / other.
- Metals – collected in mingled form for later separation into steel, aluminium and mixed.
- Plastics – collected mingled.
- Organics – vegetation and putrescibles.
- Textiles – clothes, shoes, furnishings etc.
- WEEE – as described by the WEEE Directive.
- Inert – demolition and landscaping spoils that can be reused for high and low grade purposes.
- Bulky items such as white goods and furniture which can be collected for repair and reuse on an ad hoc basis via community project such as the Furniture Recycling Network.

Domestic

Domestic properties in the urban core will contain an in-sink macerator for putrescible food waste. This will be linked to the foul sewage system to be carried to settling facilities to be de-watered, and then used as a fuel for an anaerobic digester. This system will produce methane for a CHP plant, plus valuable additives to the composting process. Properties in a more sub-urban setting containing gardens will be encouraged to compost vegetable matter in their gardens along with soft green waste. The remainder of food waste will form part of the "mixed" waste stream.

Dry recyclables (plastics, metals, paper and card) will be collected separately from mixed waste, as is the case in many existing council schemes. This can either be in a commingled kerbside dry recyclable box (KDRB) that is sorted by collection staff into a segregated vehicle, or in segregated containers for more rapid collection, but higher risk of stream contamination. The dry recyclables will be taken to a central depot for further sorting as required to produce virgin material substitutes.

Glass can be included as part of the KDRB scheme but this does create some safety issues for both collection and sorting operatives and the public. It is proposed that glass is better dealt with using a self-bring scheme at convenient neighbourhood locations. Local self-bring sites will also include depositories for green and inert waste, textiles and electrical (WEEE) equipment.

The residual mixed waste stream represents all material that cannot be segregated and to avoid transporting and paying for this waste to be disposed of as landfill, consideration has been given to using the waste as a source of fuel for an EfW plant.

Even though the bulk of the wet putrescible waste should have been removed from the collection process, the actual extent will be dependent upon public awareness and participation. Accordingly, there will still be health and safety issues associated with the handling and disposal of the residual mixed waste. The proposals endeavour to minimise both the quantity of mixed waste and the risk to public health. Ultimately, our society needs to address what we produce, as this is what we will be disposing, whether this is via landfill, gasification or another method.

Commercial and Industrial

Collection of commercial waste streams will follow a similar pattern to the domestic sector. However, factors such as scale are incorporated, as well as the fact that much of the waste from the commercial, and particularly the industrial sector, is more uniform and predictable. Direct waste recycling streams can be created that remove any need for sorting.

Most waste generated in public areas is not recycled
Photograph: Camden Borough Council

The macerator scheme may be appropriate for many small commercial buildings, but where the requirement exceeds the drainage provision putrescible material will be collected separately. The KDRB scheme will be scaled up as appropriate for the building / group of buildings as required.

Recycling bins designed specifically for parks, green spaces and public areas will be introduced. These will separate cans, glass, paper and residual waste. A new trial in the London Borough of Camden aims to reduce waste to landfill by 65% through the introduction of public recycling bins.

Reuse and Recycling
The following reuse and recycling schemes are proposed to gain the most cost-effective benefit from the available materials:

Textiles
Reuse of clothes and textile material is well established in the UK in the form of "charity shop" style schemes. Such a scheme will form part of the community facilities in Z-squared. It is anticipated that of a total 109 tonnes textiles per year, 76 tonnes will be reusable as second hand clothing or rags. The remainder will be too soiled for reuse and will be used as a feedstock for an EfW plant.

Case study: Recycled clothes and accessories from Traid

Textile Recycling for Aid and International Development ("Traid") collects clothes from 700 clothing banks around the country, sorting, cleaning, mending and remodelling around 2,000 tonnes of unwanted materials each year. A team of designers customises clothing and accessories under Traid's own Remade label. The refashioned items are sold through their shops, six in London and one in Brighton, with proceeds going towards projects to combat Third World poverty and fund sustainable development.

Source: www.traid.org.uk

Glass
The expected quantity of glass generated each year is 175 tonnes. This is formed of clear, green, brown and other decorative coloured glass. Glass recycling is mature and straightforward, with a well established market already in existence. In simple terms, clear glass is recycled to either more clear or green glass depending on quality. Green glass is recycled into more green or brown glass. Brown glass can be recycled into more brown glass, or can be crushed for other aggregate-substituting uses in building materials. It is anticipated that all glass in Z-squared will be recycled or reused.

Metals
Metals are fully recyclable and sorting is relatively straightforward. Z-squared is expected to produce 179 tonnes of metal waste each year. This will be sorted into aluminium and steel. The remainder will comprise mixed metal alloys. All these materials have successful end-uses by substituting virgin metal ores in new products.

Paper and card
There are three options for paper and card waste available:
1. recycle into more paper and card products.
2. use paper and card as feedstock to an EfW plant for energy gain.
3. compost paper waste.

Following a detailed study into the impacts of these options with respect to the energy requirements, risks of pollution and the burden on natural resources, it was shown that the optimal strategy is to maximise recycling of all clean paper and card. Any waste that is too soiled for the recycling process will be used as EfW feedstock. One option included composting of "soft" paper waste for comparison.

The expected quantity of paper and card waste generated each year is 1,487 tonnes and the vast majority of this should be separable. A significant proportion of this will be high-grade office paper which will use a separate recycling process for this higher quality resource. The bulk of the waste will be separated according to the requirements of the end-products.

WEEE
Waste electrical and electronic equipment will conform to the WEEE Directive. Equipment will be returned to suppliers for reuse / recycling. A total of 74 tonnes of WEEE are expected to be generated each year.

Plastics
The main report details a comprehensive breakdown of the anticipated plastic waste stream components for the six main plastic types – PET, HDPE, PVC, LDPE, PP and PS. Four strategy options were investigated that either recycled or recovered energy from particular plastics, considering the calorific value and the embodied environmental impacts of each type. The options were as follows:
1. Recycle all (except inseparable mixed polymers).
2. Recycle PVC and PET; remainder for EfW.
3. Recycle PVC only; remainder for EfW.
4. No recycling; all plastics to EfW.

It was identified that the most beneficial options are 2 and 3; where the most environmentally damaging plastics are recycled without a significant reduction in the total energy value gained from the plastic feedstock for EfW. PVC and PET are of relatively low calorific value and high embodied impact in terms of CO_2 emissions and pollution.

A total of 716 tonnes of plastic waste is expected to be generated each year. The sorting of plastics is a complicated and costly endeavour, and more work needs to be done to verify the viability of a plastic segregation plant.

Types of Plastic in the Waste Stream

1	PET	Polyurethane
2	HDPE	High density polyethylene
3	PVC	Polyvinyl chloride
4	LDPE	Low density polyethylene
5	PP	Polypropylene
6	PS	Polystyrene
7	Other	Mixed polymers

Waste Management Options

In order to ascertain the optimal approach for the waste management solution, a number of scenarios were identified that varied the amounts and compositions of the waste stream allocated to the different treatment / management options. The scenarios arrived at are as follows:

Option A **Base Case**
- Uses the UK average recycling rate of 10.2% for glass, metals and paper / card.
- Anaerobic digestion is used for sewage sludge only.
- Some vegetation is composted.
- All other waste is landfilled.

Option B **Maximise recycling for currently sorted waste**
- Recycling of currently sorted glass, metals, paper / card, textiles and WEEE, plus plastics into 6 categories.
- Anaerobic digestion of sewage sludge and putrescible matter.
- Composting of vegetation and digestate.
- Remaining mixed waste sent to municipal-scale EfW plant.

Option C **Maximise EfW with recycling of low-calorific value (CV) material**
- Recycling of glass, metals, paper / card, textiles and WEEE, plus PVC and PET plastic types.
- Anaerobic digestion of sewage sludge and putrescibles.
- Composting of vegetation and digestate.
- EfW on a local scale using mixed waste plus remaining plastics.

Option D **Maximise composting with high recycling and some EfW**
- Recycling of glass, metals, "hard" paper & card, textiles and WEEE, plus plastics into 6 categories.
- Anaerobic digestion of sewage sludge and putrescibles.
- Composting of vegetation, digestate and "soft" paper waste.
- EfW on a local scale using remaining mixed waste.

Option Z **"Zero" material waste option**
- Maximise recycling by breaking down "mixed" waste streams into component parts.
- Recycling of all glass, metals, paper / card, textiles, WEEE and all 6 plastic types.
- Anaerobic digestion of sewage sludge and all putrescibles.
- Composting of all vegetation and increased amount of digestate.
- Reduced amount of waste to local-scale EfW plant giving 1.7% special waste to landfill.

Energy from Waste

Two forms of EfW were considered appropriate for the Z-squared scheme: anaerobic digestion of putrescible waste material and gasification / pyrolysis of material of a significant calorific value. Full descriptions of both these processes can be found in the main report.

Anaerobic Digestion

Anaerobic digestion (AD) is an established process for treating sewage sludge, but can be used for a variety of putrescible materials. There are pre-treatment requirements to comply with regulations that control the use of animal wastes, and this can be incorporated into the digestion system. The end-products are:

1. Biogas – a methane / CO_2 gas mixture used as a fuel for a CHP plant. Approximately half the energy generated from this fuel will power the AD plant, with the excess exported to the community network. The CV of the biogas can vary, but the process is expected to produce an average CV of 18 MJ/m3.
2. Digestate – can be separated into fibre, a nutrient-rich fibrous material which will be added to the composting process to result in a high-quality compost product, and liquor, which is a valuable soil additive. The pre-treatment processes will ensure that this digestate material is suitable for arable, as well as horticultural, agriculture.

The system flow quantities through the AD system are as follows:

Table 7: Anaerobic mass flows for Z-squared waste management options

	Input		Output	
	Sewage Sludge (tonnes pa)	Putrescibles (tonnes pa)	Energy potential (GJ pa)	Digestate (tonnes pa)
Option A (base case)	502	0	0	201
Options B, C, D	502	852	931	542
Option Z	502	1457	1432	784

Gasification

Gasification and pyrolysis are the favoured EfW options for using mixed combustible wastes as a feedstock. This feedstock is reduced to a synthetic gas (syngas) with a calorific value dependent upon the input components. The syngas is then used as a fuel for a CHP plant to generate heat and electricity for export into the local distribution systems. The main environmental benefits of these processes over incineration are derived from the greater efficiency of transferring feedstock into energy-generating output, so reducing emissions of harmful gases. The solid residues resulting from the process comprise of inert ash, which can be used as an aggregate substitute for building products, and a small amount of hazardous material from the gas cleaning process required to minimise emissions, that is a special waste requiring landfill disposal.

After an investigation into the commercial viability of currently available technologies, it became clear that gasification and pyrolysis plants of the size to serve the Z-squared community (up to 4,000 tonnes pa input) are too small to be viable. Such plants exist as demonstration installations, but the minimum cost-effective size starts around 30,000 tonnes pa). While it is felt that local EfW plants may produce a cost-effective solution as the market matures, and this scenario has been used in Options D and Z, the current market landscape will require a municipal scale EfW plant that serves all, or a substantial part, of the Thames Gateway. This is beyond the scope of Z-squared, but would contribute a low-carbon energy input for part, or all, of the Thames Gateway.

It is recognised that EfW processes are inherently "waste hungry" and strict management controls are required to ensure that the first option for waste is reuse and recycling, with energy recovery a secondary option. Additionally, as waste minimisation targets are achieved, the available feedstock will reduce. To combat this, a possible solution would be to utilise existing landfill sites as supplementary feedstock. Landfill mining is an embryonic process that can generate a variety of valuable resources. Older stable landfill sites will contain substantial metal content that can be readily recycled, and plastic waste that will have high calorific value for an EfW process. The mass flows for a gasification process at Z-squared are as follows:

Table 8: Gasification EfW mass flows for Z-squared waste management options

	Input	**Output**		
	Mixed Combustible Feedstock (tonnes pa)	Energy Potential (GJ pa)	Inert Ash for recycling (tonnes pa)	Waste to landfill (tonnes pa)
Option A (base case)	0	0	-	6,304
Option B, D	3,999	49,028	615	160
Option C	4,436	54,385	651	177
Option Z	2,513	30,809	503	101

Recent developments have indicated that an emerging technology exists which can link organic-based treatment with fuel cell generation of electricity, heat and water. Plasma torch pyrolysis is a high temperature pyrolysis method (7,500 degrees centigrade) which can potentially treat all organic and hydrocarbon waste, including PET and PVC plastics with good quality emissions due to the extremely high temperature used by the plasma arc. Whilst this research was carried out too late for inclusion within the initial design for Z-squared, early indications are that such a waste treatment plant can be commercially viable if linked to a 5 MW output fuel cell generation facility by "cracking" the organic and hydrocarbon waste mix into free hydrogen for use in the fuel cell with the possibility of sequestering the CO_2 produced for use as a refrigerant gas, or other industrial or horticultural processes.

Municipal waste summary

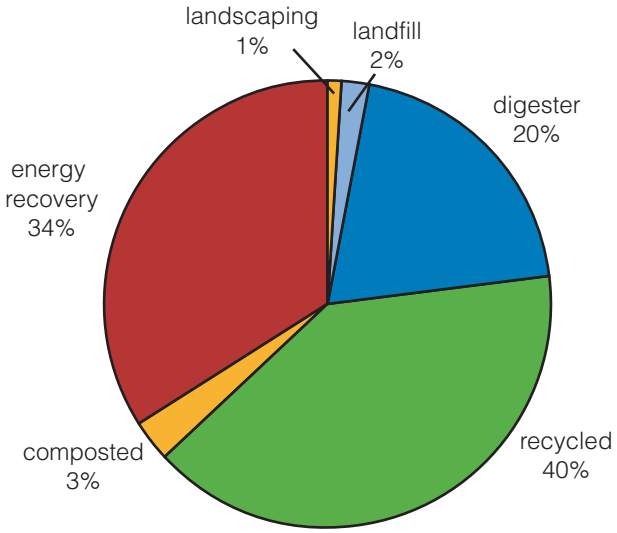
The success of a community based on the principle of zero waste to landfill will rely completely upon the support from the LA and the UK Government. Any waste collection strategy must be thoroughly integrated with the Local Plan of the appropriate LA. Existing partnerships with waste management contractors covering the borough may conflict with, or may enhance, the Z-squared approach, and these issues will need to be addressed depending upon the site selected for the community.

More importantly as far as achieving "zero" waste to landfill, is the clear dependence on some form of residual waste treatment for, as a minimum, 2,500 tonnes of mixed waste each year for Z-squared. Until the components of the waste stream, namely the composition of the products and their packaging used throughout society, are designed to enable complete disassembly and reuse or recycling, there will remain a quantity of waste which cannot be re-introduced into the supply chain, and so becomes a waste to be disposed.

At present, landfill is the cheapest development option. Alternative solutions are therefore dependent upon a mix of Government action, e.g. taxes or incentives to meet waste and carbon reduction targets, and minimise the social damage cost, and public demand, due to rapid increase in Council Tax resulting from falling supply of landfill sites and rising transportation and disposal costs. Using the residual waste as a feedstock for an EfW system not only minimises landfill impacts, but creates a carbon-neutral fuel supply (except in the case of the plastic component) that will contribute to our energy demand in a more environmentally benign way.

EfW plant is expensive; they are not cost-effective on a local (Z-squared) scale, so this community cannot achieve waste management autonomy as the technology and market currently stand unless operated as a small scale subsidised pilot project. A municipal-scale EfW plant designed for the residual waste of the Thames Gateway region and funded by UK Government would enable a low-carbon energy contribution to the regional distribution network, and safely treat the waste with minimal impacts to the environment, both locally and globally. However, for the Z-squared project, further research is to be undertaken into the opportunity of installing a pilot modular EfW plant sized to address the residual waste volume of the Z-squared community. This will involve monitoring emissions in the area prior to installation, selection of plant to meet emission requirements, post-installation monitoring of emissions and an undertaking to shut down the facility if emissions are breached over a pre-determined timescale, though recognising that this would result in an increase in waste going to landfill in the absence of any alternative. This pilot project would seek to allay public perception issues, gain hard data about emissions against pre-installation baseline data and would meet the proximity principle.

Figure 12: Option Z waste stream destinations



The levels of recycling achieved by this scheme demand a substantial investment in waste separation processes. While some materials can be readily segregated, others such as plastics require a sophisticated (and expensive) series of processes to ensure an uncontaminated product for re-introduction into the supply chain. Sorting at source will go a long way towards enabling separate waste streams to be identified early reducing the need for several sorting processes later on. This requires community acceptance and "buy-in" to having segregated bins in the home, a convenient and effective collection system, and regular feedback to the community relaying the performance of the overall scheme. However, source-separation will only achieve so much, and some subsequent processes will be necessary to gain the maximum resource benefits from the waste stream.

While this report does not reveal the ultimate cost-effective option that all communities of this size should strive towards, it does present a series of effective waste management options, and a way towards them that is achievable given today's technology. The market landscape in which Z-squared will live is in constant flux, and the policies that could be employed to guide waste management towards a sustainable goal are in place. However, zero waste to landfill requires acceptance and support from a number of levels. In addition to Government policy and capital initiatives, the LA must accept and enable the proposed waste collection and treatment strategy, and the community must be involved in the process. Initiating and maintaining public support will be the foundations on which this sustainable waste management solution will be based.

Construction and demolition waste

The construction industry is responsible for around 24%[iv] of total waste arisings in the UK. A number of methodologies have been developed to enable developments to maximise materials recovered from demolition and construction for reuse, to reduce the volume of waste arising that would otherwise be sent for landfill disposal:

- **BRE SMARTWaste** – a suite of tools that apply the concept of sustainable waste management, including:
- SMARTStart – a benchmarking tool
- SMARTAudit – an auditing tool to measure the source, type, quantity, cause and cost of waste, using embodied CO_2 as an indicator
- SMARTStart LG – a tool for monitoring and target-setting for local government, contractors and managers
- BREMAP – a geographical information system that helps identify the best practical environmental option for waste

www.smartwaste.co.uk

- **The Demolition Protocol**
  A pre-demolition audit generates a Demolition Recovery Index (DRI), identifying the potential for cost-effectively recovering material from demolition. This may be used in conjunction with a New Build Recovery Index which provides a tool for establishing the potential percentage and quantity of recovered materials that can be specified in a new building or other structure.

www.londonremade.com/publications_research.asp

- **Environmental Performance Indicator (EPI)**
  This is expressed as m3 of waste sent for disposal (i.e. not recycled or reused) during construction of domestic dwellings per 100 m2 of floor area. The Movement for Innovation (M4I) Sustainability Working Group has used data obtained from some residential sites using BRE's SMARTWaste tools to create initial benchmarks. Performance ranged from 5.1 to 16 m3 per m.

www.constructingexcellence.org.uk

- **Key Performance Indicator (KPI)**
  Advocated by DTI, the Construction Best Practice Programme has produced a set of ten Environmental Key Performance Indicators that includes waste in the construction process. The benchmark converts performance in m3 per £100K into a % benchmark score. The 0% benchmark is 250m3 per £100K up to a 100% benchmark of 0m3 per £100K.

www.cbpp.org.uk/kpizone

iv BIFFA Future Perfect

Case study: Greenwich Millennium Village

Greenwich Millennium Village (GMV) exceeded its target to reduce – by 50% – on-site construction waste for its Phases 1a and 2a of the development. More than halving the number of skips required has led to an estimated cost saving of £150,000. A key factor in the GMV waste reduction strategy was the use of BRE's SMARTAudit, which measured the underlying causes of waste, enabling subsequent actions to be monitored throughout the lifetime of the project.

GMV guides[18] to waste reduction and maximising reuse and recycling of materials suggest a number of essential actions to be taken:

- Establish a waste reduction strategy early in the process
- Contractually oblige sub-contractors to co-operate in waste minimisation as part of their tender
- Communicate regularly with all sub-contractors and site operatives
- Partner with a waste management contractor to maximise recycling and reduce disposal costs
- Engage the whole supply chain – GMV partnered with British Gypsum who took back their own plasterboard
- Design to reduce waste
- Segregate waste streams to minimise contamination and allow for maximum reuse
- Compact waste and load skips to reduce waste volume
- Reuse and recycle waste where possible
- Ensure there is suitable storage for all materials and accessible areas for waste skips
- Plan for high volumes of waste in the final construction stages

Source: http://www.smartwaste.co.uk/smartaudit/gmv.jsp

Z-squared will adopt construction practices that will ensure sustainable construction and waste management such as:

- Use of reusable or steel formwork rather than timber – where timber is used, it should be Forestry Stewardship Council (FSC) / Pan-European Forest Certification (PEFC) or similar
- Use of modular construction methods to encourage repetition and flexibility of building resources
- Off-site pre-fabrication (where appropriate) to minimise and control waste and ensure good workmanship and durability
- Strict construction waste management practices that adopt the principles of the waste hierarchy and provide segregated waste storage on-site, thus ensuring better use of resources
- Construction traffic managed to minimise haulage journeys, CO_2 emissions and community disturbance by grouping small deliveries, and integrating supply chain and transportation. This links to the local materials sourcing strategy described in Section 10: Sustainable construction materials.

8. Sustainable Transport

Objective
- To provide a safe, reliable sustainable transport system with reduced fossil fuel consumption and a virtually car-free environment

Target
- Develop a Sustainable Transport Plan and indicators
- Target to achieve maximum credits associated with "transport" under BREEAM and EcoHomes
- To reduce the number of journeys associated with commuting to work through local employment opportunities and provision of a broadband network allowing residents to work from home
- To reduce the number of journeys associated with driving to shops
- To provide a car club and secure cycle storage

Concept design
- Car-free core and local facilities and amenities within easy walking or cycling distance
- High density development near transport nodes
- Safe network of pedestrian routes, cycle paths and home zones where pedestrians and cyclists take priority
- Incorporate car clubs / car share groups and develop mobility packages incorporating various transport alternatives
- Provide opportunities for zero and low emissions transport – electric, biodiesel and hybrid vehicles

Transport infrastructure is inextricably linked to land use planning. The transport sector is responsible for 25%[v] of UK carbon emissions, of which road transport accounts for 85%. Passenger cars account for around half of all transport-related carbon emissions and around 18% of an individual's carbon footprint is attributable to personal transport. Reducing these emissions is achievable through reducing the need for journeys and reducing the impact of these journeys.

Z-squared will have a car-free core and an integrated transport policy aimed at reducing fossil fuel miles while allowing efficient access for emergency vehicles, deliveries and waste collection.

Reducing the need to travel by car and encouraging use of alternative modes of transport

63%[vi] of journeys are made by car (of which 13% are shopping, 11% visiting friends and 11% commuting). Outside London, 70% of people commute to work by car (40% in Greater London). In London, 50% of people use public transport to get to work. Across the board, only 3% cycle to work and just 1% walk.

The above figures reflect the availability, reliability, suitability and frequency of public transport systems between people's homes and where they want or need to travel to. In this rapidly changing world, where people cannot rely on one employer or skill for their whole working life, it is inevitable that people will continue to choose to live in the most pleasant and safe environment that they can afford within commuting distance from a number of employment opportunities and short travel distance from schools having a good reputation.

Within the Thames Gateway, there need to be frequent, rapid and efficient mass transport systems, primarily trains into central London but also orbital tram or bus routes, with transport nodes sited to suit public demand. Local and development planning should also take into account the need for local employment and facilities and a range of practical measures that can be taken to reduce the need for travel by car and encourage use of alternative modes of transport.

Density of development and proximity to local facilities

Higher density development increases the catchment for local employment, services and facilities, which in turn may reduce the need for car ownership and provides a larger potential market for accessible public transport. Information on public transport times and routes must be easily available to all residents. Greater use of public transport can be encouraged by discounts and well-planned integrated transport nodes. Re-routing of traffic and managed reduction of traffic within the core of the development will allow the provision of a high quality, largely traffic-free pedestrian environment.

Parking

Lower provision of parking spaces allows for a greater number of homes per unit area thereby increasing development density. Limited parking, CCTV monitoring and effective enforcement of permit parking may reduce car ownership, increase use of public transport and local facilities and reduce the likelihood of crime. Parking should be managed at the perimeter of the site, at grade or under buildings or in multi-storey car parks. Provision of some reduced-sized spaces for smaller cars will save space, and

v department for transport (2003)
vi department for transport (2002)

money; two standard Smart cars can fit in a standard parking space and have emissions of just 0.116 kg per mile (the same as the hybrid Toyota Prius). Provision also needs to be made for trade vans and off-road delivery areas to ensure main transport and emergency access routes do not get blocked. Garages at street level and other unmanaged dead areas will be discouraged since these increase the likelihood of crime.

Technology
Advances in technology have led to greater opportunity for teleworking and live-work arrangements which obviates the daily commute. However, there is still a need for close proximity to local services to meet human need for social interaction.

Walking and cycling
400m is generally accepted as the maximum distance that people are generally willing to walk to a transport node or local facilities, although previous research[19] found that around half of trips under one mile were made by foot. Providing safe, segregated, well-lit direct routes is key to encouraging people to walk or cycle, as is the design of residential areas as Home Zones, areas where pedestrians and cyclists take priority and speed limits are restricted. Secure cycle storage is key throughout the community.

Car clubs
A car club is a number of vehicles shared by members of the club. A typical car club has up to 20 members for each vehicle, and members can hire a vehicle for as little as a one hour at a time. Vehicles are parked in "car stations" within walking distances of member's homes or workplaces. Members pay a monthly or annual membership fee and then use the vehicles on a pay as you go basis. Access to a car without paying for the fixed costs of ownership puts car use on an equal footing with public transport. Membership of car clubs can incorporate extra benefits such as reduced rates for longer journeys and discounts on public transport.

Car clubs offer convenience and flexibility by providing access to car travel without having the responsibility for servicing, maintenance or insurance of a vehicle. In addition to these financial benefits, the car club also provides a variety of vehicles to suit particular journey needs, from small cars through to vans.

Low and no-car housing becomes a feasible option with car clubs enabling reduced car ownership. Car clubs also reduce mileage – experience of European car club operators is that members reduce their car mileage by up to 50% and increase walking and public transport use. Since one car is shared by up to 20 members, the number of parked cars and traffic is reduced, improving the quality of the environment and road safety. At BedZED, the second highest contributor to carbon savings is the car club which currently has around 40 members. The car club forms part of the Green Transport Plan which was a pre-requisite of planning.

Public transport
Improved provision of public transport such as introducing new bus stops and stands that ensure ease of pedestrian access to and from all facilities and other modes of transport will reduce the need for people to own and use cars. Bus shelters will be lit at night to make people feel safer while waiting. The shelters will be powered by the site's renewable energy.

Solar-powered bus stop
Photograph: Transport for London, London Buses

Reducing the impact of vehicles

Cars
With increasingly stringent emissions targets and improved engine efficiencies, together with technological advances producing hybrid engines, the carbon emissions from a 2-seater Honda Insight are just 0.08 kg CO_2 per mile, less than half that of the best-selling Ford Focus (0.186 kg/mile) or the Ford Ka (0.161 kg/mile), while the family-size Toyota Prius emissions are 0.116 kg/mile. Encouraging residents to switch to more carbon-efficient models and making them available in the car club would significantly reduce domestic transport-related carbon emissions.

Zero (carbon) emission cars are now also a possibility, with electric cars, diesel engines able to run on 100% biodiesel which can be produced from biomass crops (although these are often grown with fossil fuel inputs) or recycled vegetable oil, and diesel / electric hybrids that offer even greater efficiencies. Several major car manufacturers are trialling hydrogen fuel cell vehicles which have just water as a byproduct. This option is only as clean as the method of

fuel manufacture. Hydrogen is often considered emission free but this is only the case if it is created from water using renewable energy. At present 95% of hydrogen used in vehicles in the USA has been sourced from natural gas with consequent carbon emissions. Z-squared could be a pilot for clean hydrogen fuel cells. An alternative fuel filling station could be established at the edge of the site to encourage residents and passing motorists to switch to greener fuels such as hydrogen and liquefied petroleum gas (LPG).

There is also scope for a biodiesel plant to be set up as part of an adjacent eco-industrial park. The EU has adopted legislation that requires the UK and other EU countries to set targets for the use of biofuels for transport with a target of 2% by 2005 increasing to 10.75% by 2010[20].

Other vehicles

Other road transport is responsible for 35% of transport-related carbon emissions. Since public transport will be provided via Transport for London (TfL) and third parties are responsible for other vehicles, there is limited scope for reducing these carbon emissions, with the exception of specifying zero or low emission vehicles to be used by businesses operating within Z-squared, including municipal waste-handling vehicles. There have been a number of developments and trials of vehicles running on hydrogen or biodiesel (see case study).

Case study: Buses and trucks

Fuel cell buses: TfL London Buses is taking part in a European trial of hydrogen fuel cell buses in partnership with Daimler Chrysler, BP, the Government, Energy Saving Trust and FirstGroup plc. The fuel cell buses carry up to 70 passengers and have a range of 200-250km fuelled on compressed hydrogen which has been converted from natural gas. Shell is operating a trial of fuel cell buses in Amsterdam where the hydrogen has been sourced from water and renewable energy. Source: The Mayor's Ambient Noise Strategy (2004)

Diesel / electric hybrid trucks: In California, FedEX, in partnership with Environmental Defense and Eaton Corporation has introduced a diesel / electric hybrid delivery truck into its fleet. The environmentally-superior vehicle is expected to reduce particulate emissions by 90%, reduce smog-causing emissions by 75% and travel 50% further on a gallon of fuel, thereby reducing fuel costs by 1/3.

Source: FedEX

A biodiesel sports car

9. Sustainable Water Strategy

Objective
- To minimise mains water use through use of water-efficient appliances and fittings
- To manage rain and wastewater locally for reuse where appropriate
- To address flood management issues
- To consider the use of water for amenity and recreation

Target
- To develop a Water Conservation Plan and indicators
- To reduce the amount of water used for flushing toilets, washing, laundry and irrigation
- To treat wastewater on-site
- Target to achieve maximum credits relating to "water" under BREEAM and EcoHomes

Concept design
- To incorporate wastewater treatment into form and landscaping
- To develop a design that allows flood risk management

This chapter summarises the results of a study by Fulcrum Consulting into the water supply and wastewater treatment infrastructure for a 2,000 home community in the Thames Gateway. Behind this overview, a series of Fulcrum Consulting reports covers the main research and bibliography in more depth.

Background

Design of the infrastructure scheme is driven by three principles: firstly, demand side measures to limit water consumption, secondly, optimisation of the relationship between water supply and demand to reduce CO_2 emissions and, thirdly, reduction of waste and byproducts generated in the community by linking to other local processes.

Water supply

Greywater recycling systems and greenwater supply systems for use in WC flushing has been rejected on the basis of cost against water saved. However in public toilets that are frequently used, the use of greywater recycling may be justified in terms of water saved. The lowest environmental cost water source would be on-site boreholes to access a local aquifer, if possible. This is of particular benefit in reducing the need to provide additional reservoir water storage capacity and may reduce the embodied energy of water supply from 0.2kwh of electricity per cubic metre as distribution networks are shorter reducing pumping energy usage. If suitable local aquifer groundwater is not available, full treatment of rainwater coupled with low water usage appliances and the minimum mains water back up supply should be adopted.

Wastewater treatment

Full on-site water treatment is proposed, including a constructed reed bed-based treatment system with full pathogen removal. The treatment system should be located above the 1 in 50 year flood risk level to limit pathogen dispersal during a flood incident and it may not be possible to achieve this at many sites within the Thames Gateway.

Organic waste treatment

To ensure the highest possible percentage recovery and treatment rate, it is necessary to maximise the percentage of organic waste passing through a water treatment and recovery system, preferably on-site to minimise the increase in demand on the existing sewer system. This includes household and kitchen organic waste and sewage, but is particularly important for kitchen organic waste. The system adopted utilises waste disposal macerator units in every dwelling and has been hypothetically calculated to save greenhouse gas emissions equivalent to two thirds of the CO_2 emissions of the exemplary scenario for the site, from all other infrastructure supply systems combined. Key components of the waste treatment system are:

- in-sink macerators
- sedimentation tanks
- anaerobic digestion
- gas storage
- composter
- gravel bed hydroponics (GBH) and reed beds

Wastewater and organic waste

Z-squared approach

As long as there is access to a water course, on-site full wastewater treatment plant must be considered to relieve pressure on existing municipal treatment and to maintain design and operational control over the treatment system to ensure the lowest environmental impact.

This system doubles as an organic treatment plant as it is more efficient the higher the nutrient content of wastewater. In-sink waste disposal units can be used to capture close to 100% of the household organic waste produced by the residents. On-site drainage gradients need to be sufficient to cope with solid organic waste and off-site drainage may need to be reviewed for change in flow. This includes the proposed discharge to the water course.

After an organic separation tank, a low energy, low maintenance, low environmental impact greywater treatment system is required, comprising the following:

- GBH system comprising gravel building rubble or crushed recycled glass "gravel" trenches to convey greywater as an initial form of treatment, acting as a water transport system, an initial water treatment system and a filter which does not require maintenance.
- GBH to final constructed wetland treatment system can be provided close to the river to guarantee exemplary water quality before discharge to the river.
- GBH design can be programmed and monitored alongside the construction phasing.

Pathogen control

Wastewater and organic treatment systems achieve full treatment, but must be positioned in areas that are not liable to 1 in 50 year flooding. With global warming likely to increase the likelihood and level of flooding and many sites within the Thames Gateway being below the current 1 in 200 year tidal flood plain, the requirement for specific flood protection measures will need to be addressed on a site-by-site basis. The GBH treatment is associated with the level at which buildings are to be constructed and is assumed to be flood risk free. Sufficient area of GBH treatment and further constructive wetland treatment should be provided beyond the line of flood risk to prevent pathogen dispersal during a flood event.

Both the local sedimentation tank scenario and the central sedimentation tank scenario will have to use a GBH system at the built level to enable this and greywater pumping will have to employed at an energy cost. Not withstanding this, this is effectively the only energy cost plus the transportation energy used in the small electric vehicles taking the sludge to the digester and will be considerably lower than municipal embodied energy treatment which is approximately 0.3kwh per cubic metre of wastewater treated plus the embodied energy of organic treatment.

On-site sewage treatment on the scale of this project is fully commercially feasible and is likely to provide sewage treatment costs which are lower than those offered by the present statutory drainage authority in the area. By providing on-site sewage treatment, the site has control over the provision of exemplary technology to treat site derived sewage. This technology will incorporate anaerobic digestion equipment as discussed above to return the organic content of the sewage to the site as electricity and high grade heat via a co-generation plant.

Options for organic waste collection

Municipal sewage treatment plants and household organic treatment plants (particularly landfill) can produce methane which is released into the atmosphere. Any on-site treatment system must minimise any release of methane as, molecule for molecule, methane is 200 times more potent a greenhouse gas than CO_2. We have therefore calculated that the waste strategy outlined for Z-squared will remove an additional greenhouse potential equating to 21,100 tonnes of CO_2 per year. This calculation is based on that used to agree the Kyoto convention and similarly uses (a possible underestimate) the concept that the atmospheric half life of the methane is 10 years whilst CO_2 is 100 years and that methane is effectively only 20 times the greenhouse gas of CO_2. This system achieves a greenhouse effect "saving" for Z-squared of approximately 2/3 of the total CO_2 produced for supplying heat, cooling and electricity.

Water supply

When rain falls on porous ground it seeps through the earth into underground layers of water bearing rock, known as aquifers, filtering out contaminants naturally. This process filters out contaminants depending on rock type and other environmental factors. An aquifer-derived potable water supply will remove the pressure on providing additional reservoir storage capacity to feed advancing development in the South East which has already been identified as one of the barriers to development in this area.

Both rainwater harvesting and greywater recycling systems rely on the provision of a separate "greenwater" pipe network to supply WCs and possibly cleaning equipment such as washing machines or dishwashers. The provision of a brand new piped service is not easy to accommodate either in cost or co-ordination terms. Greywater recycling systems also require the provision of a separate greywater drainage system serving bath and shower rooms which bring in additional cost and complexity issues.

Borehole water

An initial desktop study by the British Geological Survey suggests that artesian water below some areas of the Thames Gateway may be contaminated with minerals that are expensive to remove. An average London borehole yield will supply the needs of 2,400 people living on the site, i.e. only two to three boreholes will be required to serve the needs of the site.

Rainwater

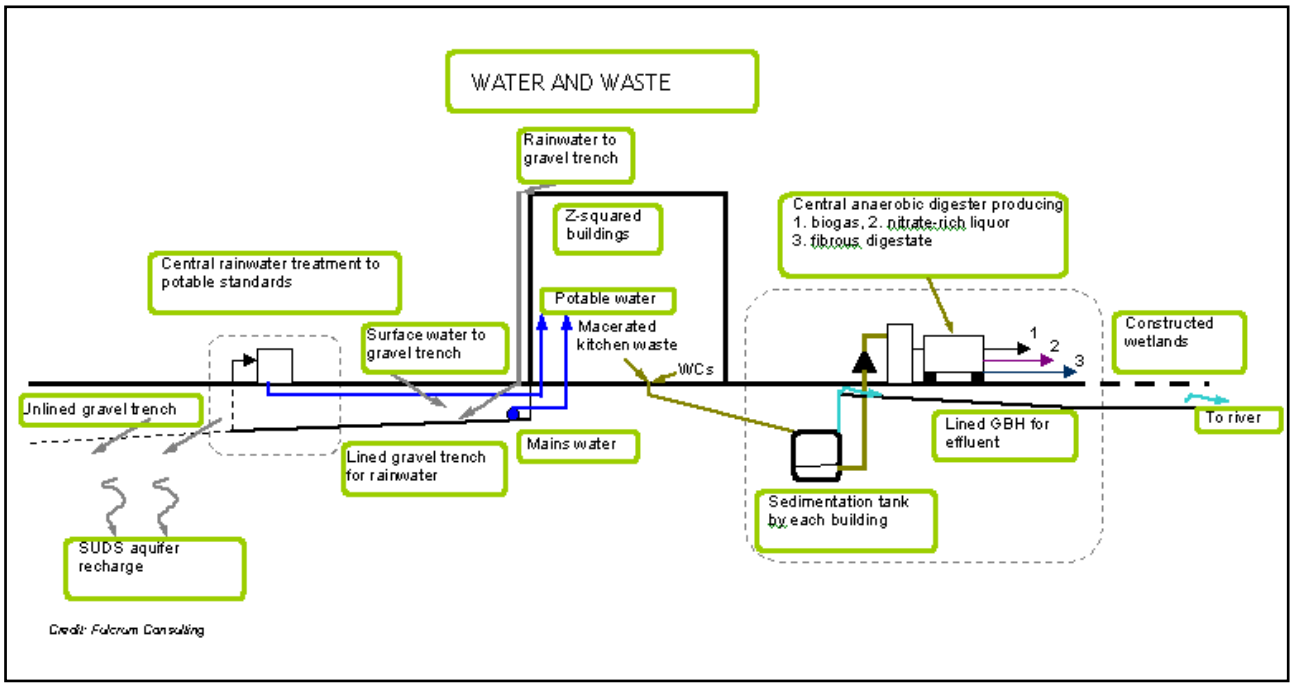
Sustainable urban development involves high density mixed use, low energy buildings. High density means relatively small areas of roof per person meaning that rainwater collection from roofs represents a small proportion of overall water use. To provide 100 litres of water per person per day, typical of the low water consumption achieved at BedZED through specification of water efficient appliances, 65m2 of roof area per person is required to collect sufficient rainwater: 32 hectares. Rainwater harvesting may be considered to supplement a mains water supply and utilised to flush toilets which are more heavily used, such as those in offices or public places, where the incremental cost of dual pipework is offset by the water savings.

A separate system of GBH trenches is proposed to collect and convey, filter and store rainwater collected not only from roofs but also from all available hard landscaping surfaces provided. If borehole derived water is not feasible, harvested rainwater will be conveyed in lined GBH trenches

to a treatment plant above the flood line. Here rainwater will be treated to potable standards and piped to be used in domestic hot water generating plant as it is naturally soft and will reduce heat exchanger maintenance and energy wastage costs caused by scaling from hard London water. GBH trenches should also be used as cheap, accessible distribution routes for other site services.

If rainwater is not to be recycled in dwellings, lined GBH trenches will collect rain to replace landscape irrigation from the mains. Rainwater that is not used for irrigation will be allowed to run through unlined GBH trenches from where it can soak away to recharge the aquifer as part of a sustainable urban drainage strategy (SUDS).

Figure 13: Water and organic waste flows



Section C: Other aspects of One Planet Living

10. Sustainable Construction Materials

Objective
- Materials for buildings and infrastructure chosen to provide high performance in use with minimised impact in manufacture and delivery

Target
- Develop a Sustainable Building Materials Plan with accompanying indicators
- Target to achieve maximum credits relating to "construction materials" under BREEAM and EcoHomes
- Materials selected that balance low embodied energy and low energy in use, setting a target of embodied energy (g CO_2 per m2) depending on construction methodology and informed by LCA methodology
- Set minimum specifications for recycled and reclaimed materials
- Maximise materials sourced from within a 50km radius of the site, particularly bulk materials
- Maximise use of renewable materials from sustainable managed sources, e.g. FSC timber
- Minimise use of toxic and unhealthy materials, in particular materials with ozone-depletion potential – chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), Volatile Organic Compounds (VOCs), virgin PVC and formaldehyde
- Development of a construction systems approach that harnesses the benefits of Modern Methods of Construction (MMC) and the use of local labour
- Design for adaptation to a changing climate

Concept design
- Will feature in detailed design and specification
- Reduce need for new construction by utilising existing features and buildings where practicable with minimum adaptation
- Consider whole life environmental and cost benefit principles for development during detailed design
- Opportunities taken to establish businesses that can supply Z-squared with materials with recycled content
- Consider how best to use materials to create a safe and pleasant environment

The materials used in constructing and maintaining our buildings and infrastructure globally make up over half of all our resource use by weight. This predominantly linear flow of resources consisting of energy-intensive extraction and processing of virgin (and often finite) resources followed by a short period of use before being discarded, has considerable impact in terms of environmental, financial and social sustainability.

Of 420 million[21] tonnes of material used each year in the UK for construction, about 10% are recycled materials (mainly in the form of aggregates), approximately 5% are from secondary sources (industrial byproducts) and less than 1% are reclaimed materials. However, many construction materials have low environmental impact. The most sustainable option is to consider how the existing features and buildings can be utilised, reused or recycled with minimum adaptation and embodied energy.

The specification of appropriate construction materials is vital to achieve long-term sustainability in any development. The choice of building materials governs heat loss, potential for reuse / recycling, durability and aesthetics. Some modern building materials are energy intensive in their manufacture, whilst others can reduce overall carbon emissions during a buildings lifetime. The choice of materials will also impact on those environments from which the material is sourced and areas where products are manufactured.

Low impact materials and building products can reduce the environmental impact of the building in areas such as:
- Greenhouse gas emissions
- Pollutant emissions
- Non-renewable resource consumption
- Waste creation

Applying a sustainable construction materials sourcing policy to a large scale development project such as Z-squared has the potential to deliver a significant reduction in environmental impact. Social benefits will also accrue, with the selection of local materials and labour leading to increased investment in the local economy. The use of sustainable construction materials may also deliver financial benefits through lower lifecycle costs and potentially

cheaper upfront cost through use of recycled and reclaimed materials, and local sourcing.

The construction material selection strategy for Z-squared will be informed by the benefits of using sustainable materials for the construction of homes, infrastructure and other buildings. The following issues are particularly relevant:

- Embodied energy and CO_2
- Recycled and reclaimed materials
- Local materials
- Certification
- Toxicity and other environmental issues
- Construction methodology
- Opportunity to develop new materials and kickstart local businesses

In developing the specification for construction materials, reference will be made to Association of Environmentally Conscious Building (AECB) guidance and the BRE's Green Guide to Specification and The Green Guide to Housing Specification. Products in the guides are rated according to their impacts on a range of sustainability issues, including resource consumption, pollution, climate change, ozone depletion and waste. The contribution from each element to the overall impact is also shown and ratings are given according to environmental impact. Many green developments choose to specify products that have been given an "A" rating. BRE EcoHomes, BREEAM and the SEEDA Sustainability Checklist can act as reference documents to inform the design and specification of the development and a recognised means of transferring requirements to individual site developers and contractors.

Embodied energy and CO_2

The embodied energy associated with a product or material is the amount of energy used in its extraction, refining, processing and transportation. Over the lifetime of a typical building, approximately 10% of the total energy used is embodied within the fabric of the building itself. The selection of robust materials with low embodied energy can therefore make worthwhile environmental and CO_2 emission savings.

The M4I[vii] Sustainability Working Group has developed a suite of Environmental Performance Indicators (EPIs) including embodied CO_2 emission for schools, hospitals, offices and domestic dwellings. This is measured in terms of kg CO_2 / m2 / year, the amount of CO_2 produced from the energy used in the extraction, fabrication and transportation of the materials used in the construction of domestic dwellings. These should be incorporated within the design brief and construction contracts.

Manufacturers are sometimes reluctant to divulge details of embodied energy but if environmental performance becomes a criteria by which products are selected, there will be an incentive for manufacturers to both provide information and improve their processes to ensure that their products are most competitive.

When selecting materials on the basis of embodied energy, it is necessary to consider the impact that this has on energy in use. The environmental impacts of the materials used in a building are far less significant than the performance of the building over its lifetime. Domestic household energy consumption accounts for 26%[viii] of UK CO_2 emissions, whereas the materials used in construction account for just 2-3%. The aim of Z-squared therefore is to minimise energy demand during use and meet that demand as far as possible through the use of renewables, and to minimise the embodied impacts of the materials used in construction of the design.

Recycled and reclaimed materials

The Mass Balance Study of the Construction Industry[22] found that the UK industry consumed 420 million tonnes of material resources each year, to build 275 million tonnes of built infrastructure. Construction and demolition produce around 90 million tonnes of waste each year, of which around half is recycled, mainly into construction.

The specification (by value) and use of reclaimed and recycled materials can reduce environmental impact by both reducing the amount of materials sent to landfill and reducing the amount of virgin and non-renewable resources consumed. In August 2004, The Waste and Resources Action Programme (WRAP) published a reference guide to *Opportunities to use recycled materials in house-building*[23] which outlines options for using recycled content in house-building using options that are cost-competitive, eligible for EcoHomes credits and are readily available and meet industry norms for technical performance.

In the construction of BedZED, 15%[24] (3,404 tonnes) of total materials used were reclaimed or recycled materials, reducing BedZED's embodied CO_2 by 4%. All of the recycled or reclaimed materials sourced were either cheaper than, or the same price as, the conventional option. Reclaimed steel and recycled sand achieved 96% and 97% embodied CO_2 savings respectively against the conventional alternative, virtually eliminating their environmental impact.

The specification of timber is a good example of where simple sourcing and procurement decisions can be made. 54,000m of 50x100mm and 75x100mm reclaimed timber studwork was used in the internal partitions at BedZED. The partition studwork was neither structural nor exposed to any weathering. Once installed, it was not visible and did not require any sanding, grading or durable treatment. This low-specification reclaimed timber was straightforward to source economically from reclamation yards and was cheaper than new softwood.

Since the construction of BedZED, the market for reclaimed and recycled building materials has grown, making it easier to specify these materials in future. The development of new standards, for example through the Construction Products Directive, means that the potential for specifying demolition recyclate in new buildings is continually

vii www.cbpp.org.uk
viii DTI

increasing. The Demolition Protocol's[ix] New Build Recovery Index (NBRI) provides a tool for establishing the potential percentage and quantity of recovered materials that can be specified in a new building or other structure. Where a project involves demolition and new build, the NBRI can be linked to the Demolition Recovery Index (DRI) which identifies the materials that can be recovered from demolition, and provide a model for assessing the efficiency of resource use for the whole project.

Long lead times and storage space are key to making reclaimed and recycled materials possible. There is scope at Z-squared to establish a reclamation yard that can be used during the construction of the development and to service the wider area.

Increasingly, there are new products being developed which make use of materials that would otherwise have gone to landfill. A WRAP-funded project explored the potential for different construction products incorporating the sludge waste byproduct from papermills, which otherwise dispose of this waste in large volumes to landfill[25]. Six products (sludge softboard, hybrid medium density fibreboard (MDF), cement-bonded sludge board, sludge tile, low-density cement blocks, sludge hardboard) were developed and tested to determine whether they met the requirements of the relevant product standards. The sludge softboard is suitable only for non-structural use but the other products met the required standards. The prototypes are being promoted but they are not yet available for commercial application. Specification in a major development could provide a market for new products such as these.

Materials

Local materials

The movement of construction materials around the UK accounts for around 30%[x] of all road freight. This represented around 0.5 billion tonne kilometres[xi], which has embodied CO_2 burden of 28 million tonnes (equivalent to around 500kg per person, or 4% of an individual's total CO_2 annual footprint).

A strategy of sourcing materials locally can significantly reduce the environmental impact associated with construction materials, while also supporting local businesses and communities. Using local materials can help new buildings integrate visually with neighbouring developments and can also make reference to the cultural or historical heritage of an area.

At BedZED, a target was set to maximise the amount of bulk materials and goods sourced within a 35 mile radius. A post-construction analysis of the local sourcing strategy found that around 50% of materials (by weight) were obtained within the radius and the average distance was 66.5 miles. Local sourcing of heavy materials such as bricks, concrete, aggregates, etc., can lead to greater environmental savings in terms of transport emissions avoided, whereas lighter, "value-added" items such as photovoltaic cells can be imported from overseas (provided they are not air-freighted).

Certified materials

Even construction materials such as timber which, being a renewable resource initially appears to be inherently sustainable, can have considerable impact on the environment, particularly in developing countries. The unsustainable harvesting of timber is having global impacts in terms of deforestation, depleting natural resources, habitat destruction and the decline of some rare species including medicinal plants. The UK is a major consumer of timber, using almost three times the global per capita average, and imports more than 80% of hard timber used.

The Forestry Stewardship Coucil (FSC) assesses and approves timber from sustainably managed forests and supply chains. It is an international, non-governmental organisations dedicated to promoting responsible management of the world's forests. Specifying use of certified timber is addressed by BRE EcoHomes and BREEAM, as well as the SEEDA Sustainability Checklist, and at BedZED was found to be a cost-neutral procurement decision.

Toxicity and other environmental issues

Other environmental impacts associated with construction materials, which cannot be represented in terms of embodied energy or resource depletion include toxicity, climate change and ozone depletion. Toxicity includes the impacts that some materials such as heavy metals and other chemicals may have on human health and the environment. Climate change considers the global warming potential of recognised greenhouse gases such as CFCs, HCFCs, methane and CO_2, while ozone depletion acknowledges the gases that damage the stratosphere's protective ozone layer.

Occupants of many modern buildings complain of "sick building syndrome", often caused by materials that emit gases, smells, particles or radiation that can result in an unhealthy indoor environment with poor air quality. Another One Planet Living Principle is "Happy and Healthy Lifestyles" which may be cross-referred to the choice of building materials for a healthy environment. The choice of materials used can have a direct impact on the health of builders, occupants and future generations with natural materials often being considered to be healthier. A healthy materials specification would not necessarily prohibit the use of materials that emit formaldehyde, such as chipboard, plywood, MDF, or insulation that uses urea, but their use and the exposure to occupants must be considered. Use of water-based paints or those containing low VOCs will contribute to improved internal air quality and possibly reduce incidence of asthma.

ix www.londonremade.com
x Carbon Neutral Toolkit – Part 1
xi Freight Transport Association

Construction methodology

In addition to considering the construction materials used within the buildings and infrastructure, consideration may also be given to construction techniques and methodologies and their contribution towards sustainable construction:

- Training local people in line with anticipated needs, particularly where there are local skills gaps, multi-skilling people to ensure reliable quality and minimise defects, while reducing construction times
- Exploiting the benefits of off-site construction to make efficient use of materials and reduce waste
- Using modern construction techniques to reduce the proliferation of trades, promote multi-skilling and increase on-site productivity
- Maximising thermal properties and buildability through use of a hybrid of heavy and lightweight construction in line with energy strategy
- Integrating infrastructure and buildings to provide holistic best practice solutions.

11. Local and sustainable food

Objective

- Through the provision of sustainable choices, to enable residents to reduce the environmental impact arising from consumption of food

Target

- Develop a Local Food Plan and associated indicators
- Increase the proportion of locally-sourced food consumed by the community
- Reduce the proportion of internationally-sourced food consumed by the community
- Maximise local food production, mainly organic or low chemical input produce
- Ensure local seasonal organic food is available in shops, restaurants and market through purchasing schemes

Concept design

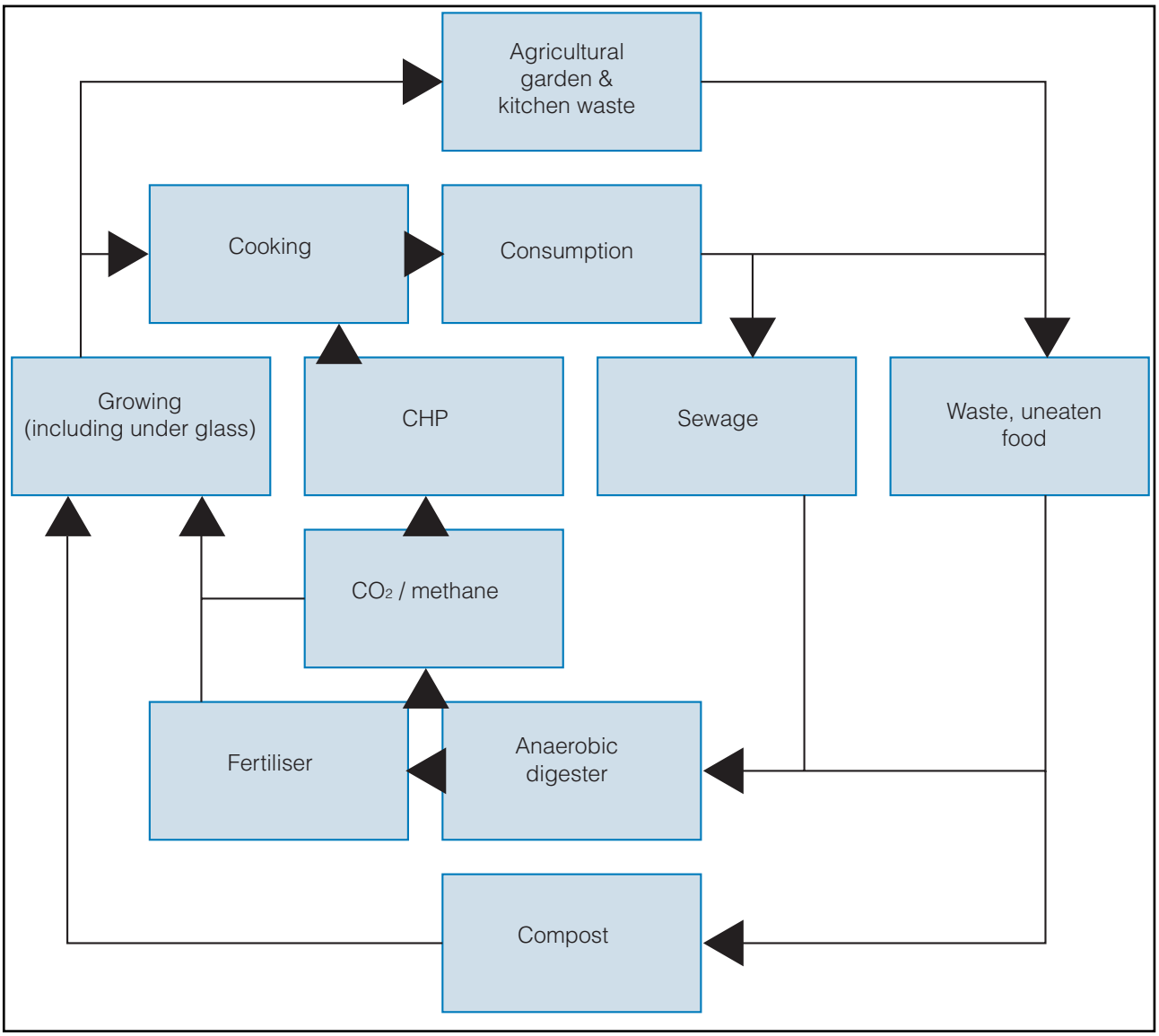
- Masterplan incorporates opportunities for local food growing and distribution including community space for hosting farmers' markets
- Edible landscaping opportunities exploited with fruit and nut-bearing trees

Food comprises around a quarter of the ecological footprint of an individual living in the South East of England. Our modern food system involves resources being consumed and pollution and waste being generated at each stage of the linear food chain: production, processing, packaging, distribution and retailing. A traditional British meal of lamb casserole and apple crumble could have travelled up to 12,000 miles to reach your plate with lamb from New Zealand, onions from Spain and South African apples. Agricultural and food freight accounted for 30%[xii] of all road freight in 1999 – 47 billion tonne-kilometres. One approach to reducing food miles is to grow produce locally.

Research into food production suggests that energy use per calorie can vary by a factor of ten between organic and conventional methods of vegetable growing and by up to 10,000 between organic smallholdings and factory-farming meat production[26]. The environmental impact of food can be reduced by eating organic locally-grown seasonal produce, reducing packaging, switching to a low meat and dairy diet and switching to a circular system for food production (see Figure 14) which diverts organic waste from landfill and generates energy and compost on-site, thereby creating a "closed loop" which greatly reduces the environmental impact arising from food consumption.

xii Freight Transport Association

Figure 14: A circular food system



Source: Adapted from Lucas & Jones

The UK's Environment Agency estimates that the food and drink sector produces between seven and eight million tonnes of waste per year, second only to the construction industry, and consumes approximately 900 megalitres of water each day, enough to supply almost three-quarters of all customers' needs in London daily.

Any community that is aiming for sustainability should aim to produce as much food to meet its needs as it can. In order for a 5,000 people community to be self-sufficient in soft fruit and vegetables, an area of approximately 5 hectares must be dedicated to growing them using bio-intensive gardening; this method of production has much higher yields than commercial mechanised farming[xiii]. 10 to 20 hectares would provide the needs of the community if less intensively farmed.

The FLAIR Report 2003 found that the local food sector "makes a positive contribution across all aspects of sustainable development in both urban and rural areas and can help restore the environmental, social and economic assets of a region". In contrast, much of the food that is imported, particularly fresh fruit and vegetables, is grown as cash crops in developing countries where there are high levels of poverty but the proceeds of exports are often used to fund hard currency debt. Every £10 spent on local organic food generates £25 for the local community whereas the same £10 spent in a supermarket generates only £14[27].

A recent Soil Association report[28] found that organic food shoppers appear to be shifting away from supermarkets to farmers' markets, farm shops and box schemes with consumers demanding more local seasonal food. The organic produce sector in the UK continues to grow with total sales reaching £1 billion in 2003. However, much of this is imported.

xiii Based on 100 square feet yielding up to 322lbs of vegetables and soft fruit during a four to six month growing season (Todd & Todd, 1994)

How food is served, prepared, purchased and produced can have a huge impact on the health of individuals, communities and the environment in the UK and overseas. Sustainable food is about[29]:

- Promoting good health
- Having access to healthy food and helpful information
- Engaging with the local community
- Supporting your local economy by buying food from as close by as possible
- Eating food in season
- Sustainable farming, involving high environmental standards and reduced energy consumption
- Promoting animal welfare, and valuing nature and biodiversity
- Fair prices, fair trade and ethical employment in the UK and overseas

The London Development Agency (LDA) has recently set up a new body called London Food to devise a more coordinated approach to food and farming for the capital as 80% of food eaten in London is produced outside the capital despite 8% of Greater London being farmland[30].

There are a number of ways in which local sustainable food may be introduced into Z-squared.

Growing food on-site

Grown by residents

The provision of allotments, gardens, balconies and rooftop gardens enables those residents who so wish to grow their own vegetables. Community gardens and school gardens can also grow food that can be used or distributed within the neighbourhood.

Grown commercially within Z-squared and supplied to box schemes, farmers' markets, local stores and other enterprises

The energy and waste strategies for Z-squared allow the opportunity to use waste heat and CO_2 emissions in greenhouses that are integrated into the community design, thus extending the growing season and yield of seasonal vegetables. The constructed wetland, wastewater and organics treatment system included within Z-squared increases productive area for potential on-site food production. Edible landscaping will be considered. Compost and anaerobic digestion byproducts can be used as "free" resources for food and energy crop production. Depending on the site, an on-site organic farm should be considered within Z-squared. This would provide employment for local people, educational value for school children as well as an attractive landscape for local residents and visitors. However, in an area where land is expensive and possible contaminated, it may be more appropriate to consider horticultural options and establish links with local farmers to source local organic food for residents.

Local food schemes

Vegetable box schemes

Vegetable box schemes, linked to local producers, offer residents the opportunity to buy a range of seasonal produce throughout the year. A scheme may be provided from within Z-squared or via links to a Z-squared community supported agriculture (CSA) farm and could be promoted by the developer, management company or Community Trust at Z-squared. The proposed community space could act as a central drop-off and collection point. Bulk deliveries could also be coordinated by a caretaker, residents association or Community Trust representatives to reduce transportation impact further. Information on sustainable food and minimising the transportation associated with goods should form part of any resident induction materials or service. The CO_2 emissions relating to locally sourced produce bought from a home delivery box scheme are 300 times less if similar produce were air-freighted from South America and bought by driving to a supermarket[31].

Community supported agriculture

CSA is a partnership between farmers and consumers where the responsibilities and rewards of farming are shared. In England, there are a variety of initiatives ranging from whole farm CSAs, customer-supported initiatives, conservation-based initiatives, rent or adopt schemes, urban food growing projects, community allotments and other charitable projects. Typically, CSA farms use organic or biodynamic farming methods to provide fresh, high-quality food to their consumer members and have greater employment rates than conventional farms[32].

Case study: Tablehurst and Plaw Hatch CSA, Forest Row, East Sussex
This Community Supported Agriculture scheme farms around 700 acres on two small mixed farms, Tablehurst and Plaw Hatch that are 3 miles apart. The farms have an annual turnover in excess of £250,000.

The CSA scheme aims to "re-establish the connection between the process of food production and the people who consume the food, creating support for sustainable farming practices in the future."

The farm business is owned by a co-operative, with shares owned largely by the local community. In addition to farming livestock, growing vegetables and cereals and beekeeping, the business runs an extremely successful farm shop, employing a full-time butcher to cut and process the meat, a flour mill, a flock of milking sheep and a variety of on-site activities add value to the products.

Source: Soil Association[33]

Outlets for local food

Farmers' market
Farmers' markets have grown massively in popularity in recent years. Selling produce directly to the consumer can mean that the producer receives 80-90% of the "food pound" against approximately 10% obtained through the conventional supermarket system. Public open spaces should be designed to enable holding such markets and they will be actively promoted to the wider community in the initial stages as the Z-squared community forms and develops. There is a potential supply chain linkage to the on-site organics treatment system whereby nutrient recycling can be achieved by local farmers taking nutrient-rich digestate or compost, producing food locally with nutrients returned via food sold at the farmers' market.

Local food available at supermarket and convenience stores
Many supermarkets offer local produce, with Asda being the latest to announce the introduction of a Local Choice offer in all its stores in 2005 following trials in the Lake District[34]. Out of this World provides a good model for prioritising ethical concerns where products are selected that make a positive contribution to five main criteria: fair trade, healthy eating, animal welfare, environmental sustainability, and community development. Other retail outlets such as Fresh and Wild have also embraced organic local food. Within Z-squared, retailers will be encouraged to source local organic food and other products.

Case study: Fresh and Wild
Fresh and Wild is an organic grocery chain of six stores based in London. Its environmental policy aims to reduce the environmental impact of its operations and to support community liaison.

Approximately 10% of Fresh and Wild's stock is sourced from within 100 miles of London, including fresh fruits and vegetables, alcoholic and soft drinks and juices and dairy product. Over 15 suppliers are based within Greater London, including suppliers of smoked fish, bread and cakes. Other products come from further afield.

Source: Capital Eats (2004)[35]

Schools, cafes and restaurants sourcing food locally
Schools can play a significant role in encouraging children to adopt healthy eating habits which in turn lead to health benefits. Involving children in cultivating vegetables and preparing food will enable them to develop lifelong skills. Research by the Countryside Agency suggests that children who spend more time outdoors have increased independence and self-reliance, have a greater sense of freedom, and have more developed creative thinking processes. An allotment scheme – "Plots for Tots" – encourages children and their parents to grow flowers and vegetables.

London is home to the world's first two certified organic pubs and many restaurants now feature organic ingredients. Within Z-squared, other public eating places such as pubs, cafes and restaurants will be encouraged to adopt a local sourcing policy for food and other products. A local organic meals on (electric or biodiesel) wheels service could be established for elderly residents within Z-squared and the surrounding area.

12. Natural Habitats and Wildlife

Objective
- To increase biodiversity through provision of a range of habitats using native planting

Target
- Develop a Biodiversity Action Plan and indicators aimed at increasing biodiversity levels
- Achieve maximum credits relating to "land use and ecology" under BREEAM and EcoHomes
- Maintain and enhance blue ribbon network
- Conserve greenfield sites and primarily develop on brownfield sites
- Enhance the quality, quantity and range of habitats
- Incorporate native planting into the landscape strategy

Concept design
- Green spaces integrated into masterplan
- Most residential units to have outside spaces
- Gravel beds, reed beds and maturation ponds offer habitats for a range of species
- Green and brown roofs incorporated where possible
- An ecological survey will be undertaken prior to development

The concept design for Z-squared includes public and private green spaces which play a variety of roles within the development – food growing, flood alleviation, leisure and amenity. The Mayor's Biodiversity Strategy details the Mayor's vision for protecting and conserving London's natural open spaces. It seeks to ensure that there is no overall loss of wildlife habitats in London, and that more open spaces are created and made accessible, so that all Londoners are within walking distance of a quality natural space[36]. Access to green spaces provides a sense of wellbeing and has a positive effect, both physically and mentally on residents, as well as providing for biodiversity. Trees and greenery can help reduce the incidence of asthma, stress-related illness and skin cancer by filtering airborne pollutants, providing a buffer against noise and offering shade from the sun.

Brownfield development

By 2008, 60%[37] of new housing should be built on brownfield sites or converted from other properties. Z-squared is intended to be developed in the Thames Gateway and hence is likely to be built on a brownfield site. The wildlife value of brownfield land is often undervalued; brownfield sites often host a wide range of animals and plants[38]. Many brownfield sites are contaminated due to previous industrial use and as a result, may host unusual plants . Prior to development of Z-squared, an ecological survey will be undertaken to identify existing characteristics and a Biodiversity Action Plan will be developed to ensure that biodiversity levels are increased.

Green and brown roofs

Building Green[39] lists the many advantages to specifying a green roof. In addition to providing thermal and acoustic insulation, and slowing rain run-off thus alleviating local flooding problems, green roofs can play host to a wide variety of flora and fauna. A study[40] of green roofs in London (including BedZED which is topped with sedum matting containing semi-succulent plants), carried out in 2002, found a total of 59 species of spider fauna representing 23% of the total Greater London (and 9% of the total UK) recorded spider fauna.

Recent DTI research[41] has concluded that green roofs are best able to cope with the effects of climate change, including higher wind speeds, increased rainfall and longer, hotter summers. In urban areas, green roofs can also improve air quality.

Single or brown roofs also have a role to play in providing habitats for birds such as the Black Redstart[42], a species of conservation concern listed in the UK Biodiversity Action Plan, as well as providing microhabitats for invertebrates.

Where possible, green roofs will be incorporated into the design to increase the green footprint of the development. However, since initial construction costs are higher than other roof types, some form of government subsidy may be required to encourage uptake.

Black redstart:
© Roger Tidman and rspb-images.com

Wildlife corridors

As climate and habitat changes, the role of wildlife corridors, including blue ribbon networks, allowing migration from one green space to another becomes increasingly important to ensure survival and dispersal of species. *Greening the Gateway*[43] sets out a 25-30 year project to enhance the Thames Gateway green space and provide a continuous linked network of varied landscapes. The site-specific design of Z-squared will take note of and link into neighbouring green spaces.

Landscaping

Native and drought-resistant planting is proposed for Z-squared, with streets planted with fruit and nut trees. Opportunities for organic local food production will be maximised through the provision of allotments and a community garden. Treatment of wastewater on-site leads to the use of gravel-filled channels which can be planted, reed beds and maturation ponds, all of which add to the range of habitats available for plants and wildlife. Reference will be made to SEEDA's *Building for Nature* project and the Natural History Museum's *plant postcode database* will be used to identify local species.

Clean air, clean water, clean environment

The Z-squared design limits pollution of the air, water and soil by capturing and converting waste products to replace input resources wherever feasible. Wildlife requires a clean environment to thrive and this approach will improve opportunities for flora, fauna and biodiversity.

13. Culture and Heritage

"The historic environment encompasses the cultural and archaeological characteristics of the landscape and townscape. It is an important component of the wider environment and economy, with aesthetic, economic, cultural, recreational and education values."

The Regional Sustainable Development Framework, The South East England Regional Assembly

Objective
- Develop with sensitivity acknowledging the history of the site and surrounding locality
- Seek opportunities to develop a sense of place that will lead to a sense of community and local pride

Target
- To develop a Cultural Heritage Plan with associated indicators as part of detailed development submission that will respect, preserve and promote the cultural heritage of the site
- To work with local stakeholders to develop a scheme that reflects the diversity of the community

Concept design
- Not included at concept stage; to be taken forward as part of site-specific detailed design

Developing and regenerating communities that maintain a respect for local cultural heritage is an important sustainability issue. Making reference to the past can help to promote an identity for intervention and engender a sense of community. Considering former and current local industries and land uses can both inspire future proposals for an area and also potentially revive or re-interpret local traditions and offer employment opportunities.

Acknowledging and representing cultural heritage can also have an educational value, while developing interpretation materials from signs to preserving buildings and landscape features to museums can have a financial value in terms of employment and attracting visitors. In the London Borough of Sutton, BioRegional initiated a project to revive the traditional lavender industry.

Carshalton lavender
Photograph: Katrina Stewart

Case study: Local lavender project
Since 1996, BioRegional have worked with HMP Downview, Sutton council and Yardley to revive South London's historic lavender fields. In 2003, the project was handed over to a local community group.

The three acres of lavender at Stanley Park Allotments have matured and hundreds of people, mostly locals, turn up every year to "pick their own" at the annual community harvesting event.

The flower heads left after the picking are harvested using BioRegional's innovative harvester built by Cranfield University. In 2003, approximately 1,200 small bottles of lavender oil were produced which are sold through local outlets, Christmas farmers' markets and as a special edition Yardley oil.

The award-winning Local Lavender project aims to revive the once famous lavender fields of the Carshalton area of London, the "lavender capital of the world" in around 1900. The area helped companies such as Yardley build an international reputation in perfumery and bath luxuries. Around 100 years ago, blue fields of lavender could be seen all over Wallington, Carshalton, Waddon and Sutton. Lavender was used for scented bags, floor and furniture washes, as a disinfectant, to preserve linen from moths, and for remedies. Lavender was also used in recipes such as lavender jam, honey and custard.

- The local supermarket has erected a lavender sculpture
- The Christmas lights have a lavender theme
- A local pub has been rebranded as "John Jakson Lavender Harvester".

Source:
http://www.bioregional.com/programme_projects/ecohous_prog/local_lavender/lavender_hmpage.htm

The role of our buildings, land uses and communities of today in contributing towards the cultural heritage of the future is also important. The cultural diversity in terms of ethnicity, religion, social mix, employment of any community will need to be reflected in the built form and should be acknowledged by the development proposals. Some of London's most successful regeneration areas are former historic neighbourhoods that have been adapted to new uses with the best from the past being kept and complemented with exciting new architecture. This creates a vibrant street life and areas that people value and want to live in. Successful development of sustainable communities in areas such as the Thames Gateway must be on the basis of an understanding of what we have inherited from the past, with those features being enhanced by future development, not destroyed.

In an area such as the Thames Gateway, this would include opening up water courses, referring to the history of car manufacturing and highlighting the role of the river Thames as a historically key route into London.

Historical development of the site and surrounding area

A common approach will be undertaken for all One Planet Living Communities to ensure that the cultural heritage is researched and mapped so that it may be preserved and promoted. This will include a base line desk and site study to include the following:

- Research into the historical uses of the site
- Research into the history of the surrounding area, e.g. changing population mix, changing uses
- Research old maps and plans
- Consultation with local people who know the history of the site
- Advertising in local areas for contributions of local knowledge and contact local libraries for information

Interpretation opportunities

The cultural heritage of an area offers numerous opportunities for interpretation and education. The information gathered should be assessed for its potential for interpretation and education. Local school projects can develop plans that can be incorporated into the public realm.

Key features and place names that are identified can be brought back into use for key areas or street names. Historical names may be used in promotional literature and on signage to ensure that they become widely known and recognised.

Information boards at access points and leaflets may be developed that contain maps and give an overview of the most important historical features of the site to raise awareness and promote interest in the area. Planned walks may take routes past features of interest relating to cultural heritage and other aspects of the natural development.

Development strategy

The detailed development proposals for Z-squared will respect the archaeological significance and cultural heritage value of the site with the overarching objective being in-situ preservation of any archaeological resource and enhancement of features of cultural heritage interest.

14. Equity and Fair trade

Objective

- Create a diverse and inclusive community with a sense of identity and place
- Provide safe, accessible, inclusive and affordable facilities and opportunities for all
- Promote equity and fair trade in the construction and occupation of Z-squared
- Consultation with local community to ensure new development is accepted and embedded in wider community

Target

- Develop an Equity and Fair trade Plan with associated indicators
- Ensure that the mix of accommodation, employment and facilities provided, aims to provide sustainable growth and meet the needs of residents at different life stages
- Consult with local community to address concerns and obtain wider acceptance of the development
- Work closely with Registered Social Landlords (RSLs) to develop a sustainable and viable strategy for integrating the affordable housing provision and to meet London Plan targets for social housing provision
- Ensure the built infrastructure and public transport take account of disabled access
- Consider concessions for fair trade retailers and fair trade certification
- Promote local employment and skills training when selecting development partners and contractors
- Establish a Community Trust
- Establish a community intranet and website to facilitate spread of information to all residents and occupants
- Develop an equitable facilities management strategy

Concept design

- Provide mix of accommodation and facilities to meet needs of children, individuals, couples, families and elderly people
- Incorporate accessibility into design
- Develop external and internal community spaces for use by all faiths and nationalities

Central to the issue of sustainability is the notion of equity – namely that how we live today should not compromise the quality of life of our current global neighbours or future generations. Further more, ecological footprinting methodology measures sustainability by dividing the total area of biologically productive land by the total global population to arrive at a fair share of the earth's resources. This represents our fair share of the earth's renewable resources. Comparing this with our own ecological footprint tells us whether we are over consuming as a society and eating into the natural (non-renewable) capital of the planet.

Ethical issues have a high consumer profile with up to 80% of consumers saying that ethical issues affect their choice of groceries[44]. Spending on ethically-sound goods has increased 75% over the past three years, say Mintel, reaching £1.75 billion in 2003. There is a growing proportion of consumers acting ethically and this market growth reflects increased consumer responsiveness, particularly in relation to the purchase of food produced to prescribed standards.

Mixed tenure and mixed use development

Z-squared will offer homes suitable to a range of different housing needs which should contribute towards a diverse and inclusive community. The schedule of accommodation includes homes ranging from microflats to 5 bedroom homes, with 50% of the units provided as affordable homes, in line with the demands of the *London Plan*[45]. The location of the affordable units within the overall community should be carefully considered. "Pepper-potting" units promotes greater social inclusion and cohesion whereas grouping units of the same tenure type facilitates easier shared maintenance. Any differentiation between private and social units in terms of visual appearance, fittings and space should be minimised to allow greater integration. These issues will be addressed with a RSL partner.

The Z-squared proposals include a range of community facilities such as schools, leisure facilities, retail outlets and the One Planet Living Centre which serve the whole community without differentiation. Neighbourhoods with a good range of local facilities offer greater choice to the less mobile.

Value and affordability

In today's housing market, the affordability of private homes and ongoing resale value is a key aspect of financial sustainability. The sustainability initiatives implemented at Z-squared must not preclude the viability of the development for the developer or for future residents. The *One Planet Living in the Thames Gateway Report*[46] demonstrated how living sustainably was more affordable in terms of household budget than living unsustainably; reduced expenditure on cars, energy, water among others leads to a greater proportion of the household budget being available to spend on housing, public transport, fresh produce and other lifestyle choices.

Access for all to services and amenity

The provision of a variety of homes which are affordable must be complemented by an accessibility strategy which addresses the provision of access for all. The first Supplementary Planning Guidance (SPG) to the London Plan, *Accessible London: Achieving an Inclusive Environment*[47] was launched in April 2004. It gives advice on how to promote and achieve an inclusive environment in London and provides detail on the policies in the London Plan which promote inclusive design and access to the built environment for disabled people, including policies on accessible housing.

Designing homes to have longer lives and be adaptable for different uses over time using "long life, loose fit" principles, not only addresses environmental and financial sustainability through reduced building obsolescence and hence demolition waste, but can also have social benefits through allowing users to remain in familiar surroundings over time as their needs change. For residential homes, there are Lifetime Homes standards[48] which set out guidelines for design that will enable homes to be adapted to meet changing life circumstances.

Communities with high car dependence may experience social problems arising from the disenfranchisement of residents who do not have access to a car or who cannot drive, such as the young and elderly. At Z-squared, this is overcome by design to reduce the need to use a car, the provision of facilities within walking or cycling distance and access to a car club (for those who can drive).

Fair trade retailers

Ever-increasing consumption and retail competition puts pressure on suppliers to provide goods and services at ever-decreasing prices, threatening livelihoods and quality of life; many of these suppliers live and work in poor conditions. The Fairtrade initiative guarantees a better deal for third world producers and aims to ensure that suppliers of everyday products are paid a fair price for their goods and given access to education and health facilities.

Sales across the 18 countries that licence the FAIRTRADE mark are growing at 18%[xiv] per year and Fairtrade products are becoming mainstream products available in supermarkets and independent stores. Across the UK there are a number of towns, villages and areas that have achieved Fairtrade status through taking action to achieve a number of Fairtrade goals[49]. Oxfam recently launched a Fairtrade coffee shop called Progresso. Concessions for Fairtrade retailers and coffee shops within Z-squared will be considered and retailers will be encouraged to stock Fairtrade products.

xiv http://www.fairtrade.org.uk/about_what_is_fairtrade.htm

Case study: Garstang
Garstang in Lancashire became the UK's first Fairtrade town in 2000. A 2003 survey demonstrated 70% recognition of the Fairtrade mark amongst residents compared to a 15% recognition in 2001. Garstang is twinned with cocoa-producing town New Koforidua in Ghana and regular exchanges between townspeople take place. Local supermarkets have increased their ranges of Fairtrade products and regular promotional events are held in the town with a range of activities engaging local school children in Fairtrade issues.

Source: www.garstangfairtrade.org.uk

Allied to the Fair trade initiative, as discribed in section 11: Local and Sustainable Food, Z-squared will have a Local Food Plan which will pay a fair price to local producers and provide outlets for local food such as farmers' markets.

Local employment and skills training

The Egan Skills Review[50] outlines the skills needed for sustainable communities. During the construction of Z-squared, local employment and skills training for employees will be considered. ESCo or WWESCo involvement can generate opportunities for local high-level training and employment via the provision of local infrastructure systems rather than municipal-based infrastructure. In addition to providing high quality office space and attracting environmental industries to the eco-industrial park, Z-squared will seek to promote initiatives that enable wider employment, such as Ben & Jerry's innovative "partnershops".

Case study: Ben & Jerry Partnershop
Full of all the sights, tastes, smells and service of a traditional Ben & Jerry's shop, the Ben & Jerry's PartnerShop is a scoop shop with a big difference. The first of its kind in Northern Ireland (and only the second of its kind outside of the USA), the PartnerShop is operated bylocal social business, Cresco Trust and will offer a unique training programme to get local long term unemployed back into employment.

This exciting social and economic regeneration is being funded through Derry City Council's Local Strategy Partnership under the EU Peace II programme, through the ambitious Intermediate Labour Market pilot scheme. The Cresco Partnershop will provide opportunities fordis advantaged people from all sectors of the community to get back into employment in an area which has experienced high levels of violence and social exclusion. It will take the opportunity arising from the peace process to further develop a neutral working environment.

Ben & Jerry's first launched the PartnerShop programme sixteen years ago and currently has fourteen stores operational in the US. PartnerShops are run by non-for profit organisations to help those who may not otherwise have been able to secure employment, get that first foothold on the job ladder. Thousands of disadvantaged people have been helped in the US ... and the effects are literally life-changing - within the Juma Ventures PartnerShop network in San Francisco, 8 out of 10 of trainees were still in employment one year later.

Source: Green Futures[51]

© Ben & Jerry's

Community trust / residents association

One option for Z-squared is to set up a Community Trust in which every householder has the opportunity to become a member. It would aim to give its members a say in how the development is run and provide a collective vision for the community.

It is understood that a Community Trust has been established at a development by the Lifebuilding Company[52] in the St. James area of Northampton. Each resident is a member and contributes a monthly amount to the Trust, thereby reducing the costs of external maintenance and insurance which are shared. The play areas and open spaces are owned by the Trust and their maintenance, together with that of all communal spaces, is covered by the monthly contribution. The power of the Trust is absolute; its mandate enables it to subcontract, acquire assets or make changes. The Trust is run by a full time manager, who is on-site most of the time and a neighbourhood bulletin board and website are provided to keep residents up to date. The Lifebuilding Company suggest that there is evidence that house prices could rise at a slightly higher rate than similar properties in neighbourhoods without common interest in maintenance facilitated through a Trust.

A Z-squared Community Trust could evolve from a group comprising local residents, stakeholders and potential purchasers identified as part of the public consultation phase of the project. In the short term, this could help achieve local "buy-in" to the development and a sense of identity arising from pursuit of a common vision and the formation of a group or trust to achieve and maintain it. The sense of community engendered by the Community Trust could be a valuable marketing hook for the development.

The Community Trust could also be involved in the long-term management of the site and the provision of ongoing services in partnership with the site freeholders and facilities management organisations where appropriate. Longer term, local participation will ensure that there is a high quality public realm with less graffiti and vandalism than there might otherwise be.

Day to day contact with the Trust could be provided via a virtual community centre or intranet or caretaker or concierge staff based at the community centre. An intranet could be created very early in the development process to provide information about the proposals for the development, details of the sustainability aspects and the timescale for delivery of the development. Over time the site would evolve into a resource for the community to include a range of uses:

- details of upcoming community events and information about local leisure facilities
- information about local transport and timetables and car club bookings
- utilities information including energy and water use per home and indoor air quality after ventilation
- ime bank facility
- food ordering – fresh and takeaways and meals on wheels
- a directory of local "green" suppliers

15. Health and Happiness

Objective

- Promote healthy lifestyles including exercise, healthy food and community involvement
- Engender a sense of community and identity via community structures and networks
- Undertake ongoing monitoring of buildings and support services to measure levels of resident satisfaction and happiness
- Sustainability an integral part of educational learning and promotion of Z-squared and One Planet Living

Target

- Develop a Health and Happiness Plan with associated indicators
- To provide the means by which all residents can live happy and healthy lifestyles and achieve high levels of satisfaction for all user groups, measured using questionnaires
- Homes designed to offer a healthy internal environment – with targets set for levels of daylighting, ventilation, sound insulation and private space
- Affordable utilities – water, waste, energy and communication services

Concept design

- Schools, shops, health and leisure facilities as well as jobs, provided within walking distance of homes
- Buildings designed to last and be accessible and easily adapted to changing circumstances (long life, loose fit)
- Provide broadband-enabled homes, flexible workspaces and community time bank
- Provide “green lifestyles” induction information via community intranet and provide ongoing support

There is a proven correlation between the state of our environment – outside spaces, buildings, air and water – and our health and wellbeing. Living unsustainably can not only lead to poor quality of life for people today, but social and environmental degradation may reduce the quality of life available to future generations.

Happiness is a personal and subjective emotion. Different age groups, sexes, life stages and family circumstances mean that what is important for individual happiness to one person at a particular point in time is not necessarily important to another. An individual's sense of happiness is often bound up with having life opportunities, meaningful employment, stable family circumstances, good health and their basic needs met.

A number of recent studies and indices have shown that, while GDP has grown over the past few decades, social progress has become increasingly decoupled from economic growth. Nef (New Economics Foundation) use a Measure of Domestic Progress (MDP)[53] which adjusts the conventional measure of GDP so that the costs of crime, pollution and environmental degradation are subtracted to reflect the negative impact these have on quality of life. Their study shows that MDP has stalled completely in the past three decades. They argue that MDP comes "much closer to measures of happiness and life satisfaction than GDP does" and ask the question "what is all that economic growth for?, if it doesn't improve our wellbeing?".

The rate of divorce has significant impact, both socially and in terms of happiness. It also has a very significant economic impact and is one of the main drivers for needing to build so many new homes. The first principle of sustainability is to reduce need. Providing appropriate support facilities and creating an environment where stress levels can be reduced is an important factor in improving happiness and will enable the maintenance and rebuilding of our social fabric.

Achieving communities that enable residents to live environmentally, socially and financially sustainable lives can positively impact on both individuals' wellbeing, and the wellbeing of wider local and global communities. Within Z-squared, promoting happy and healthy lifestyles may be expressed as:

- Designing and providing a healthy environment both indoors and outdoors
- Health benefits arising from sustainable lifestyles, including improved fitness through walking and cycling, affordable warmth, community participation, access to affordable fresh local food and well-designed green spaces
- Supporting residents through the opportunity for education and meaningful employment and ongoing monitoring of environmental, social and financial issues affecting wellbeing.

These measures will enhance the quality of life for residents and focus largely on supporting the establishment of a community, as well as providing specific health and wellbeing benefits to individuals.

Healthy environments

We spend more time in buildings – homes and workplaces – than our ancestors. The nature of construction materials used and the quality of space, light and acoustics in our buildings can have a significant impact on our health and wellbeing. Internal environment issues may be addressed by ensuring that within Z-squared:

- Rooms have adequate access to natural daylight
- The use of construction materials that impact on internal air quality is minimised (this is covered in more depth in Section 10: Sustainable construction materials)
- Adequate access is given to private outside space
- Homes have adequate ventilation to prevent condensation and mould growth and to maintain healthy indoor air quality
- All homes are built to adequate noise insulation standards

These issues are addressed by EcoHomes.

Pollution arising from car emissions has been linked to ill-health. Lower car ownership and use will lead to improved air quality with associated health benefits. Vehicular traffic is noisy and disrupts streetscapes. Research has shown that the number of contacts between neighbours is inversely proportional to traffic density. The reduced traffic planned in Z-squared and incorporation of Home Zones will enhance the sense of community, lead to safer streets and likely contribute to a reduction in traffic accidents.

Health benefits arising from sustainable lifestyles and homes

Exercise and access to green spaces

The government's Chief Medical Officer issued a stark warning about Britain's "couch potato" lifestyle and outlined the importance of physical activity for public health making recommendations for active living throughout an individual's lifetime[54]. Z-squared is a mixed use development with local facilities within easy walking distance. Residents will have comfortable homes that are affordable to heat, access to community leisure facilities, green space and affordable fresh local food. In a sustainable community, reduced reliance on cars and more cycling, walking and use of public transport will increase exercise levels thereby improving health and fitness and leading to lower incidence of obesity. Walking to school will also set healthy habits at an early age in children. Access to green outdoor space has been linked to psychological benefits and provides the opportunity for exercise and even to participate in the management of it which brings social benefits through interaction with neighbours.

Local food

The opportunities for local food growing are discussed in Section 11: Local and sustainable food. The benefits of local food in terms of enabling better health and wellbeing include:

- Access to better fresh food for residents may be beneficial to health and forms part of the Department of Health's *Choosing a Better Diet: A consultation on priorities for a food and health action plan*[55]
- Providing affordable access to healthy food for people on low incomes
- Forming the basis of local community enterprise schemes which provide employment

Case study: Organic food for all
The organic association HDRA launched "Organic food for all", aimed at making fresh organic fruit and vegetables available to lower income households. Local and national community groups, businesses, health providers and LAs will be involved in promoting organic food growing in whatever space is available – from allotments and waste land to gardens, balconies and window sills. Trained volunteers will encourage and support new growers to make the move to organic.

Source: www.hdra.org.uk/foodforall/

Fuel poverty
An estimated 2.5 million households in the UK are currently described as fuel poor[xv] and the government's Energy White Paper stated an aim of eliminating fuel poverty by 2016-2018. A large proportion of fuel poor households are the elderly or single parent families. Fuel poor households are often damp which leads to increased incidence of respiratory disease such as asthma and reduced mobility. Every year, there are an estimated 20-50,000 excess deaths in winter, a large proportion of which are due to fuel poverty. The provision of well-insulated homes which can be heated affordably is a prime measure to combat fuel poverty.

Health benefits arising from sense of community and purpose

Safety and security
Z-squared will be designed to be "people-friendly" with safe areas for walking and cycling, play areas for children and a mixture of facilities to promote street life, such as outdoor events in summer, cafes and a farmers' market. Interaction between individuals is helpful in terms of increasing trust and promoting good neighbourly behaviour. These are important in terms of nurturing social capital, possibly reducing the incidence of depression, a modern malaise. Increased trust and sense of safety reduces the perception of dangerous streets, anxiety about which is often cited as a cause of ill-health.

Balanced and inclusive community
Attracting people of all ages to Z-squared will provide the basis for a balanced and inclusive community. Children benefit from watching and interacting with their elders while older people often gain great satisfaction from seeing children play and grow up. An unusual state-run retirement home in Paris which houses more than 200 pensioners, also containing a nursery which around 20 children aged 18 months to three years attend during the day in term time, has been hailed as great success[56]. Old and young share meal times, corridors and occasional outings. Since opening, five more have been opened in Paris and the scheme is being trialled in Spain. Some parents choose the nursery for their children because they want their children to learn to relate to an older generation when they have no grandparents of their own. The scheme works because it is small scale and because the elderly people choose to live there; there is a long waiting list. Such a scheme may be possible to be introduced in Z-squared.

Social interaction
The provision of communal areas, offset against reduced private space provision such as microflats or co-housing style residential accommodation which would be more affordable for residents, could be considered in the detailed design for Z-squared. Increased social interaction and sense of community could help tackle issues of loneliness and isolation which contribute to ill health. There are a number of people who seek community living and the development of a specific plan and set of measures to provide this, whilst also recognising the need for personal space and privacy, could increase the marketability and demand of units within Z-squared.

Employment opportunities
One aim of Z-squared is for residents to have meaningful job opportunities so that they have the choice of a daily commute or being able to walk or cycle to work locally. It is recognised that some people will always commute to work but Z-squared will also attract workers from outside its site boundaries. Flexible infrastructure with broadband-enabled homes, live-work units and local office support facilities (e.g. printing, meeting rooms, secretarial support) will enable flexible working opportunities. Residents could exchange their skills with other residents via a community intranet-facilitated time bank.

Lifelong learning
Equally, lifelong education should be available to all residents through the primary school, City Academy and courses held at the One Planet Living Centre. Education opportunities could be linked to childcare provision thus allowing single parents to study. Local employers could link with the City Academy to provide education programmes for skills that they seek.

Education, green lifestyles support and ongoing monitoring
Communicating sustainability to residents and users of Z-squared could have numerous benefits to the development consortium, estate management company, Community Trust and residents. Consultation with key stakeholders and future residents during the development process and the selection of sustainable features could reduce longer term problems and futureproof the development against external influences, such as global energy prices.

Information on sustainability issues could form part of an induction pack for new residents and could be complemented by a Green Lifestyle Officer who would explain the choices and technologies available to occupants of Z-squared and the benefits of choosing to live sustainably. Information would also be made available at the One Planet Living Centre, within the curriculum in the schools and via the community intranet.

xv A fuel poor household is described as one that has to spend more than 10% of household income on all energy services, which includes heating the house to a temperature of 21°C in the living room and 18°C elsewhere

Rewarding sustainable behaviour

Providing the means by which individuals reduce their environmental impact is part of the process but we also need a behavioural shift. People often see sustainable behaviour as inconvenient and not rewarded in any way, somehow dull and worthy. Using a stick can change behaviour, though not necessarily in a positive way, whereas offering some system of collecting reward points can motivate people to make behavioural changes without any compunction to do so. Experience from store loyalty cards and community time banks suggests that many people do not often use the credits they earn, but collecting points provides motivation to continue.

Case study: Curitiba, Brazil

The Brazilian city of Curitiba incentivises people to recycle by offering points for recycling rubbish, which can be spent during off-peak times on the buses. As a result, Curitiba is one of the cleanest cities in South America, paid for by spare transport capacity which would otherwise have been empty.

Source: Holdsworth & Boyle (2004)[57]

At Z-squared, people could obtain points for recycling, for participating in local food schemes, for belonging to the car club, for providing services to the community. In turn, these could be redeemed for free off-peak public transport, swimming, bicycle repairs. Car club users would have a smart card to enable them to access vehicles. With the ability to use it on public transport, or for bicycle parking, the card could become a mobility card. It is a logical extension for it to become a loyalty card as well as an access card for all of the services within Z-squared, utilising a green local currency and enabled by a community website.

Section D: Z-squared in the Thames Gateway

16. Z-squared

Schedule of accommodation

Z-squared comprises all of the facilities that you would naturally expect a 5,000 person city neighbourhood or community to provide for residents or workers. These are summarised in Figure 15.

Figure 15: Z-squared schedule of accommodation

Residential		
	Microflats / studios	100
	1-bedroom	700
	2-bedrooms	600
	3-bedrooms	250
	4-bedrooms	250
	5-bedrooms	100
	Total	2,000 units
Commercial / industrial		
	Supermarket	
	DIY store	
	Other retail to include green businesses and restaurants / cafes	
	Workspaces, including offices and business enterprise units	
	Ice cream factory	
	Microbrewery	
	Hotel	
Community, education, health and leisure		
	Nursery & childcare facilities	
	Primary school	
	City Academy secondary school	
	Wellbeing / healthy living centre	
	Leisure facilities including swimming pool	
	One Planet Living Centre	

Design approach

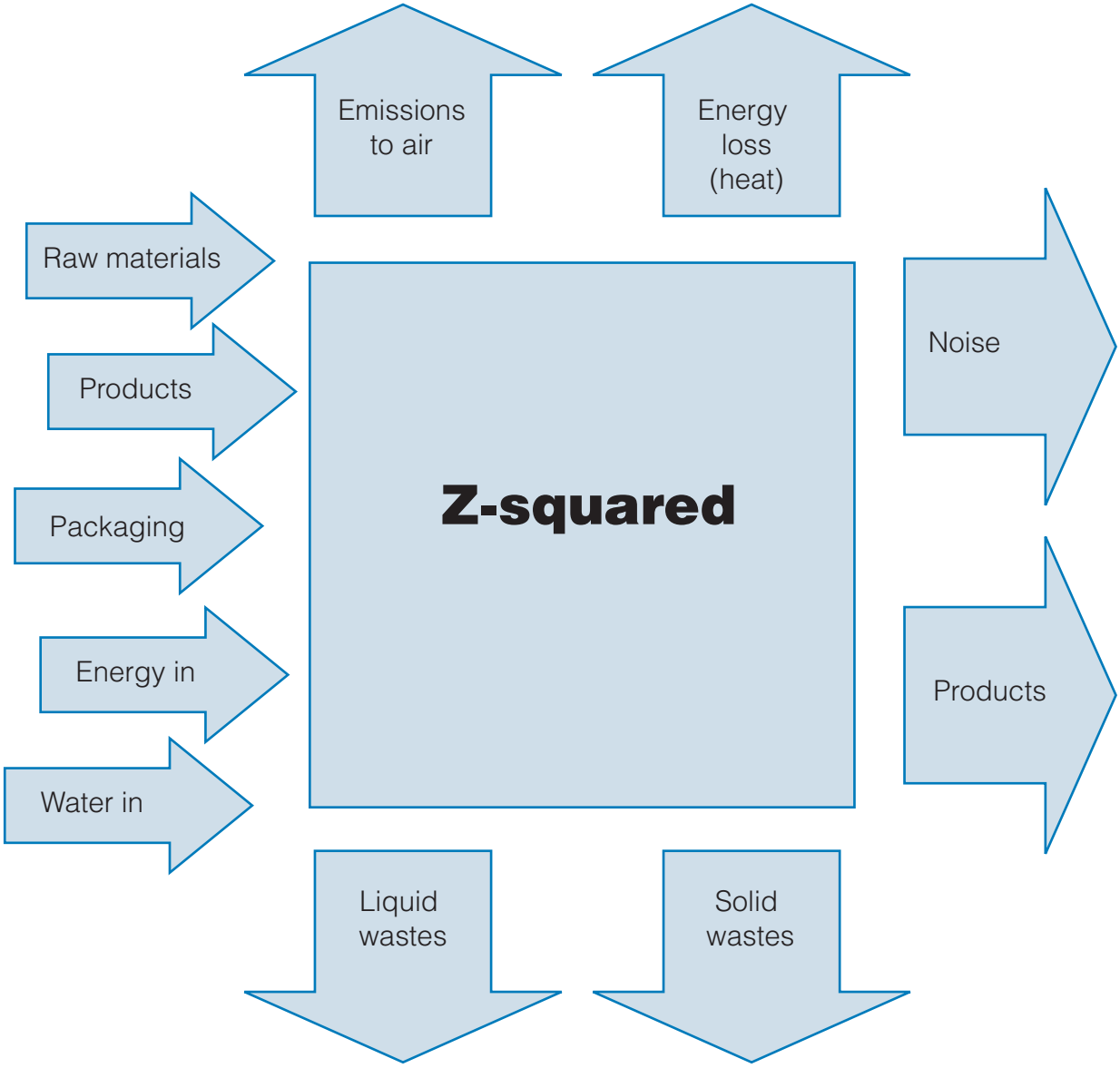
The starting point for the design of Z-squared was first to map the flows of resources through the community, i.e., based on the proposed schedule of accommodation, how much waste would be generated, water demanded, and energy required, in the form of electricity, hot water and space heating and cooling, before assessing the possible mix of technologies that could provide a zero carbon and / or a zero waste solution or contribute towards a significant reduction in carbon and waste, whilst also providing a reliable supply of energy.

KBR focussed on waste and transport infrastructure. Fulcrum Consulting assessed energy, water and wastewater infrastructure. Cyril Sweett provided preliminary capital expenditure (capex), and wholelife costings. Based on the findings of KBR and Fulcrum Consulting, and with sustainability guidance from BioRegional Development Group, Foster and Partners developed a preliminary masterplan for a site identified in the Thames Gateway.

Resource flows

As a community, Z-squared will consume materials, both raw and as products and use energy and water. Some of the raw materials will be consumed and waste produced; other raw materials will be manufactured into new products and consumed within Z-squared or sold outside the community. Noise and emissions will be byproducts and both liquid and solid wastes generated by the day to day activities of individuals and businesses within Z-squared. This flow of resources through Z-squared is outlined in Figure 16.

Figure 16: Z-squared flow of resources



As outlined in Sections 6, 7 and 8, through demand management measures such as installing energy- and water-efficient appliances, Z-squared will have lower energy and water demands than a base case development of the schedule of accommodation listed in Figure 15 built to current building regulations. These are summarised in Table 9. While we have aimed to introduce cost-effective efficiency measures such as specifying energy- and water-efficient appliances and insulation, we have not aimed to maximise efficiency as there is a trade-off whereby for each additional pound invested, the amount of energy saved diminishes and would arguably be better spent on supply of renewable energy.

Based on current waste data for the schedule of accommodation for Z-squared, the community and businesses will generate approximately 7,200 tonnes of mixed waste per annum, of which approximately 33% is unsorted or inseparable waste due to a lack of data available on waste arisings, particularly for commercial waste. Within Z-squared, the focus will be on minimising waste through awareness-raising by communication and education, also working with retailers to reduce the amount of packaging waste arising. Surveys of the general public indicate that once people are aware of the amount of waste generated, they transfer responsibility for it to the groups they see as responsible for it, i.e. manufacturers and retailers. By taking a two-pronged approach, we would hope to see levels of waste within Z-squared not increasing in line with UK waste growth which currently stands at 3% per annum, and ultimately decreasing over time.

Table 9: Z-squared annual energy and water demands

	Base case (current best practice)	**Z-squared**	**Saving**
Electricity (MWhe)	14,610	12,480	15% saving
Hot water (MWhth)	9,700	7,900	20% saving
Space heating (MWhth)	21,015	17,455	17% saving
Water ('000 cu. m.)	233.6 (640 cu. m. per day)	189.8 (520 cu. m. per day)	19% saving

Energy, waste and water infrastructure

After mapping the resource, energy and water flows through Z-squared, we identified a number of options with different mixes of technology to achieve close to zero carbon and zero waste. There is no one definitive solution to the challenge and different mixes of technology will be appropriate and more cost-effective at different scales. The range of options considered are outlined in summary in Sections 6, 7 and 8 and in more detail in supporting reports produced by KBR and Fulcrum Consulting.

The flow of resources, energy and water within Z-squared may be considered as a metabolism for the community with links between the wet waste treatment and energy, through an anaerobic digester providing biogas to a CHP, and between dry waste and energy with a pilot EfW plant sized to dispose of the unsorted residual waste arising from the community. Figure 20 summarises the metabolism of Z-squared with heating and cooling provided via an ITS-based district heating / cooling system, and electricity delivered via a private wire network.

The design of Z-squared raises the street to the first floor level, above the flood level, with parking at ground level. This provides space for services to be housed at ground level, while being easily accessible with electric carts to transport waste to a central energy and waste management centre where the CHP plant and mini materials recycling facility (MRF) will be located. All of the technologies for Z-squared, with the exception perhaps of the pilot EfW plant, are tried and tested. What is different at Z-squared is that they have been integrated at the outset in terms of design and procurement of ongoing low environmental impact-based facilities management in an attempt to achieve significant environmental savings cost-effectively without compromising the architecture or social aspects of the development.

Waste

Recycling will be maximised with dry waste separated from wet waste at the household level, collected using electric vehicles and sent via a mini-MRF to existing commercial recycling operations for paper, plastic, metals and others as are available. Organic waste will be disposed of through a waste disposal unit, co-mingled with sewage and treated in an anaerobic digester with wastewater being treated through a series of gravel beds and reed beds. This is a process that will contribute significantly to government targets for diversion of biodegradable waste from landfill as organic waste decomposes to methane in landfill, a more potent greenhouse gas than CO_2. Composting may be carried out at the household level in those homes with gardens.

Space heating

If the ground conditions are appropriate space heating will be provided through ITS utilising either a suitable underground aquifer, pilings or the earth to store heat in summer (thus providing cooling) which can then be accessed for heat in winter. As we move into a period of global warming, cooling will become increasingly important and may well become more important than winter heating in terms of energy demand. ITS is an effective way of providing heating and cooling in sync with the seasons.

Hot water

Hot water will be produced as a byproduct of power generation in CHPs fuelled by biomass, biogas and residual waste with gas as a back-up.

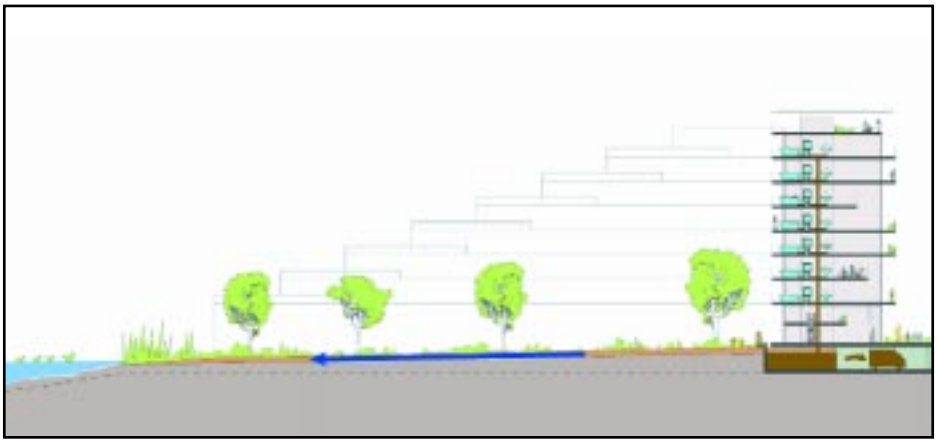
Power

Electricity will be provided by various CHPs and larger commercially-viable wind turbines, which will also power the ITS system at times when the electricity is not needed. While fuel cell technologies are making significant advances, they have not been considered in detail at this stage. However, by the time that Z-squared is in development, and certainly as plant equipment falls due for renewal, they will be incorporated as appropriate at that time. Photovoltaic cells have not been included in the overall design as on a £ per KW basis they are more expensive than other proven renewable technologies. However, they may be integrated into the design of individual buildings.

Figure 17: Dry waste strategy

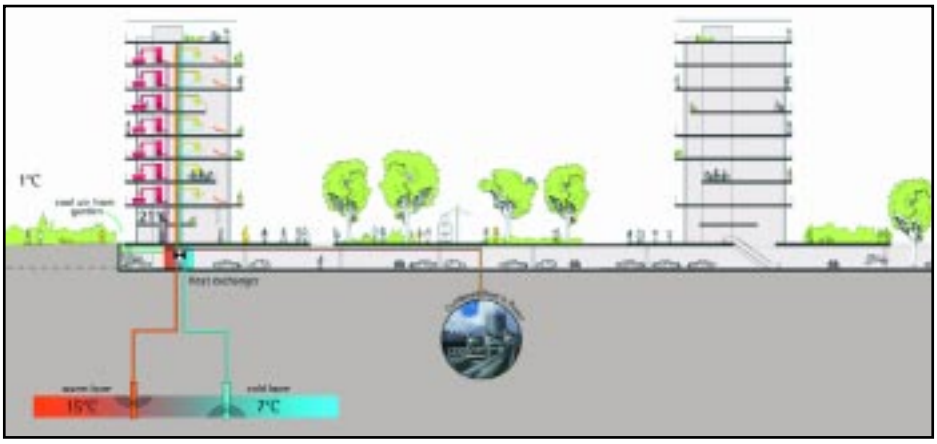
Credit: Foster and Partners

Figure 18: Wet waste strategy



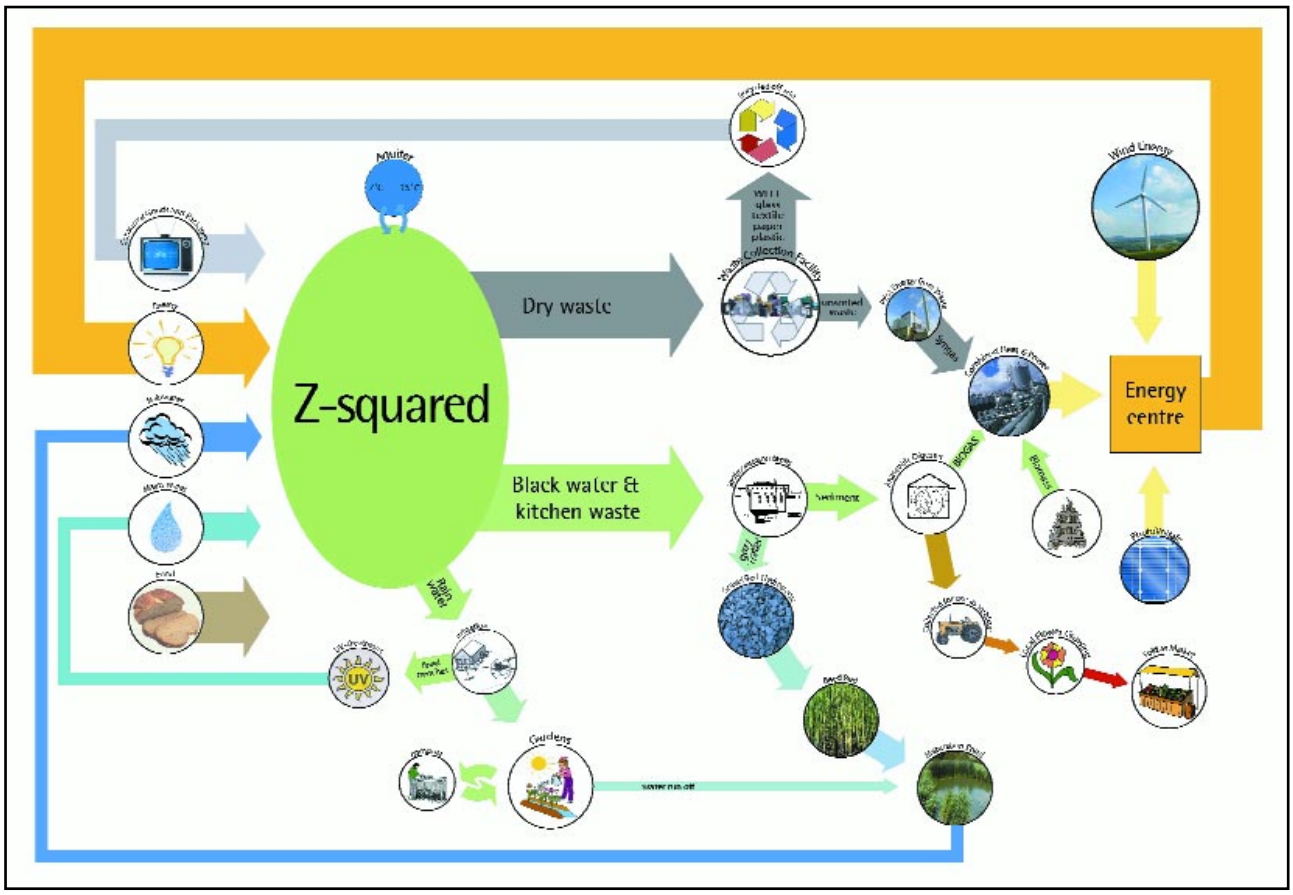
Credit: Foster and Partners

Figure 19: Energy strategy



Credit: Foster and Partners

Figure 20: Metabolism of Z-squared



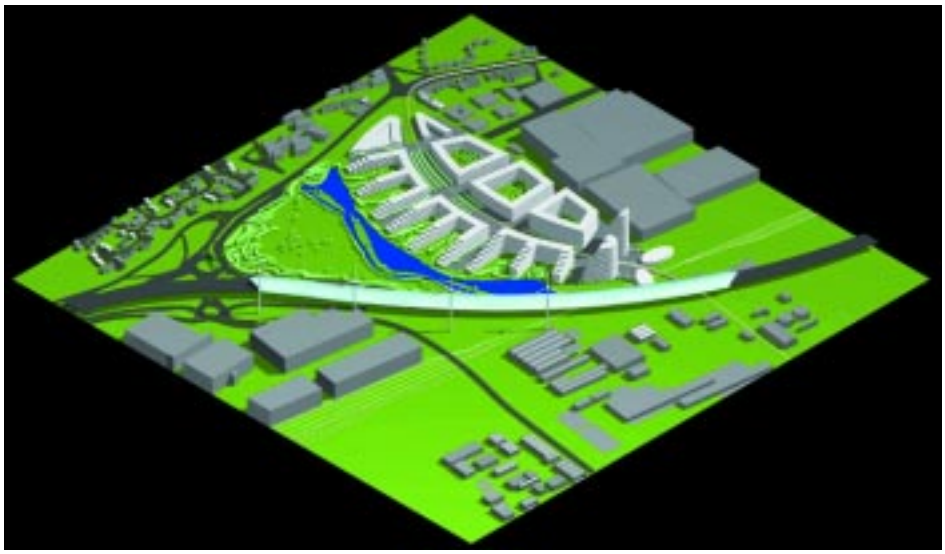
Credit: Foster and Partners / BioRegional Development Group

Masterplan

Having worked through a series of technology options for Z-squared, a brownfield site in the Thames Gateway was selected on which to work out a masterplan. This masterplan is indicative only and uses the schedule of accommodation for the ideal Z-squared development. In reality, this will be refined and adapted to the real-life requirements of a specific site.

The infrastructure-led approach to Z-squared has informed Foster and Partners' study, with densification towards a transport node situated at the lower end of the site, and incorporation of the gravel and reed beds and maturation ponds into the landscape (as can be seen in Figure 21). This also provides an area to attenuate water and alleviate flood risk, a major issue for new developments in the Thames Gateway.

Figure 21: Z-squared



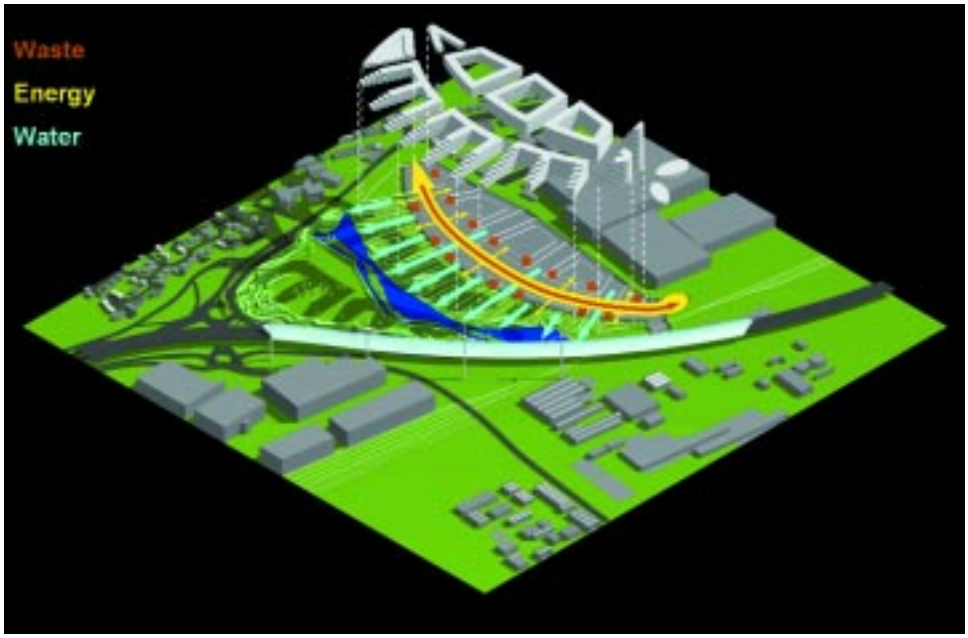
Credit: Foster and Partners

Several different approaches to massing and location of the elements of Z-squared were considered and the street design shown was chosen as the design that would allow easy access to facilities for residents and workers, link the development to the wider community at the north end, provide good access to public transport and provide a blueprint for a sustainable community.

An existing watercourse has been opened up and incorporated into the water treatment process. Attractive green space has been planned with a park, courtyards and gardens which will provide opportunities for residents to grow their own food and areas for recreation and leisure.

The approach taken to Z-squared, with local recycling and waste management, renewable energy, local food and a compact neighbourhood design with good public transport links and facilities provided within walking and cycling distance reduces the impact of each of the key areas of an individual's ecological footprint: food, transport, energy and water, waste, shared services and infrastructure, leads to more freedom in architectural design. This allows for a flexible approach to solar orientation with the aim being increased natural light, rather than solar gain for heating. With a district ITS system, summer excess heat collected by providing all buildings including dwellings, with cooling, will more than meet the winter space heating demand. Figure 21 outlines how the waste, energy and water flows are integrated with the design of the development.

Figure 22: Links between infrastructure and masterplan



Credit: Foster and Partners

Benefits delivered by Z-squared

Energy
As energy demands continue to grow, the national grid requires substantial investment in order to avoid more frequent and extensive power cuts. Oil prices have risen to new highs in recent months and as a country the UK is becoming increasingly dependent on sourcing our energy needs from overseas leading to a need to develop alternative long-term sources of energy within the UK. Z-squared uses a mix of available technologies to deliver greater reliability, both now and for the foreseeable future, in line with the aspirations set out in the UK government's Energy White Paper (2003). Residents will benefit from a secure and reliable supply of affordable electricity, hot water, heating and cooling that makes minimal contribution to the UK's fossil fuel-related carbon emissions.

Solid Waste
The UK currently sends around 75% of solid waste to landfill. At present rates of filling, many landfill sites will be full within the next few years. As landfill capacity decreases over coming years, Landfill Tax and transportation costs will increase and the public will be expected to pay through their Council Tax. Z-squared makes it easy for people to segregate materials that can be recycled and converts the remainder to energy. Z-squared residents should pay less for their council tax as the amount of solid waste going to landfill is reduced from 75% to 2%. Z-squared sets out a means by which landfill and other waste targets may be achieved.

Water
Significant investment in water supply, treatment and disposal is required in the South East of England to meet increasing demand and need for replacement of existing infrastructure. Global warming is also increasing the risk of flooding, causing risks to public health and limiting the land available for development, as well as potentially threatening

Central London's position as a global finance hub. Z-squared ensures that demand for water supply is minimised through the installation of water-efficient appliances. Treatment of wastewater on-site and use of reed beds permits natural aquifer recharge, reduces peak run-off to the stream and ensures there is no additional discharge to existing combined / foul sewers. It should also be noted that all new residential and commercial accommodation and the majority of wastewater treatment will be above the 1 in 200 year tidal flood plain. If appropriate, Z-squared could store water for market gardening, reuse or for steam generation should that be introduced as a means of energy storage.

Transport
Britain's roads are becoming increasingly congested and measures such as congestion charging and mileage charging are being introduced or considered to restrict usage. Z-squared recognises the need for personal transport through the provision of a car club, which offers substantial financial benefits to residents against the cost of owning a car. Z-squared also offers excellent links between homes, local facilities and public transport systems through a network of safe walkways and cycle paths, convenient bus stops and a railway station with good access to central London.

Flora and fauna
Globally, development has led to natural habitat destruction and species loss, as land is cleared and timber felled for building materials. With good quality green space, Z-squared will support a rich biodiversity and landscape offering a better living environment with cleaner air.

Materials
The construction industry is the biggest single user of natural resources and their freight contributes a large proportion of road use in the UK. Z-squared will use local, reclaimed, recycled and low-toxicity materials where possible, leading to the creation of local employment opportunities, environmental improvements and a built environment that provides a local identity appropriate to the area.

Food
With an increasing number of food scares and obesity a major health issue, people are becoming more aware of the food that they eat. The organic market is growing and is worth more than £1 billion per year. On average, food is the largest single component of an individual's environmental impact. Transportation of food and goods over large distances around the globe releases more carbon than the weight of the produce / goods being transported, which is clearly unsustainable. By providing opportunities for growing and selling food locally, Z-squared provides easy, affordable access to local organic food that is fresher, less-processed, healthier and sustainable.

Equity and Fair trade
With current energy, water and natural resource consumption, we are currently on a path that could lead to instability and conflict. Changes required later are likely to be far more draconian than small changes that could be made now. Z-squared aims to be one model whereby we can live within our fair share of the earth's resources, and provide opportunities for all with access to facilities and lifelong learning.

Healthy lifestyles
International measures of happiness show that the UK's levels of happiness have been declining since the mid-1970s. Z-squared offers the opportunity for people to live healthy lifestyles with exercise, healthy food and a sense of community, thus offering a better quality of life.

Cultural heritage
By acknowledging the cultural heritage of the site on which Z-squared is ultimately built, recognising the diverse mix of people in the surrounding area and sourcing local materials, Z-squared will provide the basis for a new community to develop.

Meeting aspirations
Climate change is inevitable and is occurring faster than previously thought. With global warming, cooling will become increasingly important. Z-squared incorporates cooled buildings, broadband internet access and a range of other features; all aimed to ensure that Z-squared offers a high quality of life within a more sustainable, pleasant, safe and affordable "mainstream" environment that people will increasingly aspire to, within a fair share of the earth's resources. The car club in particular releases space within the built environment to enable commercial viability and thereby enable the developer to provide more features to satisfy aspirations as well as ensuring saleability. The occupants will benefit through reduced outgoings, leading to more money being available for recreational or lifestyle improvements, and an enhanced work-life balance.

Above all, Z-squared offers a better environment where people can have an easy, affordable and attractive quality of life within a fair share of the earth's resources. Living sustainably is cheaper than living unsustainably.

Sustainability matrix

Taking each key area of the development into account, such as transport, food, energy, waste, the key issues for each user group were considered and their implication for the design:

	User group	Key issues	Implication for design
Energy	Child / teenager Single parent Family Retired	Affordable warmth	• Reduced energy demands – insulation, energy-efficient appliances and lights • Economic / affordable energy supply
	All	Sustainable energy	• ITS-based district space heating and cooling / CHP serving development / wind turbines • Energy-efficient building design
	All	Education about best options for appliances & how to use energy systems	• Induction / manual and ongoing support from ESCo and Green Lifestyles Officer • Track and promote future improvements
Waste	Child	Nappies	• Real nappy laundering scheme
	All	Simple and convenient to recycle Bring sites	• Internal and external segregated bins • Convenient bring sites for items not collected
		Reuse of products / resources	• Community tool share / hire scheme • Reclamation yard
		Education	• Residents manual / induction / support provided by Green Lifestyles Officer
Food	Child / teenager		• Local organic school meals
	Retired		• Local organic meals on wheels
	All	Access to convenient sustainable food	• Internet ordering • Home deliveries / convenient collection point e.g. school • Café / restaurant / bar selling local organic food • Farmers' market • Local organic produce available in supermarket / convenience stores • Grow your own - allotments - sell surplus to local market • Education & support provided by residents association / Green Lifestyles Officer
Water	All	Flooding / drainage	• Land use strategy • SUDS • Permeable paving
	All	Reduced water usage & cheaper bills	• Efficient appliances & fittings in all buildings • Central nappy-washing service
	All	Reuse	• Rainwater harvesting

	User group	Key issues	Implication for design
Transport	Child / teenager	Journey to school / college Meeting friends	• Walking buses • Safe, secure, well-lit footpaths and cycle paths • Regular, convenient and safe public transport
	Young professional	Getting to work & journeys for work Leisure	• Cycle storage at home and work • Showers, changing and storage facilities at work • Convenient cycle storage near places used
	Family	Access to car to transport children & associated paraphernalia	• Car share club • Regular, convenient and safe public transport • Locate facilities centrally
	Single parent	Access to shops and childcare facilities	• Safe, secure, well-lit footpaths and cycle paths • Regular, convenient and safe public transport
	Retired	Access to healthcare and leisure facilities Visiting friends and family	• Locate facilities centrally • Regular, convenient and safe public transport • Car club
	All	Information about transport options and timetables Flexible options – mode and route Affordability	• Z-squared intranet with local transport information • Mobility package – smart card giving access to public transport, car club, cycle storage facilities

Costs of developing to Z-squared standards

Cyril Sweett carried out preliminary costings[58] for the schedule of accommodation developed to Z-squared standards (i.e. to meet EcoHomes excellent with on-site energy generation and distribution, water treatment and waste management infrastructure) versus a base case developed to meet 2002 building regulations with connections to mains gas for gas-fired central heating, the national grid for power and mains sewerage. These costs and an analysis of the difference are summarised in Table 10 and Table 11.

While there is increased capital expenditure for on-site infrastructure, there are reduced whole life costs through careful specification and better building performance (1.5% saving over 30 years) together with reduced pressure on off-site infrastructure, as well as reduced contribution to climate change.

Table 10: Total estimated construction costs

	£	%
Base case	£616m	
Z-squared	£663m	
Difference	**£47m**	**8%**

Table 11: Analysis of difference in construction costs

	£	%
Site wide energy generation and distribution and other utility works, including water treatment and waste management	£35m	6%
Building costs	£26m	5%
Reduction in car parking and other support infrastructure	(17m)	-3%
Increased contingency (a function of build cost)	£3m	-%
Difference	**£47m**	**8%**

Life at Z-squared in 2015

Child

I like living at Z-squared. Mum doesn't mind me walking or cycling to school because there aren't many cars – I sometimes catch the "walking bus" with my friends.

We live in one of the houses near the park. There's a play area made from old tyres and ramps that me and my friends ride and skateboard on. I know some of it came from the Ford site nearby. When I grow up I want to work for Ford and drive a biodiesel sports car like my uncle.

School is more fun here. We learn about the planet and the things we can do to stop harming it. At lunchtime, we have a choice of fresh meals; no chips – which I do miss a bit – but now we get to eat vegetables that we've grown in the school garden. I hadn't realised that carrots came out of the ground. Last term, we went on a school trip to a farm that sells its fruit and vegetables to the supermarket down the road – it's specially labelled.

Mummy and Daddy seem much happier and less stressed since we moved to Z-squared. I like it here.

Single professional

I work as a product designer at the nearby eco-industrial park. My job involves finding new uses for recycled materials, particularly plastics – in fact, I designed the park benches at Z-squared. Where I work is within walking distance but most days I cycle on the route through the park, although if it's raining I take the bus. It runs on a hydrogen fuel cell.

I sometimes work from home, which is made easy by the communications equipment fitted in every home here. I also have to travel from time to time and I have an excellent set of transport options here. I use the community intranet to find out the times of trains and buses and to book a car club car for when I occasionally need to use one. The intranet also allows me to order organic food boxes and other items which are delivered at the One Planet Living Centre when I'm not at home – I can easily collect them on my way back from work.

While my job is busy, my social life seems even more so here. There's a lively atmosphere at the local microbrewery where I meet friends on a Friday night. I also run occasional willow weaving courses at the One Planet Living City Academy – we use some of the willow grown by the pond which collects water at the end of the water treatment system. I make sure we don't use too much as most of the wood is burned in the energy centre to provide us with hot water and electricity.

The Community Trust, which helps with the ongoing management of Z-squared for everyone, creates a strong sense of community here. Z-squared is an excellent place to live. It offers me the opportunity to have high quality of life with lower environmental impact. I like living here and am sure I'll be able to sell my flat when the time comes to settle down and start a family. I rather like the family homes near the park.

Single parent

I work as a nurse at the local health centre. I hadn't thought I'd ever be able to afford to buy a flat in an area I liked until I discovered Z-squared. Around half of the homes here are affordable. I don't drive but find I can get to most places by public transport.

My flat is great – it's light and airy, and I can't believe how low my running costs are compared with where I used to live. I have my own balcony and in summer, we sometimes eat breakfast out there looking out over the square. I grow fruit and vegetables in a mini-allotment on my balcony; the local DIY store sells kits which make it easy to get started.

As a single parent, access to good affordable childcare is very important to me. There are two nurseries here and I can drop my son off on the way to work. All the buildings here have been built with "healthy" materials, and my son's asthma seems to have improved – perhaps it's the buildings or maybe it's due to the air quality being better because there are fewer cars. Another attractive feature here is the park which has a great play area for children. We go there most afternoons; there are always plenty of other children there for him to play with. I'm not worried about him growing up here – there seem to be lots of opportunities for young people around here.

I've always been interested in healthy living – I run workshops in it at the health centre – but I'd never really made the link between health and the environment before I moved here. I wouldn't describe myself as an out and out greenie but some of the features here make me think about how the way I live affects the environment. It makes sense really – not damaging the health of the planet, our own health, or that of others, by how we live. I suppose I also think more now about the kind of world my son grows up in.

Since moving to Z-squared, I've become a convert to recycling. The divided bins at home make it easy to recycle and the waste disposal unit means that there's no smelly waste at the end of the week. I collect loyalty points for recycling and can spend them on eco-treats in the local shops. I can keep track of my balance on the community intranet.

I wouldn't want to live anywhere other than Z-squared; I'm so glad I've found somewhere to live where I'm happy and I don't worry so much about my son.

Family with young children living at Z-squared

We moved to Z-squared because of the quality of the home, the access to open space, and the opportunity to live in a community in which we can reduce our impact on the planet for the sake of our kids, and their kids in turn.

Z-squared suited our lifestyle too. I work from home for most of the week while my partner commutes to the city for her job – the transport links here are excellent. Now I don't commute to work, I'm able to spend more time with the kids and sometimes walk them to school.

The good public transport services here, the cycle paths and the convenient car club mean that we got rid of our second car when it was due for replacement. We don't miss it and it's saved us money as well. We're also more likely to go for walks and bike rides or visit the leisure centre at weekends so we're fitter too.

Our electricity, heating and hot water are produced on-site using a combination of wind turbines and a power plant running on waste wood chips. It's all managed from the energy centre which you can visit to see how things work. Apparently our heating is provided from the ground where summer heat is stored and then used in winter. Even our wastewater is treated here in gravel beds which are part of the landscape and attract wildlife.

We do our bit by recycling as much of our waste as we can. Even the kids do; they learn about it at school and often do projects to come up with ideas for new uses for some of the things we throw out. Once the kids are a bit older, I'm thinking about getting a job at the eco-industrial park nearby.

There are a lot of community events here which people attend. They're a great way of getting to know new people. I feel we know far more neighbours than where we used to live. Perhaps it's because fewer people use cars; you just don't need to when everything is within walking distance.

Retired person living at Z-squared

I have lived nearby for most of my life and was glad when I had the opportunity to move to Z-squared. I'd followed its progress since the very first public meeting. Some people were a bit concerned that it wouldn't fit in with the surrounding area but I'm glad that we're making the most of new technologies so that we have less impact on the planet.

My home is very warm and comfortable and has a great view. It's much warmer in winter than my previous house but the clever heating system means that it stays cool in summer. My bills are much lower than my friends living elsewhere; this has become more noticeable as oil and gas prices have risen over the past few years.

Most of the facilities I need are a short walk away. When the weather is good, I walk in the park. I also enjoy a quiet pint at the microbrewery. As a retired engineer, I enjoy visiting the energy centre to find out about all the different technologies that are used here. I find it amazing that all our sewage and wastewater is treated on-site.

There is a strong sense of community here – my neighbours come from all walks of life. I enjoy growing vegetables in my allotment and I help out at the school where the kids have a community garden. I use the community intranet to keep up-to-date with what's going on at Z-squared. There are courses at the City Academy, events at the One Planet Living Centre and a regular farmers' market. I even trade my gardening skills on the time bank.

I'd like to stay at Z-squared as I grow older and my home has been designed so that it's easily adaptable for when I'm less mobile. There's even a local organic meals on wheels service so I can still eat healthily. But I think that's a long way off, I'm more active now than I've ever been!

The people in the case studt photos are actors.

17. Thames Gateway

Context

The Thames Gateway is Europe's largest regeneration area, with over 80,000 hectares stretching 40 miles from Tower Bridge through east London, into Essex and Kent, towards the Thames Estuary. It was highlighted in the *Sustainable Communities Action Plan*[59] as one of four priority areas for developing new residential communities. It was proposed that up to 120,000 new homes would be built in the Thames Gateway, of which 60,000 would be in London, with a further 80,000 in three other growth zones in the South East outside London. The *London Thames Gateway Development and Investment Framework*[60] says that while 60,000 is an appropriate medium term target for London, at least 91,000 homes could be delivered with careful planning of investment and land-use priorities.

The LDA's Gateway Development Model estimates the cost of developing 91,000 homes in London Thames Gateway and the infrastructure to support them to be in the order of £16 billion, of which it is estimated that the private sector will fund £8 billion through provision of private housing, section 106 contributions and much of the physical infrastructure. Central government should meet some of the remaining costs but will not be able to meet all of the costs. In particular, there is a need for additional wastewater treatment, waste disposal, electricity grid upgrades and power generating capacity in addition to the transport, health and education infrastructure that will be required to meet the needs of an increased population. A further £3.5 billion is estimated to be required to provide skills training for both the existing population and people moving into the Thames Gateway. The LDA estimates that after private and public sector provision there will still be a funding gap of £4 billion[61].

London Thames Gateway identifies five key risks to achieving their vision:

- Inability to obtain sufficient funding from public and private sources
- Inability to establish suitable and coordinated delivery mechanisms
- Developer market not interested or has insufficient capacity to deliver
- Existing or potential residents develop negative perceptions of the vision and framework
- London Thames Gateway as stakeholders (includes Mayor of London, LDA, Thames Gateway London Partnership, English Partnerships, the Housing Corporation, TfL and the NHS in London)

Much of the Thames Gateway lies on a flood plain and therefore faces a particular risk of flooding with climate change, as sea levels rise and rainstorms and storm surges increase in intensity and frequency. The Thames Gateway London Partnership is to carry out an environmental masterplan in autumn 2004, in an attempt to counter the threat of flooding. The review is expected to recommend that natural flooding defences such as parks, wetlands and riverside paths, are interspersed between developments. The nature of the Thames Gateway has implications for insurance cover. Future development in the area will need to consider flood management measures and mitigate against the impact of flooding if in an area at higher than average risk of flooding. The Association of British Insurers (ABI) has published a list of key considerations for planning for flood risk in growth areas[62] which cover standard of flood defence over time, flood defence design, location of new developments, flood resilient construction and drainage considerations.

The Z-squared contribution

Z-squared's target is to generate all of its non-transport energy from non-fossil fuel-related means, and as such does not contribute to climate change.

Lack of infrastructure is currently constraining development in the Thames Gateway. By bringing energy generation on-site, treating wastewater locally and maximising reuse, recycling and recovering EfW, Z-squared places minimal additional pressure on Thames Gateway infrastructure. This has come at an additional cost to Z-squared against a base case development but this is offset by reduced car parking requirement and associated infrastructure. Any conventional development will require off-site investment in, among other things, the national grid, electricity generating capacity, gas distribution networks, reservoir capacity, wastewater treatment, residual waste disposal in the form of landfill capacity. We have not been able to cost these off-site investments but KBR have undertaken a rough economic appraisal which demonstrates that the overall capital investment is reduced and the annual benefit is more than £2m per year. If Z-squared was adopted across just 50% of the Thames Gateway, the economic benefit over a 30 year period would be in excess of £1bn.

Social exclusion is a persistent problem in the Thames Gateway. Z-squared offers a vision of an attractive place to live and work where a sense of community will develop through shared activities and sensible co-location of facilities. Childcare facilities, a primary school and a City Academy with One Planet Living and sustainability at the heart of the curriculum provide education and lifelong learning opportunities for all. The Healthy Living Centre will promote disease prevention through diet, exercise and lifestyle choices and also treat those who need treatment. Jobs will be provided within the community and in local businesses and light industry.

This integrated approach to energy, waste and water infrastructure, transport, food and masterplanning provides an attractive framework for development in the Thames Gateway.

18. Next steps

Making it happen

A launch event attended by a number of developers and other key decision-makers was held at the end of June 2004 and generated interest in Z-squared. There is increasing support for the Z-squared concept, at a local borough, regional and also government level. However, this warm glow needs to be translated into firm action. Preliminary cost calculations suggest that the net incremental cost of building to Z-squared standards is 3% uplift on a base case built to new part L building regulations and an 8% uplift if it is assumed that it costs an additional 5% to build to EcoHomes and BREEAM excellent compared with the base case. This additional cost is not one that a developer would usually incur. Building to Z-squared standards avoids the need to invest in additional off-site electricity generating and distribution infrastructure, waste management and landfill capacity and wastewater treatment facilities. It is necessary to find a mechanism by which these savings can be recognised. Z-squared also results in reduced carbon emissions, thereby reducing contribution to climate change, the estimated reduction in social damage cost, in line with the Energy White Paper, is in the region of tens of millions of pounds over a 30 year period.

ESCos and WWESCos

The long-term management of Z-squared will be key to ensuring that the One Planet Living Principles are consistently met and that ongoing environmental benefits are delivered, through effective facilities management, waste management, and ongoing operation and maintenance of the energy and water infrastructure. The deregulation of the energy markets has seen the emergence of ESCos who adopt and maintain energy infrastructure and bill customers for their energy services. The integrated nature of the Z-squared infrastructure suggests that a multi-utility WWESCo would be required. Initial discussions with utility companies and ESCos indicate that they would be willing to provide this service for Z-squared. This will de-risk the development of Z-squared from the developer's perspective as they can then focus on delivering the built environment. Opportunities for a community ESCo joint venture owned by the community through a community trust and an expert ESCo will be explored.

Facilities Management

Research has shown that as much as 90% of the environmental impact of buildings arises through their occupation. Consideration of management of facilities at the design stage and focussing on delivering green facilities management services will be key to delivering environmental benefits. A set of Facilities Management Guidelines[63] have been developed that will be considered in the detailed design stage of Z-squared.

Office of the Deputy Prime Minister (ODPM)

As the government body with responsibility for regeneration, planning and building regulations and delivering sustainable communities in the Thames Gateway, ODPM has a key role to play in setting targets. The competition to develop Millennium Communities shows that developers are not scared of targets as long as all developers have a level playing field. They can then find the most efficient way for them to meet the target, be it an EcoHomes rating, carbon emissions reduction or water usage. We would like to see Z-squared promoted as a pathfinder project for the Sustainable Communities Plan and London's bid for the Olympics. Through WWF's One Million Sustainable Homes Campaign, we have presented the case for Z-squared to be considered as an exemplar for the upcoming Code for Sustainable Buildings.

Greater London Assembly (GLA), Regional Development Agencies (RDAs) and Local Authorities (LAs)

The Mayor's Energy Strategy and the London Plan call for at least one zero carbon development in every London borough. Z-squared offers a vision for a development that will transform an area and act as a catalyst for regeneration. RDAs and LAs can play a significant role in the identification of suitable sites for developing Z-squared and One Planet Living Communities and in supporting planning applications that deliver such sustainable communities.

Registered Social Landlords (RSLs)

With a focus on affordability and decent homes, RSLs will benefit from Z-squared, with cheaper costs for residents and a real sense of opportunity and community. There is an opportunity for RSLs and The Housing Corporation to sign up to Z-squared and One Planet Living, offering their tenants bill savings and a better quality of life in a clean, safe environment.

Developers

Developers are increasingly considering sustainability issues in their developments, but these are all too often seen as costly add-ons to achieve planning permission. By taking an integrated approach to the infrastructure at Z-squared, the development offers long-term benefits to residents and commercial occupants through reduced bills, and a better environment. This can be reflected in increased rental yields and market values for sales of units. Recent research carried out by WWF and CABE suggests that 84% of buyers will pay an additional 2% for an eco home and a British Gas Survey found that people would pay up to £3,400 more for an energy-efficient home. By supporting Z-squared, it may be argued that developers can achieve greater and quicker sales and establish a position as a market leader in developing sustainable homes.

Appendices

Further reports

KBR	Z-squared – Moving towards a sustainable waste management solution Car Parking Assessment for Z-squared
Fulcrum Consulting	Z-squared – Energy, Waste Water, Infrastructure and the Built Form Z-squared in the Thames Gateway – Concepts of Sustainable Infrastructure and the Built Form Z-squared in the Thames Gateway – Technical Report on Energy and Infrastructure Z-squared – Energy Summary Z-squared – ESCos and Sustainable Infrastructure Z-squared – Water and Waste Summary Z-squared – Encouraging Wildlife Habitats
Foster and Partners	Z-squared
Cyril Sweett	Z-squared Cost Plan
BioEnergy Devices	A Scoping Study into Biomass CHP for Z-squared

Glossary

BedZED	Beddington Zero (fossil) Energy Development
BMW	Biodegradable Municipal Waste
BRE	Building Research Establishment
BREEAM	BRE's Environmental Assessment Method
CFC	ChloroFluoroCarbon
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
CV	Calorific Value
CSA	Community Supported Agriculture
DEFRA	Department for Environment Food and Rural Affairs
DTI	Department of Trade and Industry
EC	European Commission
EfW	Energy from Waste
ESCo	Energy Services Company
EU	European Union
FSC	Forestry Stewardship Council
GBH	Gravel Bed Hydroponics
GDP	Gross Domestic Product
HCFC	HydroChloroFluoroCarbon
ITS	Interseasonal Thermal Storage
KDRB	Kerbside Dry Recyclable Box
KW	Kilowatt
KWh	Kilowatt hour
LA	Local Authority
LDA	London Development Agency
M4I	Movement for Innovation
MDF	Medium Density Fibreboard
MRF	Materials Recycling Facility
MSW	Municipal Solid Waste
MW	Megawatt
MWhe	Megawatt hours electric
MWhth	Megawatt hours thermal
ODPM	Office of the Deputy Prime Minister
OPL	One Planet Living
PEFC	Pan-European Forest Certification
RSL	Registered Social Landlord
SEEDA	South East England Development Agency
SUDS	Sustainable Urban Drainage Strategy
TfL	Transport for London
VOC	Volatile Organic Compound
WEEE	Waste Electrical and Electronic Equipment
WRAP	Waste and Resources Action Programme
WWESCo	Waste, Water and Energy Services Company

Checklists

The SEEDA Sustainability Checklist

Although ecological footprinting can be used to represent the environmental impact of a development or community, social and economic sustainability, other concepts of resource equity, are not considered by the methodology. The SEEDA Sustainability Checklist is particularly relevant to this study because of regional applicability and because it has been designed to assess new developments and the impacts of the people living within them.

The Sustainability Checklist was developed by the BRE for SEEDA for assessing new developments in the South East. It builds on the established background of LAs producing sustainability guidance covering environmental issues, and

broadens the scope to address important social and economic sustainability issues of concern to Regional Development Agencies.

The tool is designed for LAs and developers to use when planning or building large developments including new estates to urban villages and regeneration projects, and allows the user to determine the level of sustainability that a development will achieve.

The Checklist identifies key sustainability issues and groups them under ten headings: Outward focus – impact on the wider community; Land use, urban form and design; Transport; Energy; Impact of buildings; Impact of infrastructure; Natural resources; Ecology; Community; and Business – with questions raised under each, detailing available development options. Strategies to achieve "Good Practice" and "Best Practice" are communicated using performance indicators.

www.sustainability-checklist.co.uk

EcoHomes and BREEAM

Whilst the Sustainability Toolkit can be used for appraising sustainability at a development-scale, the BREEAM suite of tools (including EcoHomes) can be used to assess the environmental impact of individual buildings. It should be noted that the tools are narrower in scope than the Checklist covering only building construction and occupancy-related environmental sustainability, although the issues are covered in more depth.

BREEAM has been used to assess the environmental performance of both new and existing buildings for more than 10 years. The success of BREEAM could be related to its ability to cover a wide range of environmental issues within one assessment, and to present the results in a way that is widely understood by those involved in property procurement and management.

The BREEAM tool for the assessment of homes is called EcoHomes. It is widely accepted in the construction sector as the most comprehensive and successful sustainability assessment tool currently available for housing. 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. Environmental performance is expressed on a scale of Pass, Good, Very Good and Excellent. EcoHomes is a reasonably straightforward, flexible and independently verified environmental assessment method. It is an easily understood, credible label for new and renovated homes including houses and apartments. It acknowledges developers and homeowners who improve environmental performance through good design, rather than necessarily high capital cost solutions.

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_2 emissions associated with meeting energy demands. Credit is also given for homes located with good access to public transport and amenities, and which are constructed from 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. Assessments can be undertaken at both design stage and post-construction. This offers the flexibility to develop an understanding of the performance of proposed homes at an early stage, rand the ability to appraise the performance based on what was actually built and not simply good intentions pre-construction.

Some LAs are beginning to investigate the potential EcoHomes offers both as a measure of sustainability and as a straightforward way to state and specify their sustainable aspirations for their respective regions. The London Borough of Brent refers to the scheme in their Supplementary Planning Guidance and the London Borough of Croydon requires large developments to achieve the "Excellent" rating. To our knowledge no authority has yet tested the legal implications of specifying an EcoHomes score as a condition of planning generally, although consultation with the Environmental Law Foundation has suggested that such a route would be open to LAs and Regional Development Agencies. It should be noted that from April 2003, all future housing association[xvi] developments seeking Housing Corporation[xvii] funding are required to meet a minimum requirement of EcoHomes "Pass", and that English Partnerships require proposed developments on their sites to score "Very Good" and their Millennium Communities must achieve an "Excellent" rating.

For the social housing sector, the Housing Corporation's Toolkit of Indicators of Sustainable Communities is a further source of guidance on how to assess the sustainability of communities where social housing exists or might be developed. RSLs are required to certify use of the toolkit when making funding bids to the Housing Corporation.

http://products.bre.co.uk/breeam/ecohomes

xvi Housing associations (HA) are the main providers of new social housing in England.

xvii The Housing Corporation is responsible for investing public money in HA and for protecting that investment and ensuring it provides decent homes and services for residents. The Corporation invests in HA to provide homes that meet local needs, and through regulation they seek to ensure that people will want and be able to live in these homes, now and in the future.

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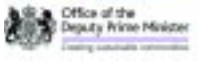


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