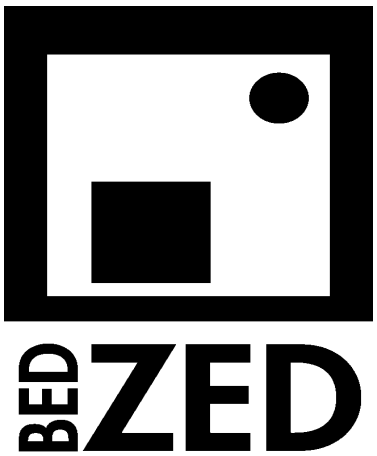
Beddington Zero Energy Development



Total Energy Strategy

including Green Transport Plan

BioRegional

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2. SUMMARY

2.1 Total Energy Balance

This chapter quantifies the predicted energy consumption of the buildings and transport at BedZED. It then sets out how renewable energy sources will be harnessed to meet these energy demands and calculates the site energy balance.

2.1.1 *Building Energy Consumption*

Chapter 3, Energy Analysis, predicts the electrical energy requirements of each house type at BedZED assuming the use of energy efficient appliances and low energy lighting. The electrical energy consumption of each house type is calculated for three scenarios. The worst case scenario is based on frequent use of appliances performing at the lower end of the energy efficiency spectrum. The best case scenario is based on less frequent use of the most energy efficient appliances on the market. These scenarios reflect the different lifestyles and energy consumption of, for instance, a couple with a child and a single person living in a similar 2 bedroom flat. Further information about the scenarios on which these calculations are based can be found in Chapter 3, Energy Analysis.

House type	*Worst case scenario (kWh / year)*	*Typical scenario (kWh / year)*	*Best case scenario (kWh / year)*
1 bedroom flat	4343	1723	989
2 bedroom flat	4867	2028	1189
3 bedroom maisonette	5863	2657	1663
3/4 bedroom town house	6137	2882	2449

Table 1: The predicted annual electrical energy requirements for each house type at BedZED

Chapter 4, Predicted Energy Use (Ove Arup and Partners, 1999) adds the electrical energy requirements for offices, community facilities and services such as streetlighting and hot water pumps. The electrical energy requirements of the offices and community facilities are based on DETR best practice figures for each building type (DETR, 1998). The predicted heat energy requirements across the site are also calculated.

	Heat energy (kWh / winter day) [1]	*Electrical energy (kWh / day)* [1]	*Total energy (kWh / winter day)* [1]
Residential	1270	723	1993
Offices	300	189	489
Community facilities	396	456	852
CHP	850	51	51
Other e.g. streetlighting	n/a	251	251
Total daily energy (kWh)	2816	1670	3585
Total annual energy (kWh)	**882,977** [2]	**640,028** [3]	**1,212,755** [4]

[1] Chapter 4, Predicted Energy Use, Ove Arup and Partners, 1999
[2] Adjusted to allow for reduced summer heating demands and 20% losses in distribution
[3] Adjusted to allow for 5% losses in distribution
[4] Adjusted to allow for reduced summer heating demands and distribution losses

Table 2: The predicted daily and annual heat and electrical energy requirements at BedZED

2.1.2 *Transport Energy Consumption*

Transport of people and goods consumes, typically, one third of a country's energy requirements (Wackernagel et al, 1993). The construction of transport infrastructure and vehicles and travel itself use huge amounts of resources in material, land, energy and time.

An energy efficient development must therefore address transport energy demands. A Green Transport Plan has been devised to reduce the energy consumption of travel by BedZED residents and workers.

It is predicted that transport energy consumption at BedZED will change over time as the composition of vehicles on site changes. Transport energy consumption will fall as:

- residents and workers reduce car use in favour of public transport, walking and cycling
- residents give up their car or forego the purchase of a first or second car to join the car pool

A shift from fossil fuel to electric vehicles will also reduce energy consumption.

Scenario	*Transport energy consumption (kWh / year)*	*% of total transport energy generated from on site renewable sources*
Equivalent conventional development	963,098	0
BedZED year 1	709,589	2
BedZED year 5	527,679	6
BedZED year 10	244,746	34

Table 3: The predicted transport energy consumption and percentage of total transport energy generated from on site renewables for BedZED and an equivalent conventional development

From table 3 it can be seen that annual transport energy consumption at BedZED in year 1 is predicted to be 75% of an equivalent conventional development. This figure is predicted to fall to 55% in year 5 and just 30% in year 10. By year 10, it is predicted that a third of the transport energy demand at BedZED will be met from on site renewables.

The reduction in transport energy consumption and shift to transport powered by renewable energy will be achieved by implementing the BedZED Green Transport Plan.
The Green Transport Plan target of reducing private, residential fossil fuel mileage by 50% compared to an equivalent conventional development is met in the scenario predicted for year 5.

2.1.3 *Green Transport Plan*

BedZED residents and workers will be offered a comprehensive package of transport options which will enable them to retain travel flexibility whilst reducing dependence on private, fossil fuel cars. These transport initiatives are brought together in a legally binding Green Transport Plan.

The Green Transport Plan sets a target of reducing BedZED residential fossil fuel car mileage by 50% compared to an equivalent conventional development.

The Green Transport Plan aims to reduce car use and car ownership at BedZED by:

i. Reducing the need to travel

- BedZED is a mixed use development, offering the opportunity for residents to live and work on site, therefore eliminating the need to commute to work.
- To reduce shopping related travel, residents will be encouraged to order shopping over the internet. Regular, co-ordinated deliveries of BedZED orders will reduce shopping delivery miles.
- BedZED incorporates a shop, café, childcare facility and healthy living centre reducing the need for residents and workers to travel off site for these facilities.

ii. Promoting public transport

- Information about local public transport services will be widely available.
- Discounted season tickets will be negotiated for residents and workers
- A minibus service to the nearest railway station will be offered at peak times
- Where there is sufficient demand, existing public transport services will be supplemented by Sutton Community Transport

iii. Offering alternatives to private car travel

- BedZED will encourage cycling by offering designated cycle storage for residents and workers, workspace showering facilities and an on-site cycle repair facility. The site will be linked into the existing cycle network.
- A car pool will be established on site, offering the opportunity to hire a range of vehicles by the hour. Residents will be encouraged to give up their cars and use the car pool.
- Residents who are keen to retain the use of a private car will be encouraged to change to an electric vehicle.

2.1.4 *On Site Renewable Energy Production*

Electricity and heat at BedZED will be generated by a wood-fired combined heat and power plant (CHP) using gasification. The wood gas fires a spark ignition engine which runs a generator to produce electricity for lighting and running appliances. Heat from the exhaust and from the engine radiator is tapped and used to provide hot water and top up heating.

Each house at BedZED is fronted by a south-facing conservatory to maximise passive solar gain. Heat from the sun makes a substantial contribution towards heating BedZED houses to a comfortable temperature, therefore reducing the need for central heating.

Photovoltaic solar panels will be built into the roof fabric of the south-facing conservatories. The electricity generated from the PV panels will be sufficient to power 40 electric vehicles.

Energy source	*kWh / year* [1]
CHP electricity output	682,550
CHP heat output	949,365

Passive solar	134,116
PV solar	97,000
Total	**1,863,031**

[1] Chapter 4, Predicted Energy Use, Ove Arup and Partners, 1999

Table 4: The annual energy production from on site renewable sources at BedZED

From table 4 it can be seen that passive solar gain contributes the equivalent of 134,116kWh per year towards heating the buildings at BedZED. As all of this energy is effectively 'consumed' for heating, the passive solar energy balance is zero. Passive solar is therefore not included in site energy balance calculations.

2.1.5 *Site Energy Balance*

The BedZED design concept is driven by the desire for a zero (fossil) energy development i.e. one which will produce at least as much energy from renewable resources as it consumes. In addition, BedZED is designed to be a carbon neutral development, resulting in no net addition of CO_2 to the atmosphere.

2.1.5.1 Building Energy Balance

	Energy production (kWh / year) [1]	*Energy consumption (kWh / year)*	*Building energy balance (kWh / year)*
Electricity	682,550	640,028	+ 42,522
Heat energy	949,365	882,977	+ 66,388

[1] Chapter 4, Predicted Energy Use, Ove Arup and Partners, 1999

Table 5: Predicted building energy production and consumption at BedZED

From table 5 it can be seen that there is a predicted excess of electrical and heat energy generation over consumption. Excess heat energy generated by the CHP is primarily used for woodchip drying (so improving the gasification efficiency) and the remainder will be lost to the atmosphere. Excess electricity will be exported to the grid, on a green tariff account. Many regional electricity companies now offer a green tariff where energy generated from renewable sources is bought from suppliers and sold to customers at a premium rate.

2.1.5.2 Transport Energy Balance

Scenario	*PV solar electricity production* (kWh / year) [1]	*Electricity consumption (kWh / year)*	*Electricity balance (kWh / year)*
Year 1	97,000	14,548	+ 82,452
Year 5	97,000	33,929	+ 63,071
Year 10	97,000	83,229	+ 13,771

[1] Chapter 4, Predicted Energy Use, Ove Arup and Partners, 1999

Table 6: Predicted transport electricity production and consumption at BedZED for years 1, 5 and 10

From table 6 it can be seen that in each predicted scenario there is an excess of electricity generation over electricity consumption. This positive electricity balance will be exported to the grid on a green tariff.

Scenario	*Fossil fuel energy consumption (kWh / year)*
Year 1	695,041
Year 5	493,750
Year 10	161,517

Table 7: Predicted fossil fuel transport consumption at BedZED for years 1, 5 and 10

From table 7 it can be seen that the use of fossil fuel vehicles at BedZED represents an energy deficit in each of the predicted scenarios.

2.1.5.3 Site energy balance

Scenario	*Site renewable energy balance (kWh / year)*	*Site fossil fuel energy balance (kWh / year)*
Year 1	+ 124,974	- 695,041
Year 5	+ 105,593	- 493,750
Year 10	+ 56,293	- 161,517

Table 8: The predicted site energy balance for BedZED for years 1, 5 and 10.

Table 8 shows a reduction in the predicted site renewable energy balance from year 1 to year 10 as an increasing proportion of electricity generated by PV solar is used to power electric vehicles. It is predicted that the negative fossil fuel energy balance will decrease from year 1 to year 10 as the number of petrol and diesel vehicles on site falls.

The use of fossil fuel vehicles on site and in servicing the site cannot be met directly by on site renewable energy generation, hence the BedZED Green Transport Plan focuses on the minimisation of fossil fuel vehicle use.

Excess electricity generated at BedZED by the CHP plant and PV panels will be exported to the grid. This will reduce the amount of electricity that needs to be generated from fossil fuel sources elsewhere, resulting in reduced CO_2 emissions from electricity generation. These savings in CO_2 emissions can be offset against CO_2 emissions from fossil fuel vehicles at BedZED.

Year	*CO_2 emissions from fossil fuel vehicles (tonnes)* [5]	*CO_2 savings from excess electricity generation (tonnes)* [6]	*Net CO_2 emissions from transport at BedZED (tonnes)*
1	202	62	140
5	143	53	90
10	47	28	19

[5] For each kWh energy used by a fossil fuel vehicle, 0.29kg CO_2 is emitted to the atmosphere.
[6] For each kWh electricity used, 0.5kg CO_2 is emitted to the atmosphere (DETR, 1998).

Table 9: Predicted net CO_2 emissions resulting from transport at BedZED in years 1, 5 and 10

Transport associated with BedZED will not be carbon neutral until all private and car pool vehicles, all vehicles that service the site and all public transport used by site residents are powered from carbon neutral sources. However, due to the measures in the Green Transport Plan, the predicted year 10 CO_2 emissions from BedZED transport will be reduced to just 4% of the CO_2 emissions resulting from an equivalent conventional development.

The net CO_2 emissions from transport at BedZED could be offset through the Climate Care scheme run by the Carbon Storage Trust. Climate Care offsets greenhouse gases by investing in presently unviable or otherwise blocked investments in energy efficiency, renewable energy and forest restoration, for £5.45 per tonne of CO_2.

The energy demands of BedZED transport cannot be carbon neutral in terms of being wholly met from on site renewables. However, if minimal CO_2 emissions are offset through the Climate Care scheme there will be no net addition of CO_2 to the atmosphere as a result of transport at BedZED.

2.1.6 *Conclusions*

2.1.6.1 Buildings

The BedZED CHP will generate sufficient heat for space heating, hot water and drying the CHP woodchip fuel. The small excess in generation is lost to the atmosphere. In addition, the CHP will generate sufficient electricity to meet the building energy demand of the site and export a predicted 42,522kWh per annum to the grid.

The energy demand of the buildings at BedZED will therefore be met wholly from renewable energy sources, within the site's footprint.

2.1.6.2 Transport

The PV panels will generate enough electricity to power 40 cars and export a predicted 13,771kWh per annum to the grid (year 10 scenario).

As long as private and car pool vehicles, vehicles that service the site and public transport used by site residents are powered by fossil fuels there will be a negative fossil fuel energy balance at BedZED. However, it is predicted that by year 10, the negative fossil fuel energy balance will be reduced to 161,517kWh per year, just one sixth of the energy consumed by petrol and diesel vehicles in an equivalent conventional development.

2.2 GREEN TARIFF ELECTRICITY

It is not economic to size the BedZED CHP unit to meet the peak electricity demand of the development. Therefore, a connection to the national grid will enable energy to be drawn in on a green tariff during times of peak demand and surplus energy to be sold to the grid at times when supply exceeds site demand.

Since the deregulation of the energy companies, the number of regional energy companies offering green tariffs has increased rapidly. Green tariff energy is energy generated from renewable sources which is bought from suppliers and sold to customers at a premium rate.

All of the green tariffs currently available involve payment of a premium. Green tariffs are either 'renewable tariffs', where for each unit of electricity used by the customer on this scheme, the

supplier will buy a unit of electricity from a renewable source; or 'eco funds' where the additional customer premium is invested in new renewable energy projects.

	Green tariff	*Quarterly increase in average bill*	*Other information*
Centrica	Planned		
Eastern	EcoPower / EcoPower Plus (Eco fund)	£3.45 and £7.04 respectively	Eastern Energy will match the money raised, pound for pound, up to a maximum of £1 million over 2 years
East Midlands Electricity	Planned		
London Electricity	Planned		
Manweb	Green Energy (Eco fund)	£3.51	Funds will be used to purchase new green electricity at the market rate or to finance new renewable projects. Companies involved will match, at least pound for pound, the money raised.
Northern Ireland	Eco Energy (Eco fund)	£1.04, £5.20, or £10.40 [7]	Also offers discount vouchers for purchase of eco-friendly products
Northern	Planning to launch in mid '99 (Renewable tariff / eco fund)	£2.88	Funds will be used to support the cost of new renewable generation, or carbon offset projects such as reforestation. Customers can choose how their surcharge is used. The tariff will also offer an introductory energy efficiency package (e.g. low energy light bulbs or discounted insulation)
Norweb	No domestic green tariff planned		
Renewable Energy Co.	Eco-tricity (available end 1999)		
Scottish Hydro Electricity	Acorn (Renewable tariff)	£2.73	
Scottish Power	Green Energy (Renewable tariff)	£3.81	Funds will be used to purchase new green electricity at the market rate or to help finance new renewable projects. Companies involved will match, at least pound for pound, the money raised.
Seeboard	Planned for mid-2000 (Eco fund)		
Southern Electricity	Acorn (Renewable tariff)	£2.73	
SWEB	Green Electron (Renewable tariff)	£7.30	
Unit[e]	Renewable tariff		
Yorkshire	Green Electricity (Renewable tariff)	£4.21	Free low-energy light bulb given to customers signing up to the tariff.

[7] Customers can choose to have 10%, 50% or 100% of their energy supplied from Eco Energy

Table 10: The current range of green tariffs available to domestic consumers
(Friends of the Earth, October 1999)

2.3 CONSUMER BEHAVIOUR TOWARDS ENERGY EFFICIENT HOUSING AND TRANSPORT

Questionnaires examining attitudes towards environmentally friendly housing were distributed to a random sample of 500 addresses within the M25 and inserted in 500 copies of the magazine Permaculture.

189 responses to the questionnaire were received, 49 responses from households within the M25 (M25 sample) and 140 responses from readers of Permaculture magazine (Permaculture sample).

The questionnaire included a number of questions relating to the BedZED energy strategy, the responses to which were analysed for this report.

Respondents were asked to rate the importance of various features of environmentally friendly houses. Energy efficiency and the use of renewable energy were identified as the most popular features of an environmentally friendly house by both samples.

Respondents were asked how likely they were to consider getting rid of one or more of their cars if a car pooling scheme was available. 64% of the Permaculture sample and 35% of the M25 sample thought it extremely or quite likely that they would take up this option. In the M25 sample, most of those who were unlikely to take advantage of a car pooling scheme (41%) felt very strongly that they would not give up their car.

Even amongst the M25 sample, who are likely to be less environmentally motivated than the Permaculture sample, a third of respondents were willing to give up a private car in favour of a pool car. This suggests that the Green Transport Plan target of 8% of BedZED residents giving up a private car in year 1 is achievable.

Further information on consumer behaviour towards energy efficient housing and transport can be found in chapter 7.

2.4 REDUCED RUNNING COSTS FOR ENERGY EFFICIENT HOUSING AND TRANSPORT

Energy efficient housing and transport offer significant benefits to the environment in terms of reduced CO_2 emissions. In addition, BedZED residents will benefit from lower household bills and residents who give up a private car to join the car pool will be financially better off. Based on the experience of members of their 'City Car Club' car pool in Edinburgh, Budget Car and Van Rental suggest that a member with an annual mileage of 11,000 - 13,000km could save up to £1,500 per year on their motoring costs.

A household living in a 3 bedroom BedZED maisonette could save up to £240 per year, £134 on electricity and £106 on space and water heating, compared to a household living in an equivalent house built to 1995 building regulations. These savings are despite the fact that BedZED households will pay a premium rate for their green electricity.

A BedZED resident giving up a private car in favour of a pool car could run a well serviced bike and take 5 local bus or train trips per week, 2 £5 minicab journeys per week and 1 day car hire per week from a local firm for the same price as running a private car. For shorter journeys, hiring a car pool by the hour will be cheaper than hiring a car by the day, offering residents greater flexibility at a lower price.

This calculation does not take into account the commuting costs for BedZED residents who work in London. It is assumed that residents will commute into London by train regardless of whether they own a car or not, as the nearby Hackbridge and Mitcham Junction stations offer regular, direct trains into London.

Further information on the potential annual savings on energy bills and car running costs for BedZED households can be found in chapters 8 and 9 respectively.

2.5 RECOMMENDATIONS FOR POLICY MAKERS

There are many opportunities for local and central government to reform and develop policies to encourage future energy efficient developments.

2.5.1 *Planning policy guidance*

The Unitary Development Plan (UDP) of a sympathetic local authority can include policies that offer an open door to green developers. However, local authorities have to wait for such developers to approach them rather than having the power to influence more conventional developers.

Local authority planning policy guidance, such as PPG1 which sets out national sustainable development guidelines, is issued from central government. PPG1 currently focuses primarily on sustainable development in relation to land use, with little guidance on achieving sustainable development in terms of building design.

It is recommended that PPG1 is extended to give a more comprehensive coverage of issues relevant to green housing developments. In addition, specific, enforceable policies would enable local authorities to impose targets for greener buildings on developers.

There are some policy areas, such as car parking, where local authorities have the power to set their own standards. As in the case of BedZED, where it can be demonstrated that parking needs will be lower than usual, the local authority can reduce the number of parking spaces required.

In cases where local authorities have greater flexibility, the opportunity should be taken to develop policies favourable to sustainable housing developments.

Local authorities have some scope to ring fence revenue for specific uses. This enables expenditure on sustainable development without increasing spending. For instance, income from car parking charges can be used to subsidise public transport. Local authorities should be encouraged to use these powers creatively to encourage sustainable development.

2.5.2 Environmental Budgeting

Local authorities have traditionally been obliged to sell land to the highest bidder. However, the land for BedZED was sold to Peabody Trust by London Borough of Sutton at a lower cash price than that of the highest bidder for the site. This was possible because a study was commissioned to attach an economic value to the environmental benefits of BedZED over a conventional development. Once the environmental benefits of BedZED were valued in monetary terms, the Peabody bid was in line with the rival bid. As a result, a local authority was able to take the environmental benefits of a development into account for the first time. Certain benefits, such as reduced CO_2 emissions were relatively easy to price but other benefits, such as reductions in water consumption and car use, were impossible to value economically.

In December 1998 local authorities were granted a general disposal consent enabling them to accept tenders up to 20% (land value £1 million or less) or 10% (in the case of higher values) lower than the land value. Local authorities are therefore no longer required to maximise income from land sales, but can consider lower bids within a certain range. It is recommended that this change be brought to the attention of local authorities along with information regarding the opportunities for using this as a mechanism for

encouraging green housing developments. Local authority attention should also be drawn to existing government guidance on attaching monetary values to environmental benefits, published in 'The Green Book – Appraisal and Evaluation in Central Government'. This information could be incorporated into the appropriate planning policy guidelines.

2.5.3 Building Regulations

Approved Document Part L of the Building Regulations which deals with energy efficiency is currently under review. It is recommended that improved standards for U-values, air tightness and ventilation are set as a result of this review process. The introduction of guidance on the use of renewable energy to meet building energy demands is also recommended.

2.5.4 Climate Change Levy

The Climate Change Levy on business use of energy will be introduced from April 2001. The government aims to achieve savings of 1.5 million tonnes of CO_2 per year by 2010 via this levy. The cost of the levy to business will be offset by a 0.5% cut in the rate of employer's national insurance contributions. Energy intensive users will be offered a reduced rate of levy in return for signing a negotiated agreement that sets targets for reducing energy use.

The levy does not apply to energy generated from renewable sources or CHP. In addition, £150 million of the revenue from the levy will be invested in renewables. The Climate Change Levy begins to tip the balance in favour of renewables and will send a clear message to business that energy is now a tax target. This should add weight to energy efficiency measures when businesses are assessing energy options.

2.5.5 VAT on energy saving products

In the November 1998 budget, the government reduced the VAT rating on energy efficiency products used in government sponsored projects from 17.5% to 5% in line with the VAT rating on energy itself. However, energy efficient products used in government sponsored projects account for only a small percentage of all energy efficient products sold. It is therefore recommended that all energy efficiency products e.g. insulation, low energy light bulbs, triple glazing are VAT rated at 5% to reduce the cost disparity between conserving and using energy.

2.5.6 Generation of renewables

It is recommended that the UK government translates the UK national target for energy generation from renewables into individual targets for energy generating companies.

A similar Dutch scheme has encouraged energy generating companies to identify new, cost effective ways of generating from renewables. In one initiative, residents are being offered free installation of PV panels and a 2 way electricity meter so that electricity generated from their roof offsets the electricity they use.