Solar Power
Feasibility Study
Sustainable Eastside

Faber Maunsell

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SOLAR POWER FEASIBILITY STUDY FOR EASTSIDE

Groundwork Birmingham

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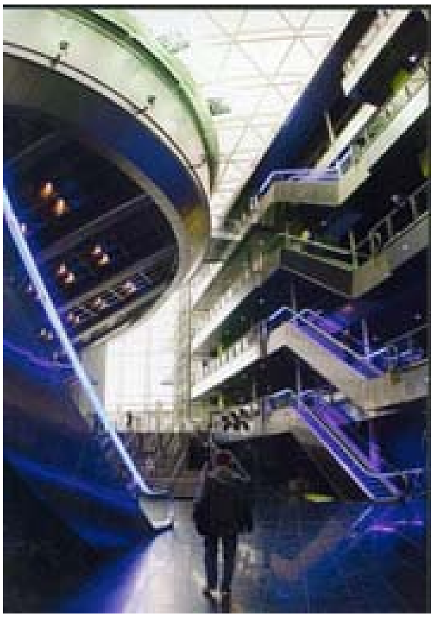
FINAL REPORT



FABER MAUNSELL

GROUNDWORK BIRMINGHAM

SOLAR POWER FEASIBILITY STUDY FOR EASTSIDE

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1. INTRODUCTION


1 Introduction

1.1 PURPOSE OF THE REPORT

FaberMaunsell has been commissioned by Groundwork Birmingham on behalf of Birmingham City Council to examine the potential for using solar technology in the Eastside development.

The aim of this report is to outline the current 'state of the art' in terms of three solar 'technologies' – passive solar, solar thermal and photovoltaics – and to relate their use to the Eastside development. Benefits and disadvantages will be examined as well as planning and other regulatory issues to help the Eastside development make the best use it can of solar power. The growing activity around renewable energy sources means that this is a crucial time for Birmingham City Council to consider the use of renewable energy sources - it is an opportunity not to be missed.

1.2 INTRODUCTION TO EASTSIDE

The planned development of Eastside is part of the larger regeneration of Birmingham City Centre that has been ongoing over the last decade. The Eastside development area includes Digbeth, the Aston Triangle and the City Centre core retail area. Digbeth has a predominately urban and industrial character and is dominated by elevated roads and railway lines. The area is also bisected by the Digbeth Branch and Grand Union canals as well as the largely hidden River Rea. To the north of the area is Aston University and Aston Science Park as well as Millennium Point, a regional landmark project to celebrate the new Millennium. A mixture of uses is being encouraged blending the new and old based on three guiding principles of *learning, heritage and technology*[1]. There are plans for a new City Park, for a 'Learning quarter' and for the development of the canal and river waterfronts. Residential development is to be encouraged to promote life and activity outside of normal working hours, the majority of which will be for private sector or for educational/student needs.

1.3 BACKGROUND TO THE STUDY

The drivers for increasing the use of renewable energy supplies are many – at both a European, national and local level. The EU ratification of the Kyoto Protocol and the internal 'Green Energy' Directive (aiming for 22% electricity from renewable sources by 2010) are considerable drivers within the EU. The UK has its own internal target of 10% electricity generated by renewables by 2010, with an aspiration for 20% by 2010 to assist with the goal of cutting UK carbon dioxide emissions by some 60% by 2050. Although wind, hydropower and bioenergy will make up a large part of the 10%, PV is playing a small but increasing role. The DTI funded demonstration 'Field Trials' and now the Major Demonstration Programme has helped increase activity in the PV market in UK (see chapter 6 for more details on funding). At the local level, individual councils are setting their own targets. For example, the London Borough of Merton has included a requirement in its Unitary Development Plan (UDP) to provide 10% of energy demand from renewables for new buildings over 1000m[2]. One of the aims of Birmingham City Council's (BCC) Sustainable Strategy and Action Plan is to: *Reduce the contribution to climate change by increasing energy efficiency, and encouraging the use of renewable energy.* The plan also confirms BCC's commitment to a 20% reduction in CO2 emissions by 2010.

The Energy White Paper also recognises the importance of energy efficiency to help decrease our reliance on fossil fuels and states an ambition to increase energy efficiency by 20% by 2020. Here passive solar design and the use of solar water heating systems can play a part. The current review of the Building Regulations is also looking at renewable sources of energy including solar thermal and photovoltaics – the new regulations will be in force by 2005. More DTI funding, under the Clear Skies programme, is supporting the installation of solar thermal systems, as well as ground source heat pumps and wind turbines (see chapter 6 for more details on funding).

[1] Eastside Development Framework June 2001, Birmingham City Council

2. CURRENT SOLAR TECHNOLOGIES

2 Current Solar Technologies

These section sets out a review of the three major solar techniques or technologies and their current state of development. Benefits of each are discussed and the different types that are available. Related costs, energy and carbon savings are described in chapter 4.

2.1 PASSIVE SOLAR DESIGN

2.1.1 WHAT IS PASSIVE SOLAR?

"Passive solar" derives from the design of a building to maximise the benefits of natural elements, particularly sun, daylight, wind, stack ventilation and thermal mass, without relying on any "active" components such as fans or pumps. All new buildings can be designed, and existing buildings renovated, to improve their passive performance by understanding the principles and following simple rules.

2.1.2 THE BENEFITS OF PASSIVE SOLAR.

Passive solar design can contribute both to the energy efficiency of buildings in use and improve the comfort and quality for occupants. There are several components to Passive Design that can be used on their own or in combination to reduce energy consumption: -

- The contribution of useful solar heating can be increased, reducing the quantity of heating required from conventional sources;
- The amount and distribution of daylighting in all parts of a building can be increased, reducing the need for artificial lighting. Where a building uses active cooling, reduced lighting energy use will also contribute to reduced cooling demand;
- The demand for cooling in a building can be reduced by solar shading, leading to reduced energy consumption where active cooling is used;
- Using thermal mass to store solar energy in dwellings can reduce heating demand and it may also be used to reduce cooling needs in offices;
- The need for mechanical ventilation and air conditioning can be avoided or reduced by adopting natural ventilation strategies which use wind pressure differences and stack effects in atria (usually considered as using passive solar design), thus saving the energy used by fans and cooling equipment.

Comfort and quality in a building can improve by passive solar design mainly in terms of increased daylighting, which is generally considered to be better for occupants well being than artificial lighting. Passive solar heating is mostly of use in houses and, as long as overheating is avoided, occupants normally find them more pleasant to live in. Natural ventilation is liked by some office occupants compared with air-conditioned spaces, but this is not universal.

Passive solar buildings need careful design to be successful. For example, the sun can produce overheating and natural ventilation can lead to conditions that are too hot or cold and lead to poor indoor air quality. Daylighting can produce glare that causes problem for workers particularly using computer screens. As well as design of the components themselves, control systems need careful design and operation. Care must also be taken to achieve an integrated design and ensure that the benefits in one area do not cause problems in other areas, for example daylighting design leading to larger windows with consequent heat loss in winter and gain in summer.

2.1.3 TYPES OF PASSIVE SOLAR DESIGN

Passive solar heating is mostly applicable to dwellings and to a lesser extent to schools and similar use buildings. In buildings such as offices, solar gain comes at a time when it is likely to cause overheating, since many buildings have internal heat gains when occupied that provide or over-provide the heating demand.

In dwellings the following can be used to maximise solar gain: -

- Orientate buildings to face within 45^0 of south;
- Avoid overshadowing by adjacent buildings by designing distances between buildings where possible to allow the penetration of low spring and autumn sun;
- Adopt an internal arrangement which places living rooms on the south side and bedrooms and service spaces on the north;
- Locate larger windows on the south façade, and smaller ones on the north (but not so small to compromise daylighting);
- Fit thermostatic radiator valves to the heating system, to optimise the use of solar heating;
- Glazed balconies and sunspaces can be used on south sides to collect solar gain but must be unheated and separated from the living space by windows, otherwise more heat will be lost then gained.

For schools and similar uses where overheating is unlikely, similar rules can be followed. In offices, some solar gain in the mornings may be useful but generally it is not worthwhile to design for this.

Daylighting design is most important in non-domestic buildings, as in dwellings normally building depths and window sizes give adequate internal daylighting to rooms. In all other buildings, design to increase the amount and distribution of daylighting both gives more pleasant interiors and saves energy, as long as artificial lighting controls respond to actual light level demands.

Good daylighting design will include the following: -

- Buildings should have a depth not exceeding 16 metres between facades, to allow daylight to penetrate to the centre;
- Windows should be placed high in the facades to allow daylight penetration, and the bottom metre of the façade should not be glazed, as this gives little daylighting gain to the room whilst the extra solar gain can cause overheating;
- Light shelves placed internally can give better internal distribution of daylight by reducing light levels close to the window and reflecting light further into the room. External light reflecting shelves can increase daylighting into the building. Separation of windows into upper "daylight" windows and lower "vision" windows using light shelves can be used to improve daylight distribution;
- Roof lights are very effective in corridors and rooms on top floors, but unwanted solar gains must be carefully considered;
- Light internal painting will increase internal lighting;
- Artificial lighting controls must switch off or dim lighting when daylighting provides sufficient light;
- Internal atria and light wells may be used to allow daylighting into the centre of buildings;
- "Sun pipes" are devices which funnel daylight into buildings and can be used in specific situations;
- "Borrowed" light, provided by glazing between rooms and corridors, may allow daylight into areas without their own windows to outside;
- Glare, particularly with respect to computer screens must be carefully considered in all daylighting design.

Solar shading is important in non-domestic buildings to avoid or reduce overheating, and this is usually considered as part of "passive solar design".

Shading against solar heat gain should consider: -

- Shading on east, south and west facades. East and west facades are more difficult due to the low sun angle and vertical devices should be considered, whilst conventional horizontal shading is effective for south facades
- External shading keeps the heat outside the building, and moveable devices which adjust to sun angle are most effective, but costly in both provision and maintenance;
- "Interpane" shading, where a Venetian type blind is encapsulated within the (triple) glazing system, can be effective and durable.
- Internal blinds, while stopping direct sun coming into the building, will only reflect some heat out, with much staying within the building;
- Shading must not compromise daylighting entering the building, making adjustable systems, particularly automated mechanical systems most effective.

Thermal mass can be used both to store solar heat if needed or alternatively to absorb unwanted internal heat gains and thus reduce temperatures. Typical uses of thermal mass in buildings are: -

- Solid walls and floors in dwellings can warm up during the day, when solar heat enters the building, and give out the heat in the evening;
- A strategy to use thermal mass in a non-domestic building, particularly an office, includes solid floors, exposed concrete ceilings and possibly heavy weight walls, which are cooled using cool night air drawn through either by natural ventilation or mechanical means. During the daytime, the cool mass absorbs internal heat gains, reducing the need for active cooling. A "night cooling" strategy requires burglar proof openings and careful control to avoid overcooling of the structure.

Natural ventilation using wind pressure and stack effects to move air through a building can be a part of a passive solar design in non-domestic buildings.

Typical features of passive ventilation strategy are: -

- Adjustable “through the wall” vents, accessed via the radiator heating system, can allow wind driven low level ventilation in winter and can be augmented by opening windows in summer for the greater air flows necessary for cooling;
- Central atria can be used to extract used air if temperatures at the top of the atrium can be maintained higher than external temperatures, thus using the stack effect to draw air through the building. Fire risks need to be carefully considered;
- Automated control systems may be needed to maintain comfort under different conditions, and back-up extraction fan systems are useful for windless days and for peak temperature conditions.

2.1.4 CASE STUDIES

(a) The Queens Building, Anglia Polytechnic University, Chelmsford, Essex. This university building comprising offices and lecture and student facilities was constructed in 1996 near the centre of Chelmsford. It was based on natural ventilation using two central atria to extract exhaust air. Inlet air was via manually controllable through-the-wall vents into peripheral heating plenums. Exposed coffered concrete ceiling slabs formed the basis of the night cooling strategy, which operated by natural ventilation, again using the central atria for the exhaust air. Triple glazed windows were provided, including interpane venetian blinds between the outer single glazing and the double pane inner glazing. Double light shelves assisted the daylighting strategy, together with the two atria and an artificial lighting control system. Other energy saving features were high fabric insulation levels, compact design and condensing gas boilers.

Overall, monitored energy consumption was reduced by 68% compared with a comparable air-conditioned building, an annual saving of 285kWh/m^2 of usable floor area.

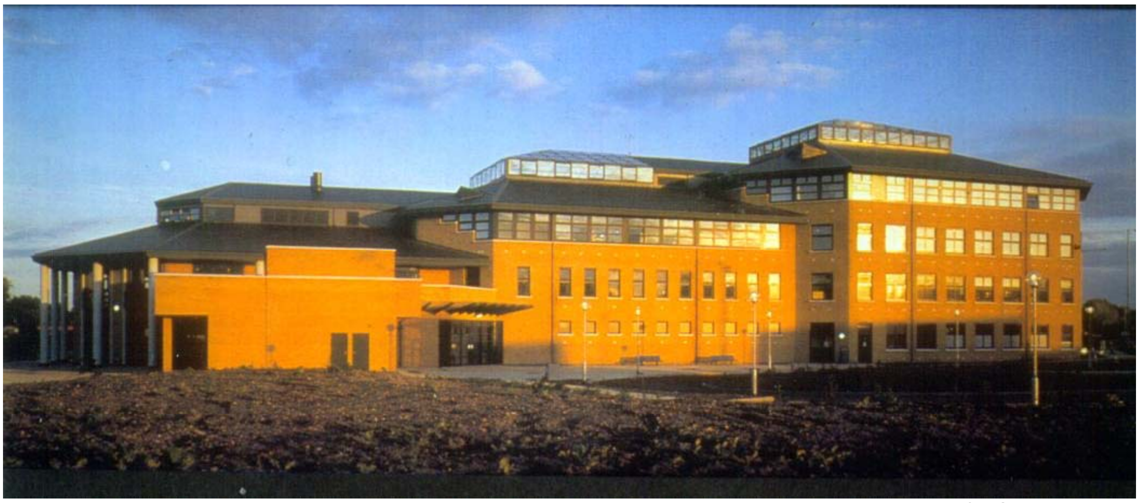


Photo courtesy of ECD Architects

(b) Christopher Taylor Court, Bournville, Birmingham. This sheltered housing project provides 42 flats for elderly people. The building was designed so that most of the flats are in east/west terraces, with windows and glazed doors on the south side. Glazed mass walls were also provided on the south sides to collect solar heat (“Trombe walls”). Corridors on the north sides insulate the living rooms and they themselves are daylight. Dual use insulated sliding shutters reduce heat transfer from the mass wall when not required, and insulate the glazing and expose the mass wall when required. External shading devices were included to stop overheating in summer.

Monitoring showed an overall 10.5% solar contribution to the space heating demand, a useful contribution bearing in mind that the heating was supplied all day and night, maintaining an internal temperature of nearly 23^{0}C.

Photo courtesy of The Bournville Trust

2.2 SOLAR THERMAL

2.2.1 WHAT ARE SOLAR THERMAL SYSTEMS?

Solar thermal systems, or solar hot water systems use the energy from the sun to heat water, most commonly (in the UK) for hot water needs. The systems use a heat collector, generally mounted on the roof in which a fluid is heated by the sun. This fluid is used to heat up water that is stored in either a separate hot water tank or a special hot water tank inside the building, which has twin coils (or heat exchangers). Ideally the collectors should be mounted on a south-facing roof, although south-east/south-west will also function successfully. Solar systems work very successfully in all parts of the UK, as they can work in diffuse light conditions.

2.2.2 BENEFITS OF SOLAR THERMAL SYSTEMS

Solar thermal systems can provide a percentage of a household's hot water needs, therefore saving money on fuel bills and associated emissions. Research shows that for a standard size panel ($4m^2$) the contribution in domestic situations is between 20% and 80% depending on the quantity of hot water required and the timing of that requirement. The percentage can be increased if:

- Hot water is drawn off during the day, allowing more water to be heated up in the afternoon
- Low flow showers and spray taps are fitted so that less hot water is required
- Showers are taken instead of baths.

The system is particularly beneficial for dwellings where residents are at home during the day, for example, young families or the elderly who are likely to need hot water during the day for washing and bathing.

Solar water heating is less common in commercial buildings except where there is a demand for low temperature hot water.

2.2.3 TYPES OF SOLAR THERMAL SYSTEMS

There are two types of collectors used for domestic hot water applications - flat plate collectors and evacuated tube collectors. The flat-plate collector is the predominant type used in solar domestic hot water (DHW) systems as they tend to be cheaper. Evacuated tube collectors are generally more expensive than due to a more complex manufacturing process (to achieve the vacuum) but manufacturers generally claim better winter performance.

Flat plate collectors

A typical flat-plate collector consists of a rectangular surface (absorber) with a series of tubes running along it. Liquid (generally water containing anti-freeze) from the storage tank flows through the tubes. The absorber is usually composed of a good conductor material, such as copper or aluminium, and is coated black to absorb as much sunlight as possible. As the plate is heated, by exposure to sunlight, it transfers the heat to the liquid in the tubes. The bottom and sides of the absorber are insulated to minimize heat loss and a translucent glass or plastic cover placed above it allows sunlight to reach the absorber while reducing the amount of heat that can escape. Selective coatings on the cover and/or absorber plate help to maximise energy capture and minimise losses by radiation from the absorber plate.

Evacuated or vacuum tube collectors

Several makes and designs of evacuated tube solar collectors are available. The system involves a solar absorber plate within a glass vacuum tube. Heat is transferred from the absorber plate to the working fluid by means of a heat pipe that has a high heat conductivity (i.e.: transfers heat very quickly). The vacuum eliminates heat losses from the tube, resulting in higher energy gain being available and the glass tube protects the absorber plate from the external environment. Water circulates from the storage tank and picks up the heat collected by the tubes and back to the storage tank.

Solar thermal systems for DHW heating use a single hot water cylinder that has two coils or two separate cylinders. In the two-coil cylinder, the lower coil acts as a heat exchanger between the solar collector and the DHW system. The second coil acts as a heat exchanger between the backup boiler and the DHW system. When two separate cylinders are used, one is fed by the solar collector and this acts as a preheat cylinder for the main cylinder.

2.2.4 CASE STUDIES

Domestic systems

The **Integer Greenfields Site in Maidenhead** is a mixture of four storey maisonettes and two storey terraced houses of mixed tenure with a large open recreation ground and a children's play area. The houses have been laid out to benefit from passive solar gain from their south-west elevation. They have green alpine sedum roofs to manage rainwater run-off and to act as a mini-habitat for wildlife and photovoltaic panels. Eight of houses also have flat plate AES solar water heating systems to back up the conventional gas boilers. Fifteen of the houses have a mono crystalline bolt-on PV system of 1-1.8 kWp. The first monitored quarterly fuel bills were only £10 in total.

Gardstens Bostäder: Gardsten, SWEDEN
255 apartments, contained within 10 buildings have been refurbished as part of a Thermie project in Gardsten north of Gothenburg. On 3 buildings, prefabricated roofs with 250m^2 integrated modular solar collectors are being used to preheat domestic hot water for all flats. One building has been refurbished with solar air collectors which distribute solar heat to the north, south and west walls via the insulated double envelope wall. The wall also has the benefit of protecting deteriorated structural joints from rain and wind, and provides additional thermal insulation. Buildings with exhaust air ventilation will utilise preheated air from glazed balconies, whilst those with whole house ventilation will be equipped with air-to-air heat exchangers. Large community greenhouses, where all tenants can grow their own plants have been built on the south facing facades. *(Photo courtesy of Christer Nordstrom, Arkitektkontor AB, Shine project)*

Hyde Housing Association: Greenwich

Hyde Housing Association has refurbished two Victorian terraced houses (late 19th century) one Edwardian house (early 20th century) and a number of other houses in Greenwich. Insulation in the houses has been improved by using internal dry lining systems and installing secondary double-glazing. Domestic hot water is preheated by a solar system with the make up heat and space heating provided by condensing gas boilers. Daylight levels on the upper floors will be improved by installing light tubes.

Commercial Systems

Leicester City Council is using an active solar heating system to help meet the energy needs of Phoenix House, one of its major office buildings. In 1997, to supplement a new gas-fired condensing boiler, an evacuated-tube solar collector was installed on the roof. It is used to pre-heat water from the mains temperature of 3-10ºC up to a maximum of 45ºC. Payback on the additional cost of the whole system was achieved, via reduced gas bills, in less than 3 years. The system is connected to the Council's computerised BEMS that monitors energy consumption and water temperature on the Council's site remotely.

Photo courtesy of Leicester City Council and Leicester Energy Agency

Josiah Wedgwood & Sons' visitor centre
Filsol have installed a 22 square metre flat plate system for Josiah Wedgwood & Sons' visitor centre. This is visitors' centre for the Wedgwood factory in Stoke on Trent. The system feeds the washrooms and café. The system feeds two hot water cylinders. When the temperature in the first cylinder reaches 60C, thermostatic values operate to divert the hot water into the second cylinder. Once the second cylinder is at 60C, all values open to allow parallel loading of both until the maximum allowed.

Photo courtesy of John Blower, Filsol

2.3 PHOTOVOLTAICS

2.3.1 WHAT ARE PHOTOVOLTAICS?

Photovoltaic (PV) systems convert energy from the sun into electricity through semi conductor cells. PVs supply electricity to the building they are attached to or to any other load connected to the electricity grid. Electricity is usually fed into the grid when the generated power exceeds the local need. PV systems can be off grid but it is unlikely any systems installed in Eastside would be of this type. More electricity is produced with more sunlight, but energy can still be produced in overcast or cloudy conditions, so PVs can be used successfully in all parts of the UK, including the Midlands. Photovoltaic panels can be fitted to existing buildings, designed into new buildings or attached to individual items such as street lights, parking meters or the sides of bridges. Ideally PVs should face between south-east and south west, at an elevation of about 30-40° however in the UK even flat roofs receive 90% of the energy of an optimum system.

2.3.2 BENEFITS OF PHOTOVOLTAICS

Incorporating photovoltaics into a development will enable the building to produce a percentage of its electricity for free, without the emission of greenhouse gases. These are clearly two important benefits but as a technology it has a number of others:

- No moving parts and therefore require little maintenance
- No emissions in use
- Easy to install as modular and light
- Technically reliable – they are generally guaranteed to last between 10-25 years but are expected to last longer. BP Solar offers a power warranty of up to 25 years.
- Avoidance of climate change levy for non-domestic buildings
- Helping to meet national, regional or even local renewable energy and carbon dioxide emission targets
- PV produces electricity at point of need so energy is not lost moving it from one place to another
- One of the few renewable technologies that can be used very successfully in urban areas
- Architectural integration – PVs can be added almost invisibly to buildings, can be used as a design element or can lead the architectural concept of a building
- Cost savings – although PVs generally add to the cost of a building, if a façade is clad with PV replacing a prestige cladding material such as marble, savings can sometimes be made
- Marketing impact – a clear statement about renewable energy

There are still some major disadvantages with PVs – the major one being high cost. They are also still a relatively novel technology so that there are not many architects, engineers, electricians or roofers with much experience of them. This means that projects involving PV will be new to many on site and therefore possibly more time consuming and problematic than without.

Before considering fitting a PV system, the energy efficiency of the whole building should be considered. There is no point in fitting an expensive PV system to a building that is wasteful of energy in other areas. If the project is a refurbishment, improving the heating system and the insulation should be considered before fitting PVs. If the project is new build, all aspects of building energy use should be considered, including layout, insulation, heating system, lighting and window types, before considering the PV system.

2.3.3 TYPES OF PHOTOVOLTAICS

PV cells come in a number of types with varying operating efficiencies in differing conditions with different costs attached:

	Efficiency	Cost	m^2 required to mount 1kWp*	Other info
Mono-crystalline silicon	15%	Expensive due to the manufacturing process a pure single crystal of silicon is drawn from molten silicon and is then sawn into wafers	$8m^2$	Can only be manufactured in batches so this technology is not ideally suited to mass production
Poly-crystalline silicon	8-12%	Cheaper than mono-crystalline to manufacture as molten silicon is cast into blocks and then sawn into wafers	$10m^2$	Not well suited to mass production.
Amorphous silicon	4-6%	Cheap to manufacture as low temperatures are required and expensive sawing isn't needed	$20m^2$	Use very thin layers of material so is referred to as thin-film and can be deposited onto a backing material such as glass or plastic (which can be flexible)
Cadmium telluride and copper indium diselenide	7-9%	More expensive than amorphous silicon due to the low volume of production and expensive of the raw materials.		Both of these materials can be deposited as thin

*A kWp (kilo Watt peak) is the standard unit of measurement for PV systems. It refers to the peak power that the system can generate. A 1 kWp system is the typical size for a domestic installation.

2.3.4 TYPICAL CONFIGURATION

PV modules come in a wide array of configurations and can be fitted onto the roofs of buildings, onto facades, integrated into different building components and fitted to existing buildings. They are particularly suited to buildings that use electricity during the day – offices, retail and schools.

Photograph courtesy of IEA PVPS Task 7 CD Rom

The simplest option is to fit a modular panel to a flat roof, inclined at the optimum angle. These would be suitable for any flat roofed building such as offices, schools, retail or dwellings. This option can easily be retrofitted to existing buildings.

Photographs in this section are courtesy of IEA PVPS Task 7 CD Rom unless otherwise stated.

Systems can easily be fitted to sloping roofs facing south-west to south east, either integrated into the roof structure as slates or shingles, or bolted in modules to the top.

These would be suitable for offices, schools, retail or dwellings. This option can easily be retrofitted to existing buildings.

Systems can be integrated into the facades of buildings. Usually this is done with taller buildings that have smaller roof area, where the PV system can displace a more expensive cladding material. A highly visible system like this can make both an architectural and an environmental statement. These are most suitable for prestige office buildings.

Systems can be fitted to shading elements providing both shade and electricity. These modules can be stationary or track the sun. A small or large area can be covered in this way. These are suitable for offices and schools or any building used mainly in the daytime.

Photograph courtesy of IEA PVPS Task 7 CD Rom

PVs can be integrated into glass modules and used in atria or balconies as a feature.

Photograph courtesy of IEA PVPS Task 7 CD Rom

Invertors
PV systems produce DC current, which has to be converted to AC current using a piece of equipment called an invertor before it reaches the grid. The invertor can be the most problematic part of the system. Invertors must be set properly for the grid voltage (however this can be vary with the seasons) as too high voltage can cause the invertor to 'drop out' and the output will be lost.

The system will also require fuses, wiring, junction boxes, isolator switches, earthing and 2 electric meters to measure the electricity flow into and out of the building.

Photograph courtesy of IEA PVPS Task 7 CD Rom

Other applications for PV
PV systems do not just have to be used on buildings – they have also been successfully used on parking meters, bus shelters, motorway barriers and street lights. These tend to be cost effective options if mains electricity is not available. Coupling the system with energy efficient lighting (e.g. LEDs) will decrease the area of PV required. Vandalism can be problem, so generally the PV should be out of view or made as inconspicuous as possible.

Photo courtesy of Riesjard Schropp

2.3.5 INSTALLATION CONSIDERATIONS
What to consider when designing a Building Integrated PV system:

- Where on the building can the system be located?
- What size of system is required? How much power is required and how much funding is available?
- What type of modules would be appropriate?
- How is the module to be fitted to the building?
- How is the electrical system to be designed?

Software for sizing and simulating energy production from PV systems can be obtained from www.pvsyst.com. PVSYST software is the leading software package in Europe.

Site issues

The site should be the most appropriate for the optimum operation of the system:

- PVs should ideally face between south-east and south-west, at an elevation of about 30-40° (although flat roof installations will still operate at 90% of the ideal orientation and elevation). Systems should be in locations that will be unshaded at all times of day if possible. Gable roofs, chimneys, cables, TV aerials, trees and other buildings in the vicinity should be identified as potential shading the modules. Trees or other parts of the building may cause the performance of the system to drop in the early morning or early afternoon. Even a TV satellite cable hanging above the modules can have a very large impact on the performance of the system because of the electrical characteristics of PV modules. Shade reduces the output of the shaded cells, the shaded cells then have an increased resistance to the flow of electric current which reduces the flow of electric current through all the cells joined to that cell.
- PVs need to be ventilated (behind the modules) so that they don't heat up – their efficiency decreases as the temperature rises. Suitable ventilation is easier to ensure for bolt-on systems.
- If retrofitting systems to existing buildings, the system must be carefully positioned on the roof to take account of the loading capacity of the roof.
- The potential for vandalism should be assessed if the system can be seen from the ground or if it is accessible due to raised pavements or other buildings. Some times it is necessary to cover panels will heavy duty Perspex to protect them from flying objects.
- Care must be taken if the systems are to be fitted to social housing properties with pre-payment meters as some meters do not allow the export of electricity and can be damaged by attempted export.
- Cleaning – if the area is known for a bird population (e.g. seagulls) they may need to be discouraged from perching near the systems

Communication issues on site

There are a range of communication issues that should be borne in mind when trying to integrate a new technology into a building project. It is important to:

- Allocate responsibilities at an early stage of the contract
- Ensure well planned logistics
- Ensure good co-ordination between PV installers and the roofers and electricians involved in the project
- Ensure effective liaison with the DNO and electricity supplier.
- Ensure that tenants / owners of the building are given appropriate training and handover documentation in the operation of the system and the expected output so that problems with the system can be identified
- Clear labelling of the control boxes is important both for the DNO and the tenant/resident showing circuit diagrams, start up sequences, disconnection settings, contact details of the DNO and installer, dual supply warnings signs at both the meter position and at the consumer unit.

2.3.6 CASE STUDIES

Domestic systems

Broughton Leys – Milton Keynes

Broughton Leys is a development of 134 homes to the East of Milton Keynes. English Partnerships had developed a brief for the site that required innovative approaches to energy and environmental issues. The strategy developed included measures to reduce energy and water consumption, the use of more sustainable construction materials, careful layout of homes and roads to reduce the impact of cars and the setting of high energy and environmental targets including the requirement that all homes should achieve a National Home Energy Rating of 10.

The development team (Bloor Homes, English Partnerships, Solar Century and FaberMaunsell) secured a grant of £200,000 from the DTI's Domestic Building Integrated PV field trials programme. This has provided PV roofs on 17 of the homes with system sizes ranging from 1.6 to 2.9 kWp (total 37kWp), with an estimated annual electrical output of 32,280 kWh/year for the site. FaberMaunsell have a two year contract to monitor the performance of the systems including grid connection issues and the knowledge gained will feed into the advice given on future projects.

BedZED[2]

BedZED is a mixed-use scheme in South London comprising 180 homes and 2500m^2 of commercial or live/work space. Heat, electricity and water demands have been greatly reduced through for example, highly insulated building fabric, a biomass fuelled CHP system, triple glazing and PVs. BedZED has 777m^2 of PV panels integrated into the building fabric within double glazed roof lights and vertical glass units in south facing balconies and as PV laminates installed as roof mounted units. They generate 108,000kWh of electricity per year, which displaces 46 tonnes of CO_2 emissions. The cost of the PV modules themselves was £339,700. The installation and associated fixings was an extra £186,948.

In Surrey, **Woking Borough Council** has invested in car park pay-and-display machines powered by PV cells. The first 14 of these machines, installed in 1997, were easy to install and have operated trouble-free ever since. PV pay-and-display machines were preferred to "conventional" grid-connected ones partly on the grounds of their lower capital cost (taking avoided grid connection costs into account). Lower running costs are another advantage: employing PV in this way avoids the need to buy over 2000kWh/year of electricity from the grid.

Commercial

Sainsbury Millennium Store

This is a 5,500m2 retail store on the Greenwich Peninsula, located in the Greenwich Millennium Village. It is a low energy building with natural lighting controlled by externally mounted louvres designed to rotate depending on light levels. It has mainly natural displacement ventilation controlled by dampers, underfloor services for heating, ventilation, refrigeration pipework, electricity and communications and small scale wind turbines and photo-voltaic cells for powering external signage. The heating is supplied by combined heat and power plant and cooling from cold water drawn from ground boreholes.

Jubilee Campus, Nottingham University[3]

© Arup/Paul McMullin

The aim of this new campus for Nottingham University is to be a model of sustainable development for the Region. Its purpose is to reduce carbon dioxide emissions by 70%, raise awareness of environmental issues amongst students and within the field of tertiary education, and demonstrate the viability of sustainable industrial regeneration. Funding assistance of £0.75M for the low-energy building specification and solar-powered ventilation strategy was gained through the European Union's THERMIE programme as a demonstration project in 1998.

A mixed-mode low pressure mechanical system with heat recovery was selected to give better energy performance than solely natural ventilation. An early decision was taken to use photovoltaic power generation to drive the ventilation of the building when there is insufficient pressure differential to operate the purpose-designed rotating wind cowls and drive the air through natural convection. The PV cells are an integral part of the atria roofs within the school of management, the department for computer science and the faculty of education. They provide shading to the spaces below and replace the glazing system with laminated glass panels with integrated square PV cells. There are 450m2 of array.

[2] Beddington Zero (Fossil) Energy Development - Toolkit for Carbon neutral developments – Part II, Bioregional

[3] Detail taken from IEA, PVPS Photovoltaics in the Built Environment CD Rom

DTI PV solar grants programme examples[4]

Alexander Stadium, Birmingham
The PV roof for the Alexander Stadium received £270,000 funding from the DTI PV solar grants programme and £70,000 from Npower. This is a 102 kWp grid-connected installation and is the UK's largest solar roof covering 1500m$^{2.}$ 80MW/yr is the estimated generation. The centre is predicted to generate more electricity annually than it uses and the excess will power other buildings on the site.

Leicester City Council, East Midlands
Leicester City Council have progressive policies on energy efficiency and renewable energy including halving their current energy consumption and using renewables to supply 20% by 2010. As part of their strategy for achieving this they are setting up a number of photovoltaic demonstration projects. The grant is for a 29.4kWp photovoltaic system at the Leys leisure centre consisting of Unisolar modules. The project received a grant of £111,461 from the DTI PV solar grants programme.

Tesco, Nottingham, East Midlands
Tesco are developing a new petrol station in Nottingham that will incorporate a 15.84kWp photovoltaic system consisting of Sharp monocrystalline modules on the petrol station roof. Tesco is currently evaluating energy use throughout their stores and has introduced many energy saving measures and envisage using wind turbines and CHP where applicable. The project received a grant of £35,686 from the DTI PV solar grants programme.

Ormiston Wire, Middlesex - Headquarters of Ormiston Wire
Ormiston Wire Ltd is a small and medium enterprise employing twelve people in the manufacture of wire for a range of applications including puppets and suspension harnesses. The company has been established for 210 years and in 1991 moved to a new site in Middlesex where they have introduced a large number of energy efficiency measures including the installation of energy efficient light bulbs, high efficiency condensing boilers and plastic skylights. Recently they started sourcing the electricity used on a green tariff and now want to develop their own on-site clean, electricity generation. The photovoltaic system will consist of
10.2kWp of monocrystalline modules mounted on the roof of the building. Further plans include the installation of a 5kW wind turbine to the roof of the building. The project received a grant of £23,121 from the DTI PV solar grants programme.

[4] http://www.est.co.uk/solar/

3. EASTSIDE AREA ANALYSIS

3 Eastside area analysis

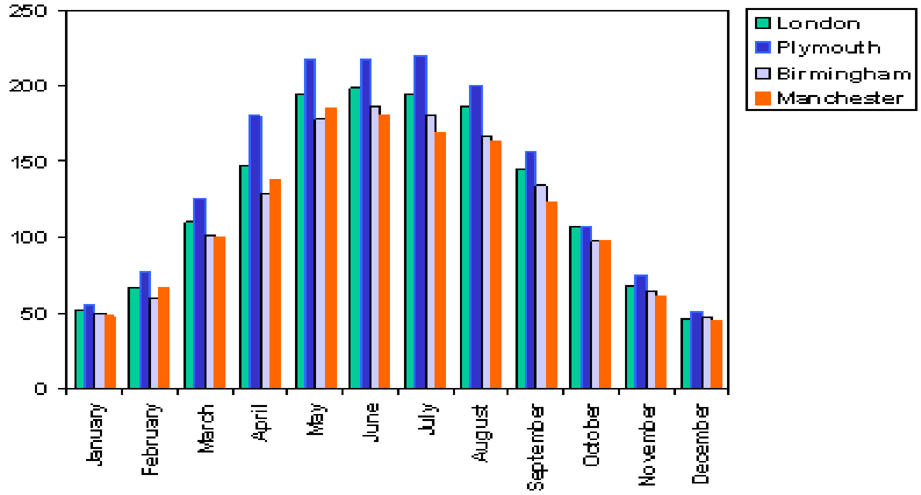
This section analyses the environment and its suitability for solar and the relevant national and local planning implications. This information is interpreted in sections 4 and 5.

3.1 EASTSIDE ENVIRONMENT AND SUITABILITY FOR SOLAR

For solar technologies, the number of hours of sunshine of day and the temperature is important. The figures below should be encouraging for anyone considering using solar technologies in the Eastside area.

The graph below shows that the 30-year average of bright sunshine for Birmingham for the summer months was approximately 170 hours a month. This is sufficient for all types of technology described in this report to be utilised successfully.

30-year (1961-90) average monthly duration of bright sunshine in hours for selected stations[5]



The following figures give the mean temperature and hours of sunshine a day for 2003 and 2004 for the Midlands region[6]. This shows that mains water is going to be heated above normal mains temperature (3-10°C on average) throughout the year, due to at least 2 hours of sunshine a day. Systems will be particularly successful during spring and summer months that have had, on average, over 5 hours of sunshine a day for the last 2 years in the Birmingham area.

Period	Mean temperature (C)	Sunshine (hrs/day)
Winter 2001/2	4.8	2.07
Spring 2002	9.1	5.17
Summer 2002	15.4	5.35
Winter 2002/3	4.7	2.23
Spring 2003	9.4	5.74
Summer 2003	16.9	6.34

Some of the Eastside development (southwards from Jennens Road) is on a south facing gentle gradient. Further details on the gradient can be obtained from Dave Koszary (0121 303 3867). Orientation and slope should not have significant impact on the solar performance of a building, as long as the buildings and any solar technologies are orientated in the optimum manner. Gradient may have an impact depending on the height of surrounding buildings due to possible shading of the systems.

3.2 NATIONAL AND LOCAL PLANNING IMPLICATIONS

There are a number of planning documents that need to be considered in relation to renewable energy technologies.

The chapter on energy in the Regional Planning Policy Guidance note 11[7] states: *There are two main energy dimensions to RPG; reducing demand for energy and facilitating the provision of renewable energy.* It states that RPGs should promote energy efficiency both in the pattern of development proposed in the spatial development strategy and in the more general advice it may set out for the preparation of

[5] http://www.met-office.gov.uk/climate/uk/location/england/sunshine.html
[6] http://www.metoffice.com/climate/uk/index.html
[7] http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_606926.hcsp

development plans and assist in the delivery of renewable energy targets set in Regional Sustainable Development Frameworks.

The Government's national planning policy with regard to renewable energy is set out in Planning Policy guidance note (PPG 22): Renewable Energy which gives local planning authorities guidance on a range of issues that affect the siting of all renewable energy projects. In April 2002, an annex to PPG 22[8] on photovoltaics was published which offers guidance on the basic technology, electrical connection and location and design. The Government has just issued a consultation on draft new planning policy guidance statement 22[9] (PPS 22) that will in due course replace PPG 22. The consultation is due to close end of January 2004. Its scope is limited to consideration of planning issues relating to renewable energy projects rather than broader issues such as the use of renewable energy, or the need to incorporate renewable energy equipment, in new housing or industrial/commercial developments.

Particular planning issues for solar technologies
Planning issues relating to solar thermal systems and PVs include conservation areas/listed buildings, visual impact of the technology and material alteration of the building.

The local planning authority (LPA) needs to decide whether or not a solar thermal system or a PV system would have a visual impact on the area. If this was thought to be the case, but the authority wanted to grant permission, the authority can impose conditions to prevent or decrease the likely impact. Both solar thermal and PV systems can be integrated into the roof itself, and PVs now come in a range of colours to help them blend in with existing roof tiles in the surrounding area. If the LPA decides that the systems would not make a visual impact, planning permission is not required. For the installation of a solar thermal or PV system on an existing building, the LPA must decide whether the system would be a material alteration of the external appearance of the building. If the LPA considers it would not be a material alternation, planning permission will not be required.

Listed buildings are likely to require an application for listed building consent even if specific planning consent is unnecessary. Each case must be assessed on its merits. When considering planning applications in conservation areas, LPAs must consider the possible impact on the character or appearance of the area.

If a planning application is refused permission, or if the LPA has not determined the application after eight weeks, there is a right to appeal to the Secretary of State.

Local planning documents relevant for Eastside
The Birmingham City Council Sustainability Strategy and Action Plan states that: *Sustainability Assessments are now carried out on all planning applications and form a key consideration in their determination. More detailed guidance on sustainable development is being included in local planning frameworks and other planning guidance as appropriate.*

Birmingham's DRAFT Unitary Development Plan mentions sustainable design principles which includes reference to passive solar and renewable energy: *The orientation, external and internal design of buildings, and use of landscaping, should maximise the use of natural heat and light, contribute to local biodiversity and minimise the use of non-renewable energy sources. The use of renewable energy sources will be actively encouraged. This should not, however, be at the expense of good urban design.* More detail on this area will be given through a Supplementary Planning Document (likely to have Supplementary Planning Guidance status) which is currently under development. It is thought that the Development Plan will be adopted sometime next year (after the Regional Planning Guidance due to be published in the Spring).

The BCC Sustainability Strategy and Action Plan also refers a number of times to use of renewable energy including the need to encourage greener building design in Birmingham, especially for major development and also the need to invest in renewable generation of power in the City. The Plan states that: '*Developers will be encouraged to incorporate green building design principles in building projects and refurbishments. In addition, the Council will identify major public and private sector developments as energy demonstration projects, to promote innovation in design and construction to achieve sustainable modern development and raise awareness of good practice.'*

The Eastside Development Framework states that *'sustainable developments incorporating innovative fuel technologies and materials will be particularly encouraged'*.

The City Council is therefore corporately encouraging renewable energy solutions including PVs and reference to the above documents could be made in planning applications as support for the technologies.

The Planning Department granted planning permission for a PV roof for the Alexander Stadium which received £270,000 funding from the DTI PV solar grants programme and £70,000 from Npower. This is a 102 kWp grid-connected installation and is the UK's largest solar roof covering 1500m$^{2.}$ 80MW/yr is the estimated generation. The centre is predicted to generate more electricity annually than it uses and the excess will power other buildings on the site.

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8 http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_606909.hcsp
9 http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_025517.hcsp

A few other planning application permissions have been given across the City to householders for small schemes. David Ward in Strategic Planning says they are enthusiastic about renewable technologies in the City.

Listed buildings and conservation areas
There are some listed buildings in the Eastside area, for example in the Digbeth, Deriten and Bordesley high Streets Conservation Area and in the Warwick Bar Conservation Area. The Curzon Street viaduct and Curzon Street Station are also listed. The grid iron street pattern surviving in parts of Digbeth is the produce of 18th and 19th century industrial growth and a proportion of the buildings in this area will remain.

Steven King (0121 464 7793) in Conservation Planning of BCC says that their department has not had any experience of dealing with technologies such as photovoltaics or solar thermal systems and they know very little about it. Understandably he thought they would be likely to be suspicious in the first instance so it will therefore be very important to involve their department at a very early stage if there are plans for installations on buildings in conservation areas. This will save time and money on unsuitable designs being developed. Photographs of the types of systems available should be made available at an early stage. It is suggested that particularly in the case of PV, an 'invisible' design may be preferable to one that is making an architectural statement in a conservation area, or one that is invisible from street level, such as on flat roofs. Installations on any of the historic buildings are unlikely to be favoured. See sections 2.2 and 2.3 for details of systems on flat roofs (which cannot been seen from the roof), integrated into roof tiles and facades.

It is always worth engaging at an early stage with planners where new technologies are to be used in a development, particularly if they are not familiar with them. The benefits of the systems should be demonstrated as well as the rational behind the architectural approach (e.g. is an effort being made to integrate the systems invisibly into the roof line or are the systems being made a distinctive feature to add to the technological aspirations of the area)

Summary of planning policy issues:

- There is support for renewable energy technologies in national planning guidance
- There is support for renewable energy technologies in local documents such as Birmingham City Council Unitary Development Plan and the Sustainability Strategy and Action Plan
- This support can be referred to in planning applications that include renewable energy technologies.
- Planning permission may be required in some instances for solar thermal and photovoltaic systems.
- Early dialogue with the planning department is advised, particularly if installations are planned in conservation areas.

4. COST BENEFIT ANALYSIS

4 Cost Benefit Analysis

This section looks at the costs of the three technologies and their associated energy and carbon savings.

4.1 PASSIVE SOLAR

4.1.1 CAPITAL COSTS

The capital costs of passive solar design are usually zero or low, since they mostly entail a design philosophy and reorientation, rather than additional components.

In housing, design for solar heat gain normally carries zero additional costs. Glazed balconies and sunspaces do have additional costs but are normally provided as amenities and should not be justified on the basis of solar heating, since the energy benefits are likely to be minimal.

In non-domestic buildings, sophisticated passive solar design can incur extra costs but may equally reduce overall capital costs, as cooling and ventilation systems may be eliminated or reduced in size. Basic daylighting design will have no additional costs and lighting control systems should be a part of normal energy efficient design. Solar shading, particularly external and automated systems, will incur costs but should reduce plant size and is often nowadays seen as a part of façade design. Thermal mass strategies cost little unless fair faced concrete ceiling finishes are used for exposed surfaces. The cost of suspended ceilings may be avoided, or their design may be modified to include use of thermal mass. Natural ventilation solutions will be cheaper than providing air-conditioning equipment. Atria are normally included for building design and use reasons and the additional costs to incorporate them into a passive ventilation strategy will arise only from roof opening and control mechanisms.

4.1.2 ENERGY SAVING

Energy savings from passive solar design vary greatly and it is difficult to quantify the “solar “ contribution separated from the general and interrelated savings from energy efficiency measures.

In new housing the additional contribution of passive solar heating is likely to be as low as 10% of the space heating demand, or around 250 kWh per year, as much of the available solar contribution comes in summer when space heating is not used. Also, compliance with current Building Regulations means that space heating demands are low (compared with older housing) and thus the energy saved by adopting a passive solar heating strategy will be small. This is likely to be true especially in flats - the majority of the housing to be built in Eastside. However for a large (75m^2) two bed top floor flat, the difference in space heating demand could be as high as 1000kWh (25% of demand) per year, when comparing a highly glazed south facing flat with a similar north facing one.

Adopting a full package of passive solar measures in non-domestic buildings, will give much greater energy savings. An effective daylighting strategy can reduce artificial lighting demand by at least 50% and passive ventilation will reduce electricity demand for fans, pumps and cooling equipment needed for air-conditioning, by between 40 to 80 kWh/m^2 (based on “Design Guide 19” as below).

The Government “Design Guide 19” for energy consumption in offices shows that annual overall energy consumption varies between 130 and 400 kWh/m^2, for a “good practice” naturally ventilated office and a “typical” air-conditioned standard office, much of which can be attributed to passive design.

4.1.3 MAINTENANCE

Maintenance of passive solar systems is minimal as there are no or few mechanical systems. The main areas of maintenance are moveable external shading systems and fans for back-up to natural ventilation and for night cooling.

4.2 SOLAR THERMAL

4.2.1 CAPITAL COSTS

Domestic installation
The table below gives prices for a selection of solar water manufacturers products included likely reductions for bulk purchases. Prices below are quoted on the basis of installation in a 4-person house.

Collector name	Price (£) for single installation	VAT	What is included in cost? - Summary	Reduction for more than one-off
Flat Plate Type				
AES solar collector	£2,500.00	+5%	Complete system installed & commissioned	Yes - down to £1500-1600 for multiple installations (quote based on 200)
Filsol panel	£1,700.00	+ 5%	Complete system	Yes – negotiable
Filsol panel	£840	+ 5%	Just the panel	
Solartwin	£2,699	(inc 5%)	Complete system installed	Yes – about 10% reduction but negotiable for larger installation
Solartwin	£1,899	(inc 17.5% VAT)	DIY Installation	
Evacuated Tube type				
Thermomax	£3,500	Inc (5%)	Fully installed	Enquire
Thermomax	£2,850	Inc (17.5%)	Kit based system	Enquire
Suntube & Turbosun	£3,000	ex.	Complete system installed	Substantial reduction negotiable for larger numbers. Also note: Riomay are the suppliers and this product has BSEN12975. For private developers, Enhanced Capital Allowances can also be claimed

Please note: The list of suppliers and manufacturers is by no means exhaustive, but is a representation of the main types of systems available on the UK market, and includes quality assured systems.

Commercial systems
In terms of costs, most larger systems (such as the Filsol's Wedgewood Visitor Centre system example) utilise unvented hot water storage (rather than header tanks) which is obviously a factor in system prices. There can also be a large variation in the costs of installation labour, pipe-work, fittings etc which relates to site specific issues. Probably the most important issues are the relative locations of the solar collectors and the hot water storage (obviously the closer together they are the shorter the pipe-runs), the degree of complication in running the pipe-runs from the collectors to the hot water storage (i.e. is there an obvious route for the pipes) and the ease (and costs) of establishing safe working access on the roof area where the collectors are to be mounted. The interface between the solar suppliers/installers and the main contractors can also be a significant factor in determining cost (where the main contractors can add a significant fee for their role in co-ordinating works).

Unvented large system costs (for installed systems) based on flat plate solar collectors probably start at around £700 per square metre but can be higher due to factors such as those listed above.[10]

4.2.2 ENERGY SAVING

An example household of 2 adults and 2 children in a 2-storey building with an area of $68m^2$ has a flat panel collector of $4m^2$ (the most common size specified for this size of dwelling). The hot water demand of this dwelling is approximately 1800kWh and the theoretical contribution from a panel is approximately 800kWh giving a contribution of approximately 44%.

Solar water heating is a very cost effective option for single domestic applications but would be less cost effective for Eastside where the residential buildings are likely to be blocks of flats. Solar water heating can be used in flats if the services are designed to accommodate them. The cost-effectiveness of solar

[10] Information supplied by John Blower, Filsol T: 01269 860229

water heating for this type of development would depend on the available roof area and the type of heating system to be specified. The carbon savings made depends on whether the solar water heating system is replacing a gas hot water system or an electric hot water system. The savings from gas (using the above figures) would be approximately 152 $kgCO_2$ (based on 0.19 $kgCO_2$ per kWh of gas[11]) and 344 $kgCO_2$ (based on 0.43 $kgCO_2$ per kWh of electricity[11]). This would be per dwelling.

Under the Home Energy Conservation Act (HECA) 1995, local authorities in the UK with a responsibility for housing have a duty to prepare a strategy to improve domestic energy efficiency by 30% over 10-15 years, and to report annually on progress. Savings produced by the installation of solar water heaters are eligible for inclusion in HECA progress reports. By saving approximately half the hot water fossil fuel heating requirements, a solar water heater can improve an individual household's energy efficiency by around 12%. Thus, any programme to increase installation of solar water heaters can contribute to HECA targets.

Estimated cost saving
Where the solar water heating is supporting a gas heating system, based on a cost of 1.5p/kWh for gas, the cost saving would be approximately £12 per year for a 4m2 panel and an average family.

Where the solar water heating is supporting an electric heating system, based on an on-peak electric cost of 7p/kWh, the cost saving would be approximately £56 per year for a 4m2 panel and an average family.

4.2.3 MAINTENANCE ISSUES
Solar water heating is a comparatively simple system and so could be installed by any plumber but it is recommended that local plumbers be specially trained on how to install the systems to ensure they are installed correctly. Often solar water companies that both provide panels and carry out installations will train up local plumbers to complete a large job. Various organisations offer training for plumbers.

Home owners with a solar system should be prepared to give the system (or pay for) an annual maintenance check (just like a gas boiler) checking that the collector surface is clean, there is no corrosion, sensors and fixings are properly in place etc. Occupants should be instructed what a correctly operating system looks like so that they can detect and report faults. If the system is operating satisfactorily, the annual check may not be necessary although it is advised. Other organisations with solar thermal systems, such as housing associations, must also be prepared to carry out an annual maintenance check.

4.2.4 REGULATORY ISSUES
There are few regulatory issues relating to solar water heating, however in a conservation area there may be planning issues (see chapter 3). Many of the flat panel collectors can be integrated into the roof to look like roof lights, which substantially reduces their visual impact.

4.3 PHOTOVOLTAICS

4.3.1 CAPITAL COST PER M2,
There is rarely a standard PV project so it is hard for manufacturers/installers to quote average prices. However, the following 'ball park' prices have been given for fully installed costs:

- DTI field trials[12] – average £6.48/Wp fully installed (made up of £4.20/Wp module cost, £0.72 module installation, £0.92/Wp electrical installation, £0.53 invertor cost)
- PV Systems[13] - £6-£9/Wp for a 1kWp system, £5.50/Wp fully installed for 5kWp roof mounted systems, £5.00/Wp for 50kWp roof mounted systems) Façade or atrium systems can be nearer £15/Wp.
- Solar Century[14] - £6.3-£8.1/Wp fully installed for amorphous silicon systems, £8.8-£13.2/Wp for crystalline silicon

These figures indicate that the cheapest system currently available is approximately £6000 for a standard 1kWp system. Module prices can vary depending on the number ordered. Installation and design costs depend on the individual project.

The local Distribution Network Operator (DNO) also requires a small payment for the connecting the PV system to the grid. This can be up to £500 for 0.5kWp to 5 kWp system and up to £12,000 for a large installation. It tends not be greater than £350/kWp.

From DTI solar PV grants scheme statistics, the average connection charge for large systems (above 5kWp) in the West Midlands area is £750 (average from 3 schemes totalling 119 kWp). The charges are not currently consistent between DNOs and are not always consistent with the size of PV system being installed. The DNO will often wish to observe the commissioning of the first system that a particular

[11] http://www.defra.gov.uk/environment/envrp/gas/05.htm
[12] DTI field trial seminar, 17 November 2003
[13] Telephone conversation, Bruce Cross, PV systems, (020 8903 0175, www.pvsystems.com), 25 November 2003
[14] Solar Century Product information sheet, 020 7803 0100

installer makes in their area, but once they are happy that the installer is competent, will allow the installations to go unobserved. The payment must still be made however.

Currently the local DNO is Midlands Electricity/Aquila but Powergen is the in process of buying Midlands the company. Powergen own the East Midlands equivalent and this will consolidate the business for this area.

Net metering and price for electricity exported
Net metering describes the commercial arrangements where a generator receives the same price for exported energy as he pays for imported energy. Until recently offering net metering on this basis cost the utility company (as they were not allowed to trade electricity that wasn't metered on a half–hourly basis). The requirement for half hourly metering for small-scale generation has recently been removed - this is called BSC modification P81. However, a limit has been set on the export allowed – up 3.4kWp (single phase) and 11kWp (three phase) and so it only suits small generation.

The prices that electricity companies will currently pay for the electricity exported to the grid ranges hugely from 1.4p/kW to 8p/kW and is negotiated on a project by project basis. However, small-scale generators are now in a much stronger position to negotiate a net meter price for any electricity they export.

Npower has a net metering scheme in partnership with Solar Century. Customers can sell any excess electricity they generate to Npower for 10p/kW. During times when there is insufficient daylight to generate enough power, users can buy electricity back from Npower, the transactions being handled via a special account. This price is only available to users who have had their PV systems installed by Npower.

These arrangements are made very much on a project by project basis and it is worth engaging with the energy supplier early in the project.

Depending the arrangement that can be negotiated with the local supplier and the amount of energy the building requires, a small income may be generated by the PV system.

Renewables Obligation and Renewable Obligation Certificates
The new Renewables Obligation came into force in April 2002 as part of the Utilities Act (2000). It requires power suppliers to supply a certain amount of the electricity they supply to their customers from renewables. This starts at 3% in 2003, rising gradually to 10% by 2010 and 15% by 2015. Eligible renewable generators receive Renewables Obligation Certificates (ROCs) for each MWh of electricity generated in a month. These certificates can then be sold to suppliers, in order to fulfil their obligation. Suppliers can either present enough certificates to cover the required percentage of their output, or they can pay a 'buyout' price of £30/MWh for any shortfall. All proceeds from buyout payments are recycled to suppliers in proportion to the number of ROCs they present. ROCs can be freely traded and the price varies according to the ratio of ROCs to buy outs (which increase the overall value of the ROCs). ROCs have traded as high as £47/MWh but there is no guarantee that they will remain at this price.

Renewable Energy Guarantee of Origin (REGO) Certificates have recently been introduced to work alongside ROCs. These will be available in units of 1kWh, therefore much more suitable for small generators. This scheme is being administrated by Ofgem.

4.3.2 ENERGY GENERATED
The amount of energy produced by each kWp of PV installed in a year should be in the range:

- 600 kWh/kWp/year (for less favorable orientations)
- Up to 1200 kWh/kWp/year (for favorable orientations)

To predict the energy production from a PV system multiply irradiance on the system x size of system in kWp x performance ratio. In the UK irradiance figures vary from 1300 kWh/m2/yr in Cornwall to 800/m2/yr in Scotland. A value of 1000 kWh/m2/yr is reasonable irradiance figure for southerly facing sloped surfaces in Eastside. The performance ratio for a BIPV system is normally in the range 60 - 75% so 70% is a reasonable figure to use for predictions. Hence a 1kWp system in the UK could be expected to produce 700 kWh/yr.

Domestic examples
A gas heated 2 bed/ 4 person flat (built to 2002 Building Regulations) uses approximately 1500 kWh/year in electricity (for lights and appliances), so a 1kWp system would provide approximately 45% of the dwellings electricity needs, saving £44 (assuming a domestic electricity price of 6.4p/kW)

A gas heated 4 bed/ 7 person 3 storey terraced house (built to 2002 Building Regulations) uses approximately 2500 kWh/yr (for lights and appliances), so a 1kWp system would provide approximately 28% of the dwellings electricity needs.
From the DTI domestic field trial performance analysis of 113 systems, the average contribution of PV system to the electrical load has been 43%. This figure falls into the percentage range of 30-50% contribution to load that is generally quoted. This clearly depends on the size of the system installed but is also a function of the availability sunlight throughout the year.

Commercial example

It is harder to give a useful generic example for a commercial building as they vary so much in size and energy consumption. It is best to use the rule of thumb that a 1kWp system generates approximately 700kWh/yr.

However, as an example, a modern 6-storey office building with 8190m^2 lettable space has an estimated 115.44kWh/m^2/yr electricity usage, giving 945100 kWh in a year total. The approximate roof area for the building is 1700m^2. A 50 kWp polycrystalline system would require 500 m^2 of panels and would generate approximately 35,000kWh a year, about 4% of the annual electricity load. This would cost a very approximate £250,000. Assuming the electricity generated is displacing electricity bought at a rate of 4p/kW, £1400 would be saved in yearly bills.

Carbon saved
Fossil fuel generated electricity emits 0.43 kgCO_2 per kWh of electricity. Therefore, if an average 1kWp PV system produces 700KWh/kWp/year, 301 kgCO_2 will be saved per year.

4.3.3 MAINTENANCE ISSUES
As mentioned in chapter 2, one of the benefits of photovoltaic systems is their low maintenance. If a system has been correctly installed, and the invertor has been correctly set for the grid voltage, the system should need little attention. Most have self cleaning surfaces, but it is advisable to inspect panels for excess dirt (or bird droppings) periodically.

4.3.4 REGULATORY ISSUES
There are no licensing requirements relating to PV systems but if they are to be connected to the grid, the consent of the local Distribution Network Operator (DNO) is required (in the Eastside area this is Midlands Electricity, although Midlands Electricity is currently being acquired by Powergen). This is to ensure that distributed grid connected generation systems will not pose a risk to engineers working on the network. The electricity being fed into the network must also comply with main power quality requirements.

Small PV systems will come under the scope of Engineering recommendation G83/1 – *Recommendations for the connection of small-scale embedded generators (up to 16 a per phase) in parallel with public low-voltage distribution networks* [15]. This is the revised version of G77. It doesn't cover practical or safety issues but is aiming to encourage the use of approved inverter equipment and recognised connection procedures to decrease the need for DNO staff to carry out local tests. G83 is not mandatory but it has been signed up to by all the DNO companies. Experience from the DTI field trials indicates discrepancies between the different DNO companies regarding commissioning of PV systems. Some wish to have a member of staff present for the commissioning of all PV systems, others are happy to observe one, and for the rest on a development to be carried out by the electrical contractor on site[16].

Larger systems are be required to meet Engineering Recommendation G59 – *Recommendations for the connection of embedded generating plant to the regional companies' distribution systems*

Warranty issues.
We have heard of instances where NHBC said their warranty would not cover the roof due to the PV installation.

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[15] ERG83/1, September 2003, Electricity Association Publicity Department, T: 020 7963 5803
[16] Participant speakers, DTI Field Trial seminar workshop, 17 November 2003, BRE

5. SOLAR PLAN FOR EASTSIDE

5 Solar plan for Eastside

This section summarises the most appropriate applications of solar for the Eastside site. The section is summarised in a diagram in Appendix C.

5.1 SUMMARY OF SUITABILITY OF EASTSIDE SITE FOR SOLAR

5.1.1 PASSIVE SOLAR

Passive solar design is applicable to proposed Eastside housing developments. The blocks of flats would benefit from passive solar design, although overshadowing of lower level flats will exist.

The density of development proposed for Eastside will restrict the extent to which passive solar principles can be applied effectively to non-domestic developments. The close spacing of buildings, typical of city centre areas, will give: -

- Overshadowing, with resulting daylight restriction on lower storeys;
- Poor external air quality restricting the use of natural ventilation;
- Low and variable wind pressures, making wind driven ventilation unreliable; and
- “Heat island” effects, increasing external air temperatures in summer, both at day and night.

However, as artificial lighting is one of the principle energy uses in offices, daylighting design is very applicable to Eastside developments. Solar shading, particularly on upper storeys, will also give large benefits.

Where small developments are planned such as schools and sport and recreational facilities, passive solar may bring some benefits.

For retail developments and centres, passive solar design is unlikely to bring many benefits in Eastside.

5.1.2 SOLAR THERMAL

It is anticipated that due to the type of development proposed, solar water heating is unlikely to be widely applicable for Eastside. It is assumed that most residential dwellings will be flats, possibly with community heating systems, where solar thermal would be unnecessary. However, for flats with individual heating systems, top floor flats could be serviced by a solar thermal system. This would involve more complex services design, but could reduce the energy required for heating hot water by 800kWh for a 4 person dwelling. Installing solar water heating would also require the installation of dual coil hot water tanks, which may not otherwise be included in smaller dwellings. This may be suitable for the Rea Village and Aston Triangle areas of development. Due to the need for a dual coil hot water tank, solar water heating is a less cost effective option for retrofitting unless a new hot water tank is required anyway, or unless there is space for a second tank to store pre heated water. Solar thermal systems are also not very compatible with combination boilers as a pre heat tank will have to be installed and often a combi will have been installed due to a lack of space.

Where there is suitable demand, solar water heating systems would also be suitable for schools, visitor attractions and offices where there are is a suitable daytime hot water demand such as kitchens or canteens as well as washrooms. This could be relevant for the Learning Zone.

5.1.3 PHOTOVOLTAICS

Photovoltaics are applicable to most of the development in Eastside due to the range of building types planned and the range of PVs available. As has been described earlier, PVs can be integrated into or bolted onto most roof types or integrated into atria, windows, shading or facades etc. The cost however will remain prohibitive so are likely to be applicable for prestige office buildings, technology park buildings or possibly universities and housing associations where reasonable grants are available.

5.2 VISION

Descriptions of the development in the areas below have been identified from the Eastside development plan. A summary of this section ‘Solar Plan for Eastside’ is included in Appendix C.

Jennens Road

The aspiration for Jennens Road is to provide the character of a boulevard that can allow public transport and vehicle movements as well as offer an attractive and safe pedestrian environment. Buildings should have ‘active’ frontages and there should be a mix of uses including office, residential, retail and bars/restaurants.

If new street or car parking lighting is required, lighting powered by PVs could be considered. The panels can be high enough to be out of reach from vandals. The roofs of bus shelters along the road could also become mini generators. South facing awnings over cafes or shops, if suitably unshaded could become photovoltaic canopies providing shade and a distinctive feature. Assuming the roofs are unshaded, any prestige office buildings along the road could either have PV integrated roofs or facades. Solar thermal systems could also be installed to supply restaurant kitchens and bathrooms.

City Park
A new city park of around 9 acres is proposed extending from Park Street to the Canal at Curzon Street. The park will be a major new environmental and leisure amenity for residents, workers, students and visitors alike.

One of the aims for the park is to apply state of the art practices for environmental, economic and social sustainability - integration of renewable technologies into any infrastructure of the park would be a way of addressing this aim. Another aim is to encourage walking and cycling and it is therefore likely that the park will need to be lit at night to ensure safety. Lights could be powered by photovoltaics (with batteries) and wind.

Buildings along the northern boundary of the park, and the new city library (the eye shaped building in the drawing below) will be roughly south / south-east facing and so should be designed with passive performance in mind. As they will not be surrounded by buildings on all sides, there will be more opportunities to use passive ventilation techniques and overshading will be less of a problem. Photovoltaic panels will therefore also be a possibility on both facades and roofs. The buildings are to have 'active' frontages – integrated PV panels into glass facades would make a good architectural feature and talking point.

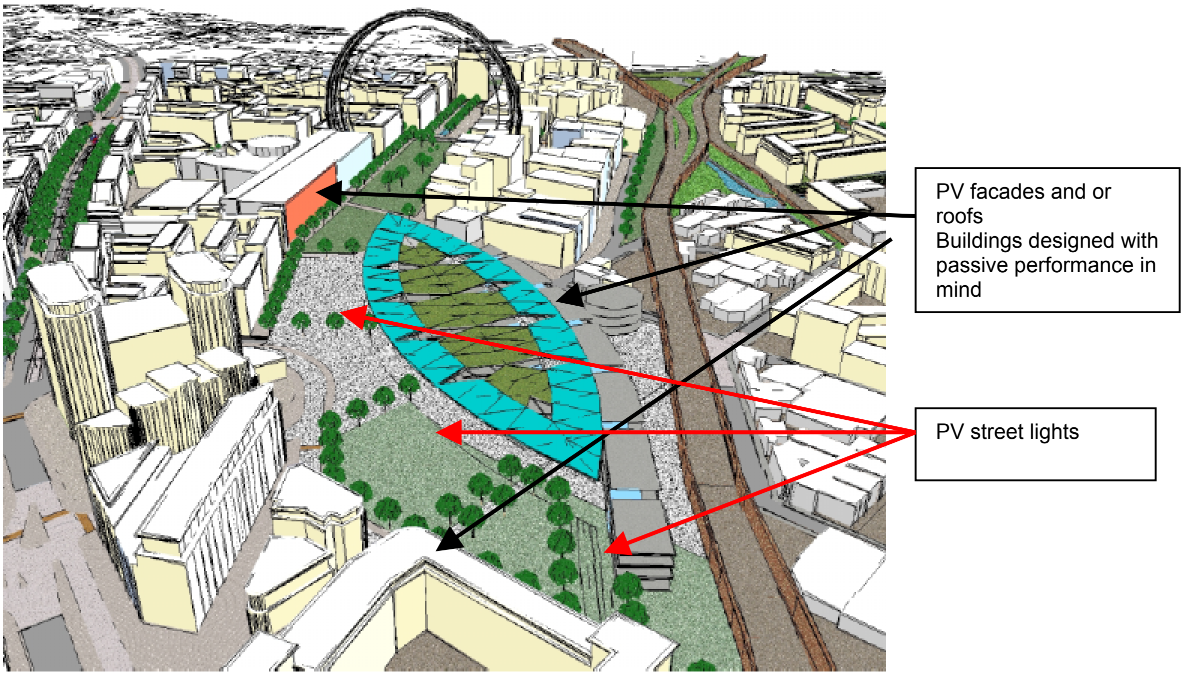


Image taken from Eastside Design and Movement Framework Draft Sept 03

Masshouse Circus
A prestige high density development is planned for sites 3 and 7 on the site of Masshouse Circus, northwest of the new City Park. Two 12-storey towers are planned, one as prestige office accommodation and one for prestige residential accommodation (with some mixed use on the lower floors). Solar water heating is not a feasible option for tower blocks.

As the office building is a prestige development, a PV façade could be considered. Good daylighting and solar shading design, as outlined on p8 of this document should be taken into consideration, particularly if large areas of glazing are to be utilised. The thermal mass and ventilation of the building should be carefully considered, to avoid the use of air conditioning if at all possible.

Aston Triangle
The Aston Triangle is a major focus of academic activity and considerable change is anticipated for the area, including creation of a new pocket park, closure of Aston Street, establishment of cycling and pedestrian routes. New buildings of between 5 and 8 storeys are proposed along Jennens Road to provide enclosure.

University buildings would be a good target for photovoltaic installation, both teaching departments and residential buildings. A monitoring project could be set up, run by the students as part of the course work to show how the PV system is working. University department canteens can be fitted with solar thermal systems to provide hot water needs. It is unlikely that the residential units would be suitable for solar water heating systems.


Aston Technology Park, Eastside

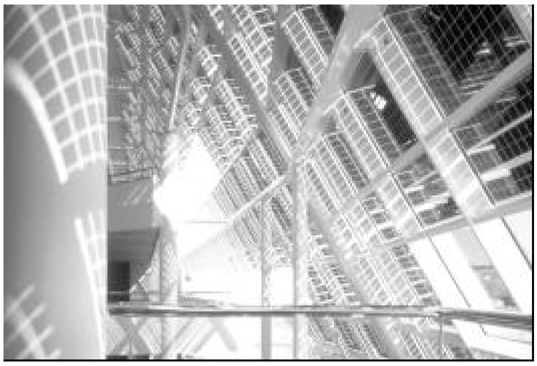

photo courtesy of IEA PVPS Task 7 CD Rom

Learning Quarter
Detailed masterplans have yet to be prepared for the Learning Quarter, but each area within it will have a particular focus such as Technology Park or Learning. A mixture of uses is required to provide complimentary uses and to ensure the area remains safe and attractive. The new City Park will ensure integration with other parts of the city.

Landmark buildings such as Millennium Point that have south facing glass facades or glass covered atrium could have integrated photovoltaics installed. The photovoltaics can be made both a high tech and green feature, providing image, some shading as well as generating electricity. In public buildings such as these, display boards explaining the importance of the technology can be installed, with LCD displays showing how much electricity is being generated at the current time and how much has been generated over the life span of the system. The displays could also include carbon and energy savings made. The PV installation then becomes a learning tool for local schools, colleges as well as the general public that uses the buildings. This could therefore be suitable for buildings in the learning zone. The problem of shading would have to be looked at carefully to ensure, for example, that 'Birmingham Gate' did not cast shadows on any installation.

There is also new student accommodation planned for the Castle Cement site to the far east of the Learning Quarter. This is to be 3-4 storey blocks with some affordable housing units included. As running costs are important for both students and residents of affordable housing, all the solar technologies should be considered, including passive (such as orientation, daylighting, thermal mass), solar thermal and PVs.


Millennium Point, Eastside


The Solar Office, Doxford © David Lloyd Jones
(Photo courtesy of IEA PVPS Task 7 CD Rom)

Canal Corridor
Here development is to be encouraged that presents an active face to the canal with entrances and windows as well as public uses. Although the historic character of the canal should be respected, contemporary modern design solutions will also be considered. This indicates that photovoltaics could be integrated into the design of these buildings, although the historic nature of the area indicates that the 'invisible' design may be more appropriate.

Existing buildings, such as in the Aston Science Park, which have flat roofs, could be retrofitted with modules on the roof installed at the optimum orientation and angle to provide a high tech, environmental image. These too could have the display information for visitors. Office buildings with a sufficient hot water requirement, such as those with canteens as well as washrooms could include solar thermal systems.

Rea / Media village
This area is bisected by the Digbeth Branch Canal, the River Rea and the Grand Union Canal and part of the area lies in the Warwick Bar Conservation Area. The River Rea should be a positive feature of any new development. The Design and Movement Framework also states that there is the opportunity to provide a demonstration project of sustainable design.

It is assumed that residential dwelling development will take place here. The blocks of flats would benefit from passive solar design, although overshadowing of lower level flats will exist. Good daylighting should also be considered, from both a health and well being point of view, as well as energy saving. Top floor flats could be fitted with solar thermal systems or photovoltaics assuming suitable roof orientation.

Photo courtesy of IEA PVPS Task 7 CD Rom

Chatham Maritime development

The Custard Factory
The Custard Factory lies to the far south of Eastside, within the Learning Quarter. This is one of the centres for arts and media in this area, along with The Bond (warehouse conversion) and UB40's recording studios. There are vacant factories and warehouses in the area that are suitable for conversion for similar uses. The possibly high-tech uses of these buildings means that sympathetic installation of PVs could be made into a feature.

There is a new South Birmingham College building also on the south boundary of Eastside, near the Custard Factory. This is a 3 storey building with a glass atrium containing teaching facilities. As the building is new, it would not be sensible to retrofit a solar thermal system. However, PVs modules could be fitted to the roof. As described earlier, display boards explaining the importance of the technology can be installed, with LCD displays showing how much electricity is being generated at the current time and how much has been generated over the life span of the system. The displays could also include carbon and energy savings made. The PV installation then becomes a learning tool for the college.

Other
Photovoltaics could clad south facing viaducts, or barriers shielding or separating roads to add a feature to an otherwise non descript piece of infrastructure. Such an installation could be made into a feature to welcome visitors to the new, improved Eastside.

5.3 NEXT STEPS

This short feasibility study should be considered as only the first step towards the implementation and delivery of solar technologies in the Eastside Development.

We recommend a series of 'next steps' to ensure that solar technologies are integrated successfully into Eastside:

1. Ensure the masterplanning team are fully aware of the opportunities for solar technologies at an early stage. This is particular important regarding layout and orientation of streets and buildings, and the heights of buildings to ensure solar access.
2. Review design proposals in terms of solar technologies for individual areas or buildings and run workshops with design teams to focus on the use and design of solar technologies.
3. Ensure that the development brief for an area includes a way of checking that proposals are being delivered (e.g. Post Construction Reviews as part of handover)
4. Set up and implement a Sustainability Management System to deliver the sustainability agenda on the project. This could be at an area or building level.
5. Develop an integrated energy supply strategy for all renewables being considered and CHP including analysis of energy demand profiles to match the availability of possible renewables.
6. Carry out more detailed feasibility studies for solar technologies once progress has been made on the master plan, including sources of funding and practical implications.
7. Appoint Sustainability Champion(s) to work with design teams and to ensure implementation of renewable objectives across the whole site.

APPENDIX A: METHODS AND SUPPORT SYSTEMS FOR IMPLEMENTATION

Appendix A: Methods and support systems for implementation

This appendix covers the grant systems that are currently available for solar thermal systems and PVs, and other sources of advice and support. Lists of registered installers for solar thermal and PV systems can be found in Appendix B

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GRANT SCHEMES

Clear Skies

The £10 million Clear Skies initiative aims to give homeowners and communities a chance to become more familiar with renewable energy by providing grants and advice. Homeowners can obtain grants of between £500 - £5000 whilst community organisations, including local authorities, can receive up to £100,000 for grants and £10,000 for feasibility studies. Technologies supported include wind, solar water heating, hydro, ground source heat pumps, automated wood pellet stoves and wood fuel boilers. Currently funding is not available for feasibility studies for the installation of solar water heating, although capital grants are available. Grants will only be awarded where an accredited installer is used.
http://www.clear-skies.org/default.htm

So far the West Midlands area has had 29 solar thermal installations funded by Clear Skies.

Solar PV grants

The DTI Solar PV Grants programme provides grants that contribute towards the cost of installing grid-connected photovoltaic arrays (PV) on public, domestic and commercial buildings. Up to 60% of eligible costs can be grant funded for public sector bodies such as local authorities and housing associations. Up to 40% of installation costs are available to commercial organisations. These grants are awarded on a quarterly competitive basis. It is anticipated the grants will last until March 2005.
www.est.co.uk/solar

So far the West Midlands area has had 17 installations, giving a total of 32 kWp under Stream 1 (below 5kwp systems) and has had 3 installations of a total of 119.82 kWp under Stream 2 (above 5kWp systems).

Energy Saving Trust's Innovation Programme

The Energy Saving Trust's Innovation Programme funds innovative carbon reduction projects. These can be innovative in terms of the technologies used, approach, process or methodology taken. Novel partnerships are particularly important to Innovation programme projects. At present a local authority partner must be involved in an Innovation Programme project, although they do not have to be the lead partner. Applications involving housing associations are particularly welcome. With a focus away from renewable technologies and increasingly on energy efficiency the Innovation Programme aims to work with other sources of funding, to deliver Carbon emissions reductions.
http://www.practicalhelp.org.uk/initiatives/initiative.cfm?initiative_id=16

Energy Efficiency Commitment

EEC is a statutory obligation on energy suppliers with 15,000 or more domestic customers to deliver energy efficiency improvements in housing. It commits the energy supply industry to deliver domestic energy efficiency measures that will correspond with an overall saving of 62 TWh of energy and the overall target has been split between the energy companies depending on the size of their customer base. The Department of Environment, Food and Rural Affairs estimates that EEC will lead to an investment of £500 million on energy efficiency measures over the next 3 years and a reduction in carbon emissions of approximately 0.4 million tonnes a year. Local authorities and housing associations are advised to approach energy suppliers with well thought out projects. EEC will typically fund loft and cavity insulation, energy efficiency condensing boilers, energy efficiency appliances and light bulbs. Solar water heating systems are also covered.
http://www.ofgem.gov.uk/temp/ofgem/cache/cmsattach/123_9aug02.pdf

ADVICE AND SUPPORT

Energy Efficiency Advice Centres

There are 52 energy efficiency advice centres (EEACs) in the UK set up to advise the public on energy efficiency matters. The EEAC closest to Eastside is:

Central Midlands EEAC
Keith Bennett
120-122 Gazette Buildings
Corporation Street
Birmingham
B4 6TF

Tel: 0121-200-1339
Fax: 0121-200-1205
Email: cmeeac@savenergy.org

A number of EEACs are participating in a trial to provide advice on renewable energy in addition to energy efficiency. These 6 centres can provide free independent advice on renewable energy options for homes or community groups, including local authorities. The nearest renewables EEAC to Eastside is:
Black Country EEAC
Mick Trollope
Sandwell New Horizons
Kelvin Way
West Bromwich
West Midlands B70 7JW
Tel: 0121 553 6373
Fax: 0121 533 0102
Email: blac@eeac.net

Community Renewables Initiative
The Department of Trade and Industry has launched a new initiative to help schools, offices and housing developments in England play a part in reducing the effects of climate change. The £1.6 million Community Renewables initiative has set up local support teams in 10 areas covering half of England. The support teams help local people and organisations devise renewable energy schemes suited to their area. The aim is to not only create environment friendly developments but to enable community groups to directly benefit from the income generated. The local support teams, which are made up of local councils, energy experts, government bodies and other specialists provide advice and training on feasibility studies, funding, technology issues, planning, environmental assessment and public participation.

Examples of the types of projects the initiative hopes to develop include: Turning waste from farm and food waste into natural gas to generate electricity for community buildings; Using wood fired boilers to heat schools; Harnessing solar energy to power hospitals. It sounds very worthwhile - if the familiar practical and bureaucratic obstacles can be overcome.
www.countryside.gov.uk/

APPENDIX B: INSTALLERS

Appendix B: Solar water heating and PV installers

Solar Water Heating Installers
The following are installers listed as approved installers under the Clear Skies grants scheme who appear to cover the Birmingham Eastside area. A full list of approved installers and further information can be obtained from www.clear-skies.org.

Trading Name	Address	Telephone	E-mail	Website	Contact name	Regions of Operation
Blue Flag Ltd	York House Ingham Lane Bradshaw Halifax HX2 9PE	01422 248613	admin@blue-flat.co.uk		Jason Robertshaw	All UK Regions
Genersys Plc	92 New Cavendish Street London W1W 6XJ	020 7637 9708	enquiries@genersys-solar.com	www.genersys-solar.com	Douglas Dalziel	All UK Regions
Grisedale Solar	The Old Saw Mill Back River Street Congleton Cheshire CW12 1HJ	01260 278644	grisedale@solar31.fsnet.co.uk		Steve Grisedale	Eastern East Midlands North Eastern South Eastern South Western West Midlands Yorkshire & Humberside Northern Ireland Scotland Wales
Imagination Solar Ltd	10-12 Picton Street Montpellier Bristol Avon BS6 5QA	0117 942 6668	grants@imaginationsolar.com	www.imaginationsolar.com	Jon Walker	All UK Regions
Invicible Power (UK) Ltd	East Devon Business Centre Heath Park Honiton Devon EX14 1SF	01404 548896	admin@inviciblepower.co.uk	www.inviciblepower.co.uk	David Wyatt	Eastern East Midlands London North Eastern North Western South Eastern South Western West Midlands Yorkshire & Humberside
Nuaire Limited	Western Industrial Estate Caerphilly Wales CF83 1NA	02920 885911	info@nuaire.co.uk	www.sunwarm.com	Vahid Tabatabai	All UK Regions

Riomay Ltd	1 Birch Road Eastbourne E Sussex BN23 6PL	01323 648641	tonybrook@pavillion.co.uk	www.riomay.com	Tony Book	All UK Regions
Smart Energy UK Ltd	Technology House Haven Road Colchester Essex CO2 8HT	01206 516677	info@smartenergyuk.com	www.smartenergyuk.com	Alan Berry	Eastern East Midlands London North Eastern North Western South Eastern South Western West Midlands Yorkshire & Humberside Wales
Solar 2000 Lited	11 Main Drive Bognor Regis West Sussex PO22 7TN	014243 585233			R Hazzledine	Eastern East Midlands London North Eastern North Western South Eastern South Western West Midlands Yorkshire & Humberside Wales
Solar Dawn	Willow Brook 16 Brockton Lydbury North Shropshire SY7 8BA	01588 680469	solardawn@care4free.net	www.solardawn.co.uk	David Luckhurst	East Midlands North Western West Midlands Wales
Solar Tech Ltd	Harwood Church Leyes Evenley Northamptonshire NN13 5SX	01280 703607	info@solartech.plus.com	www.solartech.plus.com	Shaun Taylor	Eastern East Midlands London South Eastern West Midlands
Solar Twin Ltd	2nd Floor 50 Watergate Street Chester Cheshire CH1 2LA	01244 403 407	hi@solartwin.com	www.solartwin.com	Dave Houston	All UK Regions

Sundwel Solar Ltd	Unit 1 Tower Road Glover Industrial Estate Washington Tyne and Wear NE37 2SH	0191 416 3001	solar@Sundwel.com	www.sundwel.com	K Wilkinson	Eastern East Midlands London North Eastern North Western South Eastern South Western West Midlands Yorkshire & Humberside Scotland Wales
Sunseeker Solar Energy Ltd	Norther House Moss Street East Ashton Under Lyne Lancashire OL6 7BU	0161 343 7077	sales@sunseeker-solar.com	www.sunseeker-solar.com	David Wright	Eastern East Midlands London North Eastern North Western South Eastern South Western West Midlands Yorkshire & Humberside Wales

Installers of Photovoltaic Panels

The following are installers listed as approved installers under the DTI, PV demonstration programme grants scheme who appear to cover the Birmingham Eastside area. A full list of approved installers and further information can be obtained from www.est.co.uk/solar

West Midlands Region

Covering: Herefordshire, Shropshire, Staffordshire, Warwickshire, West Midlands, Worcester

Accredited Organisation	Contact Details	***Stream 1*** 0.5kWp to 5kWp				***Stream 2*** 5kWp to 100kWp	
		Grid-connect		**Off-grid**		**Grid-connect**	**Off-grid**
		Domestic	School/Community	Domestic	School/Community		
Action South Facing Accred no. Provisional	clive.collison@south-facing.co.uk 01142 397578		✓			✓	
A B Butt Accred no. Provisional	kgm@abbutt.co.uk tel: 0116 251 3344	✓	✓			✓	
Beco Solar Accred no. 974GC	radams@becosolar.com 01803 833 636 www.becosolar.com					✓	
BP Solar Accred no. 1001GC	CRONSHK@bp.com Mark_Wilkie@eu1.bp.com tel: 01932 779543 www.bpsolar.co.uk					✓	
Dabbrook Power Systems Accred no. 993GC	sales@dabbrook.com tel: 01493 441 711 www.dabbrook.com		✓			✓	✓
Dulas Accred no. 977GC	pvinfo@dulas.org.uk tel: 01654 705 000 www.dulas.org.uk	✓	✓	✓	✓	✓	✓
Ecosol Accred no. 985GC	info@ecosoluk.com tel: 020 8439 7097 www.ecosoluk.com					✓	
Energytech Accred no. Provisional	robspeht@energytech.co.uk tel: 01792 467222 www.energytech.co.uk	✓	✓			✓	

Filsol Solar Ltd Accred no. Provisional	john.blower@filsol.co.uk tel: 01269 860229 www.filsol.co.uk	✓	✓			✓	
Imagination Solar Accred no. Provisional	clare@imaginationsolar.com tel: 0117 942 6668 www.imaginationsolar.com	✓	✓			✓	
Proven Accred no. Provisional	info@provenenergy.com tel: 01563 543020 www.provenenergy.com					✓	
PV Facades Accred no. Provisional	pvfacades@aol.com tel: 01794 830154	✓	✓			✓	
PV Systems Accred no. 978GC	akingdon@eets.co.uk tel: 029 2082 0910 ahunjan@pvsystems.com tel: 020 8903 0175 www.pvsystems.com	✓	✓			✓	
Solar Century Accred no. 979GC	malcolm.maclean@solarcentury.co.uk tel: 0800 9700 733 www.solarcentury.co.uk	✓	✓			✓	
Solar Energy Alliance Accred no. 1000GC	energy@gosolar.u-net.com tel: 01502 515532 / 01502 561399 www.gosolar.u-net.com	✓	✓			✓	
Solar Energy Installations Accred no. 980GC	sei@solarenergyinstallations.co.uk tel: 01256 392 704 www.itpower.co.uk/sei					✓	
Solar Sense Accred no. 987GC	solarsense@blueyonder.co.uk tel: 01275 394 139 www.solarsense-uk.com	✓	✓			✓	
Solargen Accred no. Provisional	ken.bird@solargen.biz tel: 01633 281900 www.solargen.biz		✓			✓	

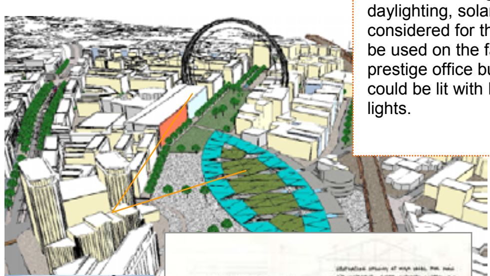
Sundog Energy Accred no. 988GC	info@sundog-energy.co.uk tel: 01768 482282 www.sundog-energy.co.uk	✓	✓			✓	
Sunpowered Energy Systems Accred no. 989GC	sales@sunpowered.co.uk tel: 02392 614 925 www.sunpowered.co.uk	**Limited area coverage**	**Limited area coverage**			**Limited area coverage**	
Sunseeker Solar Energy Accred no. Provisional	sales@sunseeker-solar.com tel: 0161 343 7077 www.sunseeker-solar.com	✓	✓			✓	
Ultima Networks Accred no. 1002GC	alanl@akhter.co.uk tel: 01279 821200 www.ultima-networks.com/index.html	✓	✓			✓	
Viessmann Accred no. Provisional	pch@viessmann.com tel: 01952 675000 www.viessmann.com	✓	✓			✓	
Wear Group Accred no. Provisional	peter@billingsgroup.co.uk tel: 01474 573109 www.designandbuild.com	✓	✓			✓	
Wind and Sun Accred no. 991GC	info@windandsun.co.uk tel: 01568 760 671 www.windandsun.co.uk	✓	✓	✓	✓	✓	✓
Winsund International Accred no. 992GC	info@winsund.com tel: 01207 255 365 www.winsund.com	✓	✓	✓	✓	✓	✓

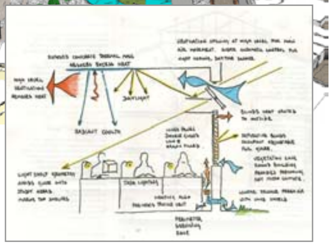
APPENDIX C: SOLAR PLAN FOR EASTSIDE

Appendix C – Solar Plan for Eastside

A Solar Plan for Eastside

This should be read in conjunction with the "Solar Power Feasibility Study for Eastside", Dec 2003, prepared by FaberMaunsell.

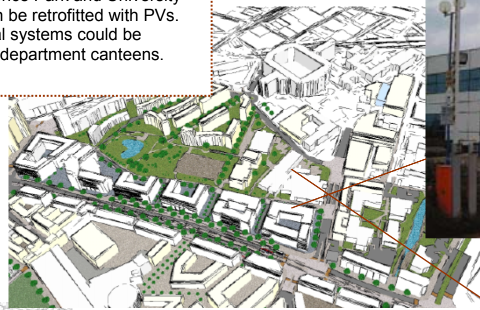




©ECD Architects

City Park
Building along the northern boundary are S / SE facing. Passive ventilation, daylighting, solar gain should all be considered for the design. PVs could be used on the facades and roofs of prestige office buildings. The park could be lit with PV powered street lights.

Aston Triangle
Existing Science Park and University buildings can be retrofitted with PVs. Solar thermal systems could be retrofitted to department canteens.



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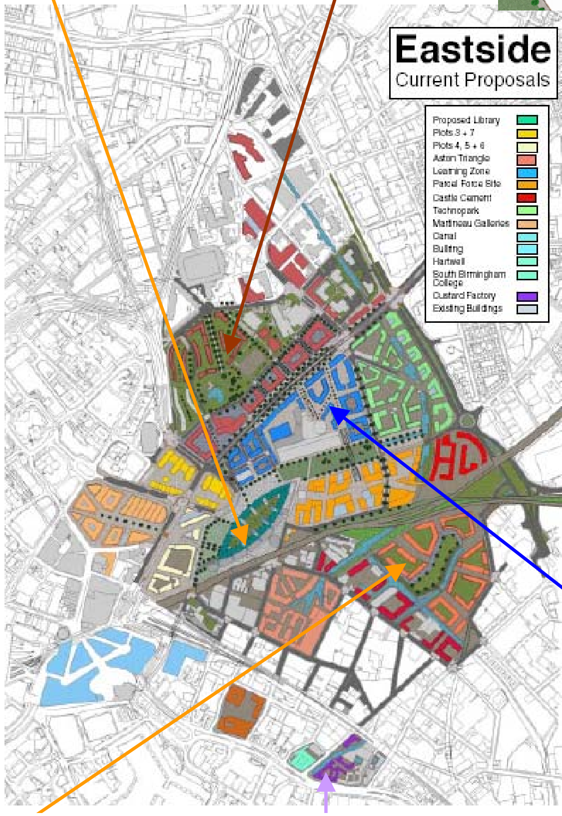

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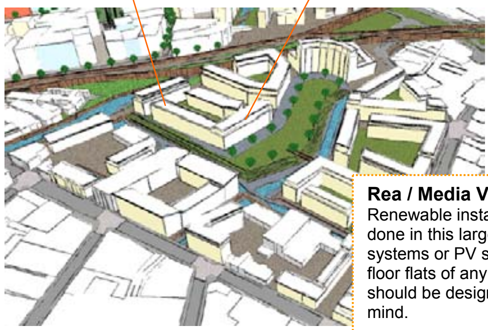

Rea / Media Village
Renewable installations will have to be sensitively done in this largely conservation area. Solar thermal systems or PV systems would be suitable for the top floor flats of any residential developments. Dwellings should be designed with passive performance in mind.

Custard factory
This is a centre for art, media and design and should make innovative use of PV, preferably visibly. An interactive display could be developed for the reception area.

Learning Quarter
Landmark buildings such as Millennium Point could have integrated PVs in their south facing facades. Interactive public display boards could ensure they are features for learning.

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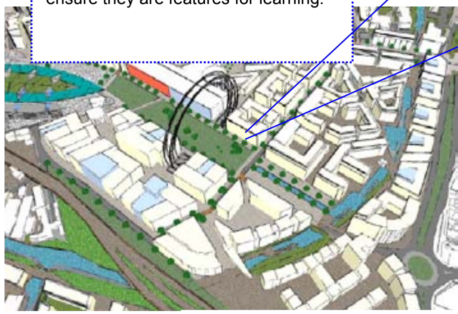

All 3-D drawings ref. Birmingham City Council