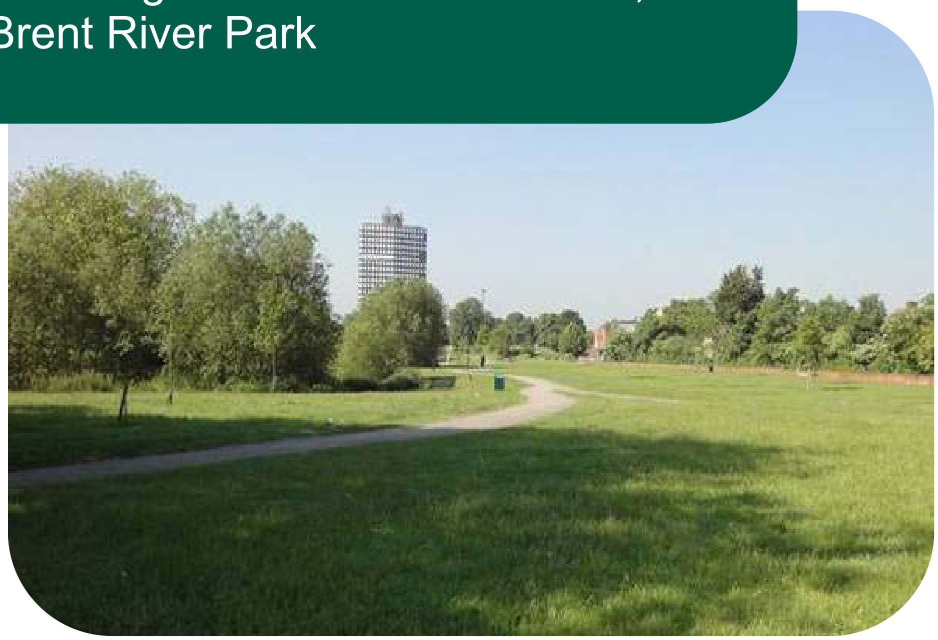
Renewable Energy Feasibility Study

C-Change Demonstration Model, Brent River Park



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helping householders, businesses and communities
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DISCLAIMER

1 Executive summary

CEN Services have conducted a feasibility study into the potential to integrate renewable technologies with a proposed new outdoor classroom at the Brent River Park. Since the classroom will not have any heating requirement, the study has looked only at electricity generating technologies, specifically solar photovoltaics, wind power and micro hydroelectricity.

Section A of this report provides a full options appraisal for the renewable technologies, including analysis of the following specific issues where relevant:

1. The site is located within the floodplain of the River Brent, therefore measures must be robust to sustain when the area is flooded.
2. The technologies should require minimal maintenance over a period of 10 years.
3. Risk of vandalism.
4. Facility to harvest the power generated to run basic electrical equipment.
5. Indicative capital and maintenance costs.
6. Legal and planning issues.
7. Advice on skills and other requirements necessary to implement the technologies.

Section B provides some guidance on energy efficient lighting options and Section C looks at funding opportunities. Since the designs for the outdoor classroom have not yet been completed, much of this report discusses the different ways in which the technologies could be integrated, depending on the final design of the structure.

The results of the technical feasibility for each technology are summarised in the table below. The conclusion is that only solar photovoltaics would be technically suitable for the Brent River Park site.

Technology	Feasible?	Reasons
Solar photovoltaics (PV)	✓	Unshaded, flat roof space.
Wind turbine	✗	Low local wind speed. Site surrounded by buildings and trees.
Micro hydro	✗	Site has low head and flow rate. Environment Agency would not authorise a development affecting their on-site gauging station.

Table 1 Feasibility of renewable technologies at Brent River Park.

Depending on the Feed-in Tariff classification assigned to the outdoor class, a payback period of between 18 and 22 years can be expected for a solar photovoltaic system at the park (9 to 11 years if 50% grant funding can be secured). This is based on installation of a very small solar photovoltaic system on the roof of the classroom, designed to generate electricity equivalent to the structure’s demand for lighting. Obtaining planning permission, flood-proofing the system and protecting the PV from vandalism are not expected to pose any major difficulties.

SECTION A: RENEWABLE ENERGY OPTIONS APPRAISAL

A thorough review of electricity-generating renewable energy options has been undertaken, in the context of the expected energy needs of the outdoor classroom and the principal functionality of the structure. The feasibility of heat generating technologies has not been assessed since the classroom is not expected to have any heating requirement. Based on CEN's site visit, solar photovoltaic panels could be a technically and financially viable option, assuming that the final design of the classroom shows appropriate integration. The site is not well suited to a wind turbine as it is sheltered and local wind speeds are low; nor is a micro-hydroelectric solution feasible. This section of the report deals in detail with each of these technologies in turn.

2 Solar photovoltaics (PV)

Solar photovoltaic (PV) cells generate light from the sun directly into electricity. They are available in a range of forms such as bolt-on panels, solar tiles and glass-glass laminates. Solar PV technology is considered feasible on either pitched roofs or flat roofs (the latter requiring an A-Frame) dependent upon roof orientation and sufficient un-shaded area. Assuming that the outdoor classroom is redesigned with the technical requirements of solar PV in mind, it is highly likely that this technology would be suitable for the site.

2.1 Solar products

Solar photovoltaics are available in a range of forms such as bolt-on panels, solar tiles and glass-glass laminates. The suitability of each product will be affected by the requirements of the classroom design, for example available space, roof type, aesthetics and cost.

An indication of predicted energy outputs per kWp, for a range of PV products, is shown in Table 2, together with typical loadings per m^2. Illustrations of the products are provided on the following page.

Technology	Electricity generated in optimum conditions (kWh / kWp / year)	Pitched roof area required (m^2 / kWp)	Flat roof area required (m^2 / kWp)	Typical weight (kg / m^2)	Guideline cost[1] (£ / kWp)	Guideline cost[1] (£ / m^2)
Bolt-on modules, monocrystalline	830	7	15	10 - 20	5,000	820
Sun slates	830	10	n/a	16	8,200	820
C21e tiles	830	8	n/a	16	7,000	900
Glass-glass laminates	830	9	n/a	40	9,800	1,090

Table 2 Outputs of solar photovoltaic products. Source: solarcentury.com

[1] Cost includes supply and installation. Prices based on those supplied by solarcentury, although they have been raised slightly to reflect recent silicon price increases.

a) Standard 'bolt-on' modules
Above left: roof-mounted, pitched roof. Above right: roof-integrated, pitched roof.
Below: mounted on A-frames, flat roof.

b) Sun Slates

c) C21e

d) Glass-glass laminate

Figure 1 Solar PV products. Source: solarcentury.com, Chelsfield Solar and BioRegional.

2.2 Building requirements for solar PV

Solar PV can be accommodated on most structures, providing that the solar panels can be mounted at a suitable orientation and pitch for efficient energy generation. The basic building requirements for solar PV are outlined below. An analysis of the suitability of the original classroom design follows in section 2.2.1.

Roof-type
PV panels should ideally be mounted at tilt angle of 30° to 40° to maximise solar gain throughout the year (see Figure 2 for details), although modern technologies allow for a lower tilt angle. In case of a flat roof, PV panels can be mounted on A-frames. Where a number of PV panels mounted on A-frames are installed, care should be taken to ensure one row does not overshadow the row behind.

Roof orientation
The roof should ideally be south-facing to maximise the efficiency of the panels. Panels mounted east or west at the optimum tilt angle would generate with 90% of the output of an optimally-mounted, south-facing panel. Given the high cost of PV technology, it does not make financial sense to install PV at a significantly less than optimal orientation.

Area required
With the example of a Sanyo hybrid panel, the roof area required would be approximately 1.25m^2 per panel on a pitched roof. On a flat roof, the same model would need 3m^2 when mounted using an A-frame. PV panels can be mounted in landscape or portrait orientation to maximise the roof space. On flat roofs, sufficient access space (minimum 0.5m) should be allowed around the rows of PV panels for maintenance purposes, if required.

Roof shape
PV panels are usually rectangular, with typical minimum measurements anywhere from 800mm x 1600mm to 1200mm x 2000mm (solar tile measurements start at around 1200mm x 400mm). Where buildings have small areas of irregularly shaped roof space, care needs to be taken to ensure that PV panels can actually fit onto individual roof spaces.

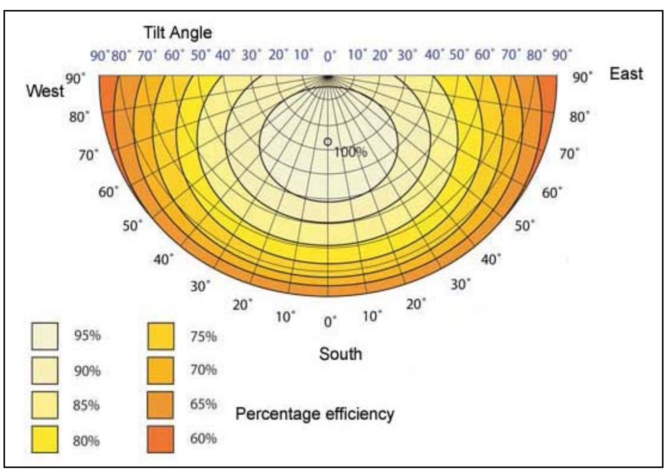

Figure 2 The reduction in output of a solar PV panel as the tilt angle and orientations change. Source: Solar Access

Loading

When designing the classroom and the PV system, checks should be made to ensure that the roof structure is able to support the additional weight of the panels. Loading calculations may also be required for Building Approval. Typical weight loadings for PV panels are provided in Table 2. The specific loading of the PV system selected for the classroom should be calculated using data from the PV manufacturer.

The fixings for the PV system must be able to withstand wind uplift on the panels. Wind loading is most likely to affect PV systems mounted on flat-roofs on A-frames, which may also need to resist sliding if they are not mechanically fixed. PV systems least affected by wind load are those which are roof-integrated and nominally airtight; the wind loading of these can be calculated as for traditional roof claddings.

To ensure that the PV system is able to withstand weight and wind loadings, CEN recommend that the contractor and solar products selected for the installation are accredited with the Microgeneration Certification Scheme (MCS). MCS contractors are required to ensure that the roof structure is capable of withstanding the loads (static and wind loads) that will be imposed by the PV modules and their mounting arrangements. Further details of the MCS are provided in chapter 2.4.6.

Flooding

Since the PV panels will be mounted on the roof of the classroom they are unlikely to be affected by flooding, except in very severe circumstances.

The electrical components of the PV installation such as inverters and wiring should be located in a sealed, waterproof unit so as to minimise risk of damage from flooding.

2.2.1 Pavilion design

The original designs for the outdoor classroom depict a canopy structure consisting of four quadrilateral panels mounted at varying heights, pitches and orientations on poles. The higher panels overlap and shade those below.

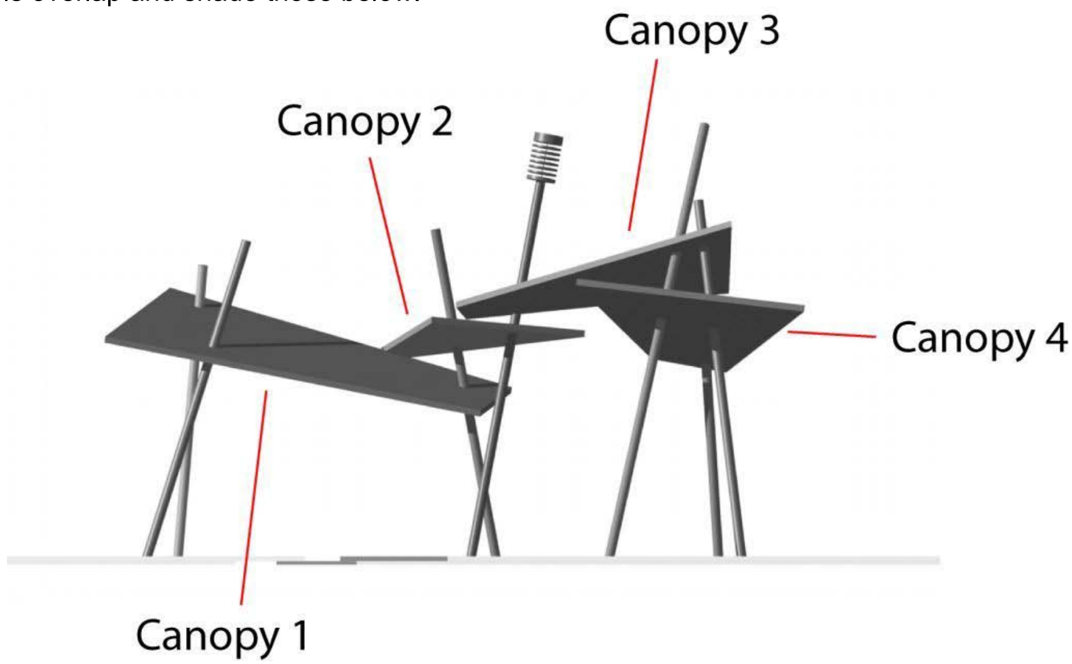

Figure 3 South elevation of the original design

The only south-facing area of the original design is Canopy Panel 1, which has an area of around $8m^2$ uninterrupted by poles, and a pitch of around 10º. Only a very small PV system could be installed on this panel (maximum 1 kWp), the efficiency of which would be reduced by near shading from the other panels and poles as well as the shallow pitch.

When the outdoor classroom is redesigned, care should be taken to ensure that there is sufficient unshaded roof space for the required size solar PV system, and that the individual canopy panels are suitably shaped to accommodate solar PV panels. Roof areas to be used for the solar PV should have an orientation between southeast and southwest and a pitch of between 30º and 45º.

A flat or near-flat roof could be used for the PV installation, but A-frames would need to be installed on top of the flat roof to increase the pitch of the PV panels (an example system is illustrated in Figure 1). This will alter the visual appearance of the structure.

2.3 Location requirements for solar PV

It is imperative that PV panels are free from overshadowing. Due to the way in which they are electrically connected, even if one small area of a panel is overshadowed, the efficiency of the panel - and even the PV array - will be significantly reduced, meaning that the output is much lower than predicted. It is essential, therefore, that PV products are mounted away from trees, other roof obstacles and shadows cast by surrounding buildings.

2.3.1 Pavilion location

CEN's site visit identified the location originally planned for the outdoor classroom as unsuitable for a solar PV installation. This was due to the area being severely shaded by mature trees from the northeast throughout to the southwest; such shading would greatly reduce the efficiency of a solar PV installation.

Following discussions with Brent Council, it was decided to move the classroom's location 40m to the south, as shown in Figure 4. There are some recently planted trees here which can be replanted elsewhere to prevent them from shading the structure.

The proposed location is about 20m north of the nearest trees to the south, which are on the banks of the river. CEN modelled the impact of shading from the trees on the efficiency of a PV system. Assuming that the trees are about 8m tall and the PV panels mounted at 2m above ground level, shading from the trees is likely to reduce the electrical output of the panels by 7-10%. If the panels are mounted at 3m above ground level, the impact of shading is expected to reduce output by 6-8%. These percentage reductions will be greater if the trees to the south are allowed to grow taller, so it is imperative that efforts are made to maintain their height.

Increasing the height of the pavilion roof will help to increase the output of the PV, as will as orienting it to avoid shading from the trees where possible.

Figure 4 Location of the outdoor classroom

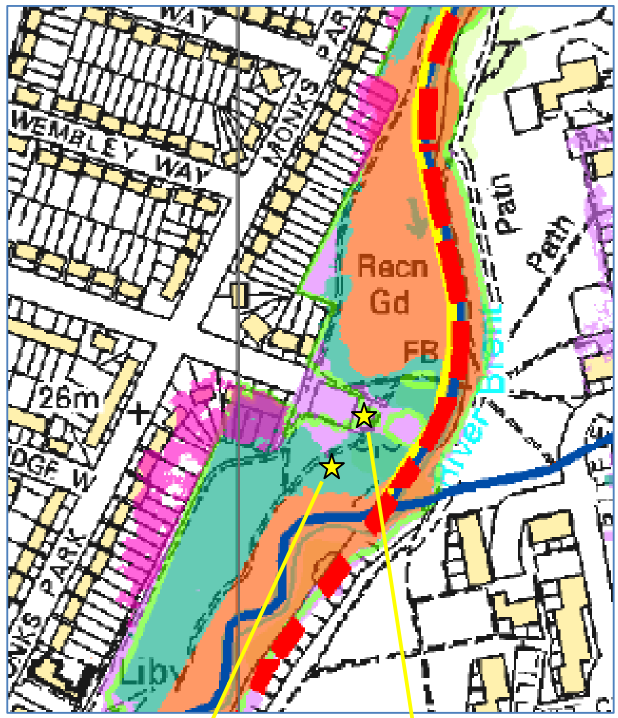

Figure 5 Proposed location for the classroom viewed from the north (left) and southwest (right).

2.4 System details

2.4.1 Capacity

Brent Council is keen to install a solar PV system capable of providing for the classroom's electrical demand. This is expected to be quite low, since the structure will have a few roof and floor lights, but no other electrical requirements. Further, there will be no daytime electrical requirement. The electrical demand will therefore not occur concurrently with electricity generation from the solar PV, however a PV system could be sized to generate energy equivalent to the electrical requirements of the lighting over the course of the year.

At the time of writing, Brent Council were not sure of the number or type of lights that would be installed at the classroom, nor of the number of hours that the lights would be used. The size of PV system required to meet the energy demand of the lights could therefore not be calculated. Once the Council has decided on details of the lighting systems, it should be fairly straightforward to estimate the capacity of solar PV that would be capable of generating electricity equivalent to the lighting's annual demand.

For example:

If 10 x 40 W bulbs are installed and used for an average of 8 hours per day throughout the year, then the energy requirement of the lighting will be:
10 x 40W x 8 hours x 365 = 1,168,000 Wh = 1,168 kWh per year.

CEN have estimated that the efficiency of the solar panels will be reduced by around 8% at the site due to shading (see chapter 2.3.1). If the type of solar PV selected for can generate 830 kWh per kWp installed per year in optimum conditions, then at the classroom site it would be expected to generate 830 kWh x 92% = 764 kWh per year per kWp of solar PV installed.

1,168 kWh per year energy requirement ÷ 764 kWh per year per kWp = 1.5 kWp. So over the course of the year, a 1.5 kWp PV system would be required to generate electricity equivalent to that consumed by the lighting in this example.

2.4.2 Grid connected vs battery powered systems

Typically solar PV systems are either connected to the National Grid, or they have battery back-up. Systems both connected to the Grid and with battery back-up are also possible, although rarely financially attractive.

For the purpose of energy security, it is expected that the Council will prefer for the classroom to be connected to National Grid. This will ensure that the lighting can be operated throughout the year, even in winter when daily electricity generation by the PV is likely to be significantly lower than the electricity consumed by the lighting.

The overall financial benefits of operating a grid-connected PV system with or without a battery are expectedly to be roughly the same. Although a battery would enable to Council to make the most of electricity bills savings (with the 1.5kWp system above, savings could be in the region of £100/year, as opposed to £35 from Feed-in Tariff export payments), these benefits would be almost entirely offset by the additional cost of replacing the batteries every few years (estimated at around £60/year on average). Additionally, a system with battery back-up will require more maintenance than one without and a very secure unit to store the batteries, which can be dangerous when not handled carefully. A battery is therefore not recommended for the PV system.

2.4.3 *Capital cost and revenue*

The typical capital costs to install a range of solar PV products are illustrated in Table 2 on page 4. Since the choice of PV product and the capacity of the system will depend on the final design of the classroom, it has not been possible to estimate these with accuracy. Instead, example costings are provided for a 1.5 kWp and a 4 kWp system of 'bolt-on' monocrystalline panels. These give a good idea of the level of financial revenue which a solar PV system could achieve, particularly with regard to income earned through the Feed-in Tariff.

Feed-in Tariff

The UK's new Feed in Tariff (FIT) guarantees financial income for many electricity-generating renewable technologies. The FIT comprises two parts: the generation tariff (paid for all energy generated, regardless of the end user), and the export tariff (effectively a fixed sale price for energy exported back to the National Grid). Currently local councils are not able to benefit from the export tariff, because they are banned from selling electricity under the 1976 Local Government Act. However, the Climate Change Secretary Chris Huhne has announced his intentions to reverse this law[3].

The tariffs vary according to the technology, capacity and type of structure on which the system is installed. If a PV system is not attached to a building nor wired to provide electricity to an occupied building, then it will be considered a 'stand alone' system – and a lower generation tariff will apply.

The tariffs in the table below will apply to PV systems installed before 31st March 2012, PV installations completed after this date will qualify for a degressed FIT rate.

Type of installation	Scale	Generation Tariff (p/kWh)	Export Tariff (p/kWh)
Stand alone	Any	29.3	3.0
New building	>10 kW	36.1	3.0

First year FIT generation tariffs for solar PV installed by end of March 2012.

Regardless of installation date, FIT payments will be indexed linked and will be adjusted every year to reflect inflation. FIT payments can be claimed for 25 years following a PV installation.

Energy exported to the National Grid will earn an export tariff of 3p/kWh. It is preferable to use energy on site where possible, since electricity offset is typically bought from the national energy suppliers at a higher rate so reducing the electricity bill is more beneficial. (The average price paid by non-domestic customers in the first quarter of 2010 was 8.47p/kWh[2].)

Since the classroom is not expected to have walls, and it will not be occupied on an ongoing basis, it difficult to ascertain whether the structure will be defined as a 'building' for the purpose of FIT. If the structure is not classed as a building, then the PV system will only qualify for FIT payments at the lower 'stand alone' rate, rather than the rate for new buildings. Neither DECC, Ofgem, the MCS nor the Energy Saving Trust were able to confirm which generation tariff rate a PV system mounted on the classroom would be awarded. However, the MCS believed that the case for the PV system to receive the higher 'newbuild' tariff could be argued, because the

[2] Source: Table 3.4.1 in DECC "Quarterly Energy Prices: June 2010". http://www.decc.gov.uk/assets/decc/statistics/publications/prices/1_20100621134719_e_@@_qepjun10.pdf.
[3] For further details, see http://www.decc.gov.uk/en/content/cms/news/pn10_078/pn10_078.aspx.

electricity generated by the PV system will not be fed into the National Grid directly, but will be used to supply demand at the classroom in the first instance.

Table 3 provides a simple economic appraisal for installation of 1.5 or 4 kWp of bolt-on, monocrystalline panels, for both FIT 'stand alone' and 'new building' payments.

System size (kWp)	1.5	4
Area required on pitched [or flat] roof (m^2)	10.5 [21]	28 [55]
Energy generated (kWh)	1,150	3,050
CO_2 saving ($kgCO_2$)	680	1,311.50
Capital cost [with 50% grant] (£)	7,500 [3,750]	20,000 [10,000]
Total annual income with 'stand alone' FIT (£)[4]	FIT: £337 Sale: £35 M&R: -£37.5 **Total: £334**	FIT: £900 Sale: £92 M&R: -£100 **Total: £885**
Approx. payback without & [with] 50% grant (years)	22 [11]	22 [11]
Total annual income with 'new build' FIT (£)[4]	FIT: £415 Sale: £35 M&R: -£37.5 **Total: £412**	FIT: £1,108 Sale: £92 M&R: -£100 **Total: £1,093**
Approx. payback without & [with] 50% grant (years)	18 [9]	18 [9]

Table 3 Economic appraisal for PV systems, depending on whether 'stand alone' or 'new building' FIT payments are received.

The classroom is expected to have an electrical requirement regardless of whether a solar PV system is installed. Costs for the solar PV's electrical connection therefore assume that there will be an electrical distribution board at the classroom.

2.4.4 Maintenance

Maintenance for PV systems is negligible. The panels may require periodic cleaning, although when at tilt angle, run-off from rain is usually sufficient. Isolators can be used in order to automatically highlight any problems that the system encounters. The system's inverters may need to be replaced every 15 years or so. Maintenance and repair costs have been estimated in Table 3 above.

[4] Maintenance and repairs (M&R) an average cost of £25/kWp is assumed; in reality this would not be spread evenly over the years but costs would occur periodically when parts need replacing (e.g. inverters).

2.4.5 Vandalism

Brent Council are concerned about the risk of vandalism, since the classroom will be freely accessible to the public and the Brent River Park is not well frequented at night.

There are a variety of measures which may be installed to reduce the risk of vandalism. The relative appropriateness of measures will depend in part on the final design of the classroom. Examples include:

- Heavy duty Perspex or tempered glass covers over the panels, to protect them from flying objects. The covers should be carefully designed to avoid blocking light and thus reducing the efficiency of the solar installation.
- Use of PV laminates or solar tiles – these are harder to remove than 'bolt on' panels.
- Securing 'bolt on' panels with locking devices, so that they cannot be removed with everyday tools.
- Motion sensor lighting.
- Access to the roof should be made difficult for pedestrians.

Regardless of the anti-vandalism measures taken to protect the installation, the Council is strongly recommended to ensure that the panels are adequately insured against damage and theft.

2.4.6 Installer selection

The Council is advised to select both an installer and solar products certificated with the Microgeneration Certification Scheme (MCS). The MCS is an internationally recognised quality assurance scheme, design to ensure high standard in the production and installation of micro scale renewable technologies. All MCS installers must sign up to an Office of Fair Trading approved Code of Practice, such as the REAL Assurance Scheme. Use of an MCS installer and MCS products are prerequisites for claiming Feed in Tariff payments.

Further details of the Microgeneration Certification Scheme, including a database of registered products and installers, can be found at: http://www.microgenerationcertification.org/.

The requirements and responsibilities of MCS accredited solar PV contractors are detailed in the "Microgeneration Installer Standard: MIS 3002", available from: http://www.microgenerationcertification.org/ewcommon/tools/download.ashx?docId=9239.

2.5 Legal and planning issues

The classroom and the PV installation will be owned and maintained by Brent Council.

2.5.1 Feed in Tariff payments

To qualify for the Feed in Tariff, the solar PV system selected and the installation contractor must both be certificated with the Microgeneration Certification Scheme (MCS).

As the owner of the solar installation, income from the Feed in Tariff will be payable to Brent Council, unless the Council assigns an alternative recipient.

Brent Council will be eligible for generation payments under the Feed in Tariff. At the time of writing, the Council would not be eligible for export payments since councils are banned from selling electricity under the 1976 Local Government Act. However, there are plans to overturn this law, to enable councils to fully benefit from the Feed in Tariff[5].

[5] See footnote 3.

Further details of the Feed in Tariff can be found at: http://www.fitariffs.co.uk/, and the Government's response to the Feed in Tariff consultation can be found at: http://www.decc.gov.uk/en/content/cms/consultations/elec_financial/elec_financial.aspx

2.5.2 Planning and Building Regulations

Planning permission and Building Approval must be sought for the PV installation, which is not covered by Permitted Development Rights (PDR) at the time of writing. A proposal to for solar PV to be covered by PDR in non-domestic premises is currently under consultation.

The solar PV installation is unlikely to negatively impact on the planning application for the classroom as a whole. However, the following limits to the installation may facilitate the planning process, as they are referred to in the proposal to make PV installation a Permitted Development Right.

If the classroom is considered to be a building with a pitched roof:

- Panels should not extend beyond the limits of the roof.
- Panels should not project more than 200 millimetres above roof.

If the classroom is considered to be a building with a flat roof:

- Panels should not project higher than 1 metre above the roof
- Panels should not be installed less than 1 metre from the edge of the building.

If the PV is considered to be a 'stand alone' system (classroom is not considered to be a building):

- Panels should not be installed higher than 4 metres above ground level.
- Panels should be a minimum of 10 metres from site boundary.
- Dimension of surface array should not exceed 3 metres x 3 metres.

Building Control should be consulted about the PV installation, however the system itself is unlikely to be a cause for concern. Loading calculations may be required to demonstrate that the classroom roof is structurally capable of supporting the system.

2.5.3 Health and safety

No PV module releases sufficient toxic materials to cause any harm during installation or maintenance. A small proportion of PV contains cadmium, the oxides of which are toxic in very small doses. Some of these may release toxic dust if crushed during disposal.

All relevant Health and Safety regulations should be adhered to during installation, for example regulations pertaining to working at height.

Maintenance should be carried out by fully trained professionals.

3 Wind turbine

Wind turbines harness the power of the wind and use it to generate electricity. The most common design is of three blades mounted on a horizontal axis, which is free to rotate into the wind on a tall tower or mast, however models with a different number of blades or a vertical axis are also available. The blades drive a generator either directly or via a gearbox to produce electricity. Most power will be generated if turbines have a constant, steady supply of wind. Wind turbines can be mounted on masts that are freestanding or tethered with wires, or on buildings. Only stand alone wind turbines have been assessed in this feasibility study - building-mounted wind turbines are not yet a mature technology[6] and the buildings in question would not be appropriate for mounting a turbine on.

It is very important that wind turbines are located in open areas with good access to wind. Although Brent River Park has some large areas of open ground, the park as a whole is fairly sheltered (there are trees throughout and the park is surrounded by residential areas). The site is therefore not considered suitable for a small wind turbine. A turbine on a very tall mast might be technically viable, but it is incredibly unlikely that this would be awarded planning permission.

In addition, average windspeeds for the local area are low. The Carbon Trust's Wind Yield Estimation Tool[7] is widely used and highly recommended for making initial estimates about the performance of small scale wind turbines. According to the tool, the average windspeed for areas of open land near the school is 2.9m/s at 15m above ground level (AGL). In low density residential areas the predicted average wind speed is only 2.7m/s at 15m AGL. These speeds are much lower than the 5m/s minimum wind speed recommended for a small wind turbine installation.

[6] A number of technical problems have been identified by manufacturers and are currently being investigated with the aim of rectifying these issues. This technology might therefore be available in the near future. CEN does not recommend the installation of building-mounted wind turbines in the current market environment.

[7] DECC's National Windspeed Database, NOABL, is also widely used, however in recent wind trials conducted by the Energy Saving Trust it was found to considerably overestimate wind yields from small turbines. Predictions made using the Carbon Trust tool were closer to actual generation figures.
Source: http://www.carbontrust.co.uk/publicsites/WPEstimator/Default.aspx

4 Micro hydroelectricity

Hydroelectric power plants generate electricity using the gravitational force of flowing or falling water. The running water drives a turbine and in turn a generator. The amount of energy which can be generated is determined by the 'head' and 'flow' of the water, as well as the equipment installed. The head is the vertical fall between the source and outflow of the water at the power plant. The flow is the rate at which a volume of water can pass through the turbine.

Micro hydroelectric power plants are usually installed in streams or rivers, typically as a 'run-of-river' system. Run-of-river systems use the natural head and flow of the waterway, without diverting large quantities of water to a store, and without building a large dam or barrage. Such systems have much less impact on the local environment than larger hydroelectric systems. The minimum head and flow required for a micro hydro installation to be financially viable are interdependent; small or slow-flowing streams require a much larger head than major rivers.

The River Brent flows through Brent River Park. For the most of the park the river has a very low gradient, however there is an Environment Agency gauging station with a small weir (see Figure 6). CEN's site visit identified this as the only stretch of the river within the park with any significant head, and therefore the only potential location for a micro-hydroelectric installation.

CEN contacted the Environment Agency to ascertain whether a micro hydroelectric development at the gauging station could be acceptable to the Agency, and if so, to obtain data on the river's flow in order to estimate potential for electricity generation. The Agency responded that such a development would not be acceptable as a micro hydroelectric installation would impact on the integrity of the flow measurement data collected at the station. Further, the flow levels at the station are frequently very low, which would minimise power generating capacity. In light of this response, a micro hydroelectric installation is not considered feasible for Brent River Park.

Figure 6 "Brent (Monks Park)" gauging station at Brent River Park. Left: blue dot identifies station location (map courtesy of Environment Agency). Right: photo of gauging station.

SECTION B: ENERGY EFFICIENCY APPRAISAL

The outdoor classroom's only electricity demand will be for a few decorative roof and floor lights, the number, power and appearance of which have yet to be decided. It is expected that these will be switched on for a few hours in the evenings.

Since the lighting will be for decorative, rather than security, purposes, the life-expectancy of the bulb should take priority over warm-up and re-strike times. Metal halide, high-pressure sodium, white sodium or LED luminaires are all relatively energy efficient and could provide suitable lighting solutions for the classroom, depending on the Council's requirements. The relative merits of each of these types of luminaire are provided in chapter 5 below.

The best lighting control solution for the classroom will depend on the Council's requirements, however if the structure is to be lit for a few hours each evening then a combination of daylight illuminance sensors and time controls are recommended. These could be set to switch on the lights when natural illuminance drops below a specified level and then to switch off the lights at a specified time in the evening.

The following publications may provide useful guidance once the Council has decided on the lighting levels that it would like to achieve. All of the publications can be downloaded or hard copies ordered for free from the publications page of Carbon Trust website (registration is required). http://www.carbontrust.co.uk/publications/pages/home.aspx

- Display lighting – In-depth technology guide (CTG010)
- How to implement external lighting (CTL026)
- Exterior lighting for small premises (ILG003)
- How to implement automatic lighting controls (CTL033)

5 Types of luminaire

Guidance on types of luminaire from the Carbon Trust publication "Display lighting – In-depth technology guide" (CTG010) is provided below.

Metal halide lamps

These lamps come in a range of types and sizes, have low energy consumption and give an excellent crisp white light which improves colour rendering. The lamp life of 6,000/12,000 hours is shorter than high-pressure sodium lamps but they still have a long operating lifetime compared with tungsten lamps. Metal halides are recommended in most applications where good colour rendering is important, such as in retail, high bay areas, area floodlighting, external lighting and hotels. Electronic control gear is available for low wattage CDM (ceramic discharge envelope) metal halide lamps. This provides improved lamp life (important due to high costs of these particular lamps) with lower lumen depreciation, as well as improved efficiency. Quartz envelope technology has also improved, including miniature 20W and 35W reflector lamps with a similar size to a standard MR16 tungsten halogen lamp.

Advantages:

- *Good to excellent efficacy*
- *Moderate to very good colour rendering*
- *Long life (6,000 to 15,000 hours).*

Disadvantages:

- *Long re-strike time (10 minutes) unless hot re-strike*
- *models are used*
- *High cost compared with standard mercury lamps.*

High pressure sodium lamps

High pressure sodium discharge lamps combine high efficacy with very long life and are particularly suited for floodlighting and illuminating larger exterior areas that need to be lit for long periods. They are not made for frequent switching and therefore should not be operated by presence detectors for security lighting. White sodium lamps have good colour rendering but are significantly less efficient (see below).

Advantages:

- *Very low running cost*
- *Very high efficacy*
- *Long life*
- *Quick start*
- *Universal operating position.*
-

Disadvantages:

- *High purchase cost*
- *Very poor colour rendering*
- *Ballast required*
- *Requires 1.5 to six minutes to run up to full output*
- *Delayed restart when hot on most lamps.*

White sodium lamps

White sodium lamps have good colour rendering but are significantly less efficient than their regular high-pressure equivalents. They provide an alternative to metal halide lamps in floodlights where a warm white colour is required.

Advantages:

- *Medium running cost*
- *Good colour rendering*
- *Quick start*
- *Universal operating position.*

Disadvantages:

- *High purchase cost*
- *Low to moderate life (6,000-10,000 hours)*
- *Poor efficacy*
- *Ballast required*
- *Requires 1.5 to six minutes to run up to full output*
- *Delayed restart when hot on most lamps.*

Light emitting diodes

A light emitting diode (LED) is a semiconductor diode that emits narrow-spectrum light. Traditionally LEDs have been low power consumption light sources with low light output. However, with increases in efficiency, LEDs have started to make strong inroads into non-domestic markets that can tolerate quite low light levels, notably external night time illumination and emergency signage. They are regularly used in situations where colour change is required for dramatic effect, and in external applications where their relatively low output3 is sufficient. The highest efficacy LEDs are coloured, and applications such as mood and other coloured decorative lighting in hotels, bars etc have almost completely transferred to LEDs. LEDs offer potentially long life and low maintenance if they are designed and controlled appropriately. A rapidly developing technology, the efficiency of LED systems can be variable, and each potential design should be critically compared with other, more conventional options.

Advantages:

- *An efficient option where coloured light is required*
- *Can provide changing colours under automatic control*
- *Can have long life (over 50,000 hours) – can reduce maintenance costs*
- *Can be focused onto display area.*

Disadvantages:

- *Not suitable for high light output applications (at time of publication)*
- *High purchase cost*
- *Manufacturers' literature is not standardised (difficult to compare products)*
- *An LED may lose a significant proportion of its original light output without failing completely*
- *Lamp colour may vary from batch to batch.*

SECTION C: FUNDING

Funding opportunities which may be available to either Brent Council or Groundwork London are detailed in the tables over the following pages. General advice on securing funding for the project is provided below. CEN would be happy to provide further funding advice if required.

- Groundwork London / Brent Council should be aware that in many instances grant funders either do not accept, or do not encourage, direct applications from Local Authorities. The project may therefore have a greater chance of raising funds if applications are made by Groundwork London.

- Grant funding for renewable technologies is very competitive. Before completing any grant application, CEN would strongly recommend that Groundwork / Brent Council contact the grant funder to discuss the project in detail. This initial contact can be useful to gain tips on the best way to present the project and to ascertain how stiff competition is at the present moment – and therefore how worthwhile a grant application to this particular funder may be.

- It will be very important to demonstrate that the renewable energy project is well-aligned with the funding body's aims and objectives, and that it meets **all** of the award criteria. Since many of the funding programmes have a strong focus on community benefit, it may be necessary to sketch out a programme of activities which could be conducted in conjunction with the renewable energy installation, maximising the value of the installation to local people.

- Except for exceptional projects, it is very rare for renewable energy funders to award their maximum grant. Applications requesting the maximum amount are sometimes turned for seeming over-ambitious, particularly if match funding has not already been secured and if the project cannot demonstrate very strong community benefits. CEN's experience shows that applications for smaller amounts are much more likely to be accepted, even where the overall cost of the project is still relatively high. We would recommend that Groundwork / Brent Council ask funders about the typical level of funding currently being awarded for similar projects, and bear this figure in mind when completing the grant application for Brent River Park.

6 Renewable Energy Grants

Table 4 provides details of grant programmes focussed on renewable energy installations, for which the Brent River Park project may be eligible

Organisation	Funding programme	Max grant (£)	Max percentage of total cost (%)	Measures funded	Limitations
BRE	Community Sustainable Energy Programme (CSEP)	50,000	50%	Renewable technologies and cavity wall insulation, loft insulation, heating controls, lighting controls.	Statutory organisations are ineligible. Funding for PV-only projects is extremely competitive. Final deadline for grant applications is 29th October 2010.
Scottish Power	Green Energy Trust	25,000	50%	Renewable technologies	**Funding from one utility company only may be accessed.**
EDF	Green Fund	30,000	50%	Renewable technologies	
E.ON	Sustainable Energy Fund	20,000	90%	Renewable technologies and energy efficiency.	

Table 4 Renewable Energy Grants

7 Landfill Communities Fund (LCF) Grants

The Landfill Communities Fund (LCF) is a tax credit scheme that enables operators of landfill sites to contribute money to enrolled Environmental Bodies to carry out projects that meet environmental objects contained in the Landfill Tax Regulations. Although renewable technologies are not a key focus of the LCF, the Brent River Park project as a whole is likely to be eligible for LCF funding under objective D of the LCF (further details below). Projects must also meet certain geographical criteria to qualify for LCF funding.

Objective D - The provision, maintenance or improvement of a public park or other general public amenity

The primary intent of this objective must be for the general public's benefit for leisure or recreation. The site where the work takes place must be open and accessible to the general public. The intention must not be to generate profit and the site where the work will take place must be within 10 miles of a landfill site.
You will be asked to demonstrate:

- *The amenity should directly benefit the general public and they should have open access to, or use of, the amenity.*
- *It is somewhere where the general public can go, join or use without any limit of restrictive use (through cost or rights of access) being in place;*
- *The amenity must be within ten miles of a landfill site;*
- *The intent of the project should not be to derive income;*
- *The site is a single location;*
- *The costs of the project must relate to the actual physical improvement, maintenance or provision of the identified amenity, rather than its management or its administration.*

Source: http://www.entrust.org.uk/home/lcf/objectives

Table 5 highlights LCF grants which fund projects meeting Objective D, and for which Brent River Park meets the geographical eligibility criteria.

Organisation	Funding programme	Max grant (£)	Max percentage of total cost (%)	Measures funded	Limitations
Derbyshire Environmental Trust	Lafarge Aggregates LCF	No upper limit	100%	Projects meeting Object D of the LCF (see above for further details).	
Veolia Trust	Enhancing Communities LCF	150,000	80% for projects over £25,000 100% for projects under £25,000		Maximum total project cost £500,000.
Biffaward	LCF	Small grants: 5,000 Main grants: 50,000	Small grants: 100% Main grants: 90%		Small grants: total project cost not greater than £10,000 Main grants: Local Authorities are ineligible.
Cemex	Cemex Community Fund LCF	15,000	100%		Local Authorities are ineligible.

Table 5 Landfill Communities Fund grants

8 Renewable Energy Loans

With income from the Feed in Tariff guaranteed, taking out a low-rate loan to pay for a solar PV installation may be considered a viable option.

Organisation	Programme	Max loan (£)	Typical interest rate (%)	Measures funded	Limitations
Carbon Trust	0% Business Loans	100,000	0%	Measures that will save 2.5 tonnes CO_2 per annum for every £1,000 of loan.	Public Sector organisations are ineligible. Private sector organisations must be SMEs.
Cooperative Bank	Renewables & Carbon Reduction Finance	25 million	Project dependent	Renewable technologies and carbon reduction measures.	

Table 6 Some sources of renewable energy loans

APPENDICES

9 Feed In Tariff rates

Table 7 lists the Feed-In Tariff levels payable for systems installed before April 2012. The tariffs are index-linked for inflation.

The levels applicable to systems described in this study have been highlighted in yellow.

Table 7 Feed in Tariff levels for systems installed before April 2012[8]

Energy Source	Scale	Generation Tariff (p/kWh)	Export Tariff (p/kWh)	Duration (years)
Anaerobic digestion	≤500kW	11.5	3.0	20
Anaerobic digestion	>500kW	9.0	3.0	20
Hydro	≤15 kW	19.9	3.0	20
Hydro	>15 - 100kW	17.8	3.0	20
Hydro	>100kW - 2MW	11.0	3.0	20
Hydro	>2kW - 5MW	4.5	3.0	20
Micro-CHP[9]	<2 kW	10.0	3.0	10
Solar PV	≤4 kW new build[10]	36.1	3.0	25
Solar PV	**≤4 kW retrofit[10]**	**41.3**	3.0	**25**
Solar PV	**>4-10kW**	**36.1**	3.0	**25**
Solar PV	**>10 - 100kW**	**31.4**	3.0	**25**
Solar PV	>100kW - 5MW	29.3	3.0	25
Solar PV	Standalone[10]	29.3	3.0	25
Wind	≤1.5kW	34.5	3.0	20
Wind	>1.5 - 15kW	26.7	3.0	20
Wind	>15 - 100kW	24.1	3.0	20
Wind	>100 - 500kW	18.8	3.0	20
Wind	>500kW - 1.5MW	9.4	3.0	20
Wind	>1.5MW - 5MW	4.5	3.0	20
Existing generators transferred from RO		9.0	3.0	to 2020

[8] Source: DECC, "Feed-in Tariffs: Government's Response to the Summer 2009 Consultation" (pp. 47), February 2010. http://www.decc.gov.uk/en/content/cms/consultations/elec_financial/elec_financial.aspx

[9] This tariff is available only for 30,000 micro-CHP installations, subject to a review when 12,000 units have been installed.

[10] These terms are defined as follows:

- "Retrofit" means installed on a building which is already occupied
- "New Build" means where installed on a new building before first occupation
- "Stand-alone" means not attached to a building and not wired to provide electricity to an occupied building.

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Investing in Opportunities
This project has received European Regional Development Funding through INTERREG IV B.
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