

West Midlands UTC – Expansion

Approach to Optimising Energy Use 4.6b

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1.0 Introduction

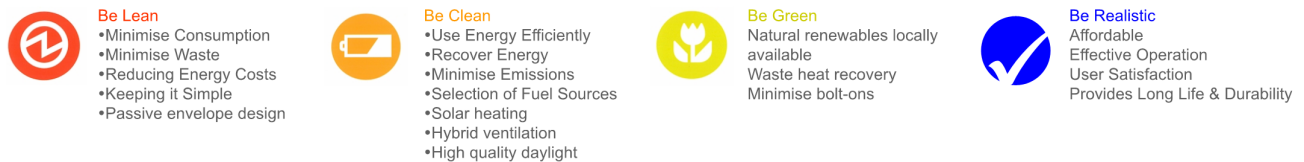
Couch Perry Wilkes (CPW) has produced a sustainability report for the new West Midlands UTC – Expansion located in Wolverhampton.

This report demonstrates how the proposed development will:

- Incorporate energy efficiency measures to meet Part L2A 2013 requirements associated with the energy demand and carbon dioxide (CO₂) emissions of the development for the new Teaching and Sports Hall Blocks.

The proposed design promotes reduced CO₂ emissions from delivered energy consumption by minimising operational energy demand through passive and best-practice measures.

The report reviews the LZC technologies to enable Part L2A 2013 compliance that would need to be incorporated into the design, if required and as deemed appropriate, as part of an integrated services strategy as opposed to a 'bolt-on' approach.



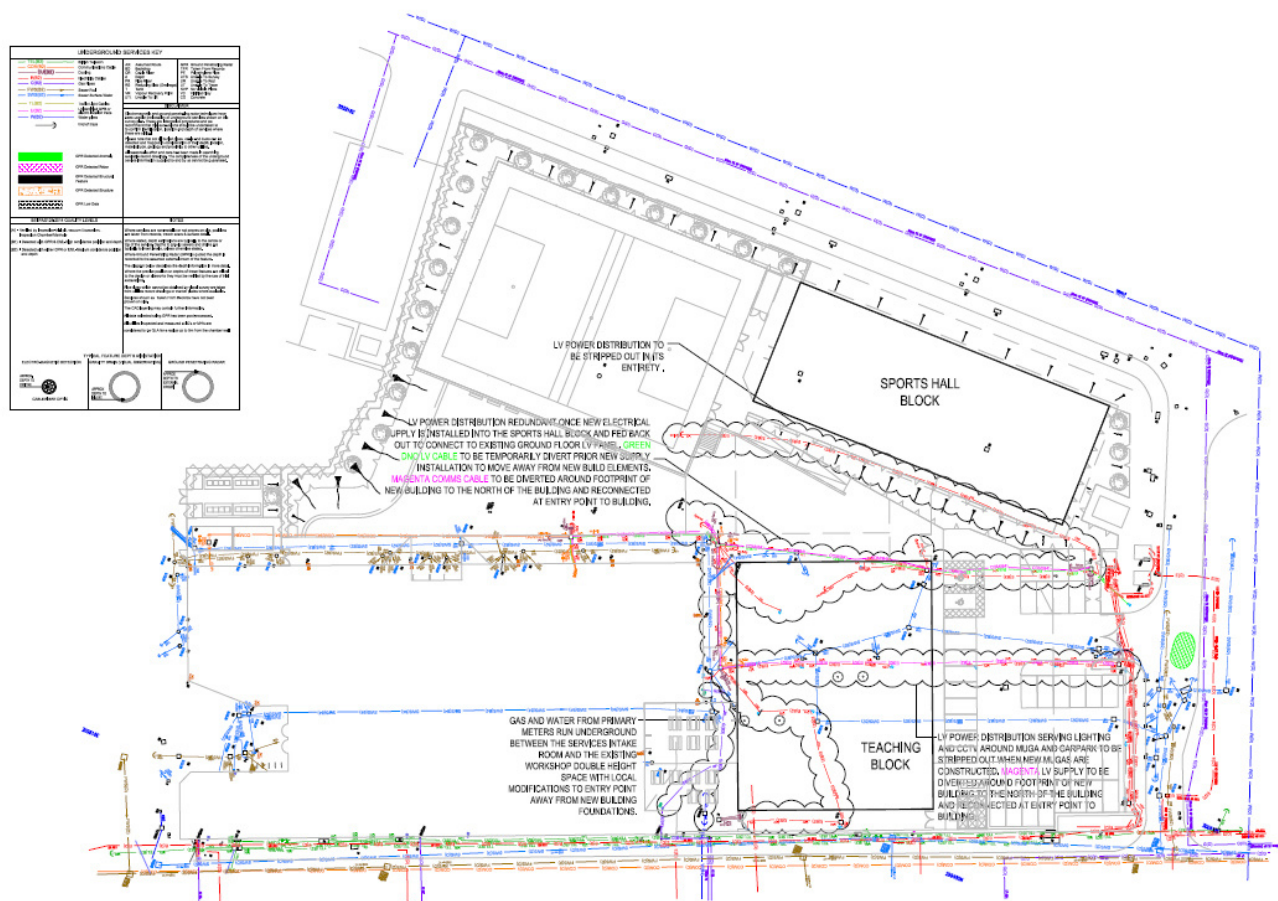


Figure 1. Proposed Site Layout Overlaid Above Existing Buried Services

2.0 Energy Benchmarking

2.1 Estimated Energy Demands and CO₂ Emissions

In order to benchmark the proposed new development, estimated energy demands and CO₂ emissions data have been calculated. This data is used as a guideline to assess the percentage of the building's total energy consumption and CO₂ emissions that could be reduced or offset by applying best practice energy efficiency measures and/or LZC technology solutions.

To assist with the formulation of an energy strategy, the estimated **regulated** energy consumption and CO₂ emissions for the development have been derived from approved DSM software (IES):

Area of the Teaching Block – 2835m²

Area of the Sports Hall Block – 1180m²

Teaching Block

The total predicted regulated notional energy consumption is: **111,500 kWhr per year**

The total predicted regulated notional CO₂ emissions are: **45,360 kgCO₂ per year**

Sports Hall Block

The total predicted regulated notional energy consumption is: **123,806 kWhr per year**

The total predicted regulated notional CO₂ emissions are: **32,096kgCO₂ per year**

Note 1. CO₂ emission factors of 0.216 for Gas and 0.519 for Electricity have been used to calculate the above and are taken from Building Regulations Approved Documents.

3.0 Energy Efficiency

In order to deliver environmentally responsible building stock, an exemplar approach is being proposed based on low energy design principles. In summary, this approach involves energy demand minimisation through effective building form and orientation, good envelope design and proficient use of services; such that the buildings themselves are being used as the primary environmental modifier.

Long term energy benefits are best realised by reducing the inherent energy demand of the buildings in the first instance before considering deployment of appropriate renewable technologies to decarbonise the development's energy supply.

These benefits are described and quantified as follows:

3.1 Building Design – Energy Efficiency

The general construction design standards to be adopted must exceed the requirements of the current (2013 Edition) Part L Building Regulations which stipulate an improvement on the CO₂ emissions of an aggregated 9% against 2010 standards.

The following table (Table 1) describes the proposed minimum building envelope thermal performance criteria.

Element	Part L 2013 Building Regulations U-Value (W/m ² K)	Target U-Value (W/m ² K)	Notes
General Glazing (including frame)	U = 2.20	U = 1.60	Glass to achieve a total light transmission of 0.70 (g = 0.40)
Roof Lights (including frame)	U = 2.20	U = 1.60	Glass to achieve a total light transmission of 0.70 (g = 0.40)
External Walls	U = 0.35	U = 0.18	
Roof	U = 0.25	U = 0.15	
Ground Floor	U = 0.25	U = 0.21	
Thermal Bridging ψ Value	0.035W/mK	0.035W/mK	

Table 1. Summary of Building Envelope Thermal Performance Criteria

In accordance with the requirements of a low energy building, the air tightness characteristics will be addressed. With robust design, the target proposed for the buildings is $4.0\text{m}^3/\text{m}^2/\text{hr}$ @ 50Pa. This compares to the current Part L Building Regulations standard of $10\text{m}^3/\text{m}^2/\text{hr}$ @ 50Pa and hence represents a betterment of 60%.

High levels of natural daylight will be provided, wherever possible, through effective window and roof lights design as required by the DfE for Climate-Based Daylight Modelling. The glazing specifications for the new buildings will be optimised to ensure that the glazed elements provide excellent thermal performance combined with optimum solar reflectance to minimise summer solar heat gains along with high daylight transmittance factors to maximise daylight factors. Encouraging the correct quality and quantity of daylight to penetrate the buildings is key to reducing the amount of light required from artificial sources and hence energy requirements.

It is imperative that the lighting design philosophy provides the correct quality of lighting with minimum energy input and hence reduce internal heat gains. In the buildings, energy efficient lighting (including LEDs with an efficacy of 100 lumens per circuit Watt,) will be deployed throughout and lighting schemes will be appropriately zoned to allow control of luminaires via switches/absence detection and daylight sensors. Output performance or Light Output Ratios (LORs) will exceed 90%.

To complement the significant improvements in envelope design and lighting provision, the building services heating and ventilation systems being proposed will also drastically reduce the inherent energy consumption of the site.

The provision of an effective control and metering philosophy is fundamental to the efficient operation of the building's environmental services. The following provides an overview of the plant efficiency and control measures that are proposed:

- Air-source heat pump (ASHP) heating/cooling (VRV/VRF) to ICT Spaces providing heating and cooling to maintain a comfortable temperature.
- Low temperature flow and return hot water heating to maximise heat generating efficiency and minimise distribution losses.
- High efficiency hybrid heat recovery ventilation with automatic control strategy to the teaching spaces via a mixture of Natural Ventilation Heat Recovery [NVHR], Mechanical Ventilation Heat Recovery [MVHR] and centralised air handling units serving large volume spaces with high occupancy levels. i.e. sports hall and drama space.
- Modular open architecture controls systems and associated network.
- High efficiency low energy motors to be used to drive mechanical ventilation systems.
- Variable speed pumps and fans to be used to promote lower operating costs and help match energy usage with the operating profile and occupancy of the building.
- Sub-metering to be provided such that approximately 90% of the input energy from each utility service may be accounted for at end use. The Building Management System (BMS) will be interfaced to provide automatic monitoring and targeting of all sub-meters to promote energy management and deliver lower consumption.

4.0 Appraisal of Renewable and Low Carbon Technology Energy Options

The technical feasibility and economic viability of installing each LZO technology at the West Midlands UTC - Expansion, Wolverhampton development have been assessed in order to discount any unsuitable options at an early stage. A summary of the feasibility process is tabulated below, and an overview of each viable technology is given subsequently.

Technology	Brief Description	Benefits	Issues/Limitations	Feasible for site
Solar Photovoltaic	Solar photovoltaic panels convert solar radiation into electrical energy through semiconductor cells. They are not to be confused with solar panels which use the sun's energy to heat water (or air) for water and space heating.	Low maintenance/no moving parts Easily integrated into building design	Any overshadowing reduces panel performance Panels ideally inclined at 30° to the horizontal facing a southerly direction	Yes
Solar Thermal	Solar thermal energy can be used to contribute towards space heating and hot water requirements. The two commonest forms of collector are panel and evacuated tube.	Low maintenance Little/no ongoing costs Income generated from Renewable Heat Incentive (RHI) scheme	Must be sized for the building hot water requirements Panels ideally inclined at 30° to the horizontal facing a southerly direction	No, due to peak delivery of system during warmer external weather which is normally when the school is closed.
Ground Source Heat Pump (GSHP)	GSHP systems tap into the earth's considerable energy store to provide both heating and cooling to buildings. A number of installation methods are possible including horizontal trench, vertical boreholes, piled foundations (energy piles) or plates/pipe work submerged in a large body of water. The design, installation and operation of GSHPs is well established.	Minimal maintenance Unobtrusive technology Flexible installation options to meet available site footprint Income generated from Renewable Heat Incentive (RHI) scheme	Large area required for horizontal pipes Full ground survey required to determine geology More beneficial to the development if cooling is required Integration with piled foundations must be done at an early stage	No, prohibitively expensive installation costs
Air Source Heat Pump	Electric or gas driven air source heat pumps extract thermal energy from the surrounding air and transfer it to the working fluid (air or water).	Efficient use of fuel Income generated from Renewable Heat Incentive (RHI) scheme	Specialist maintenance More beneficial to the development if cooling is required Requires defrost cycle in extreme conditions Some additional plant space required	No, prohibitively expensive installation costs

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Technology	Brief Description	Benefits	Issues/Limitations	Feasible for site
Wind Turbine (Stand-alone column mounted)	Wind generation equipment operates on the basis of wind turning a propeller, which is used to drive an alternator to generate electricity. Small scale (1kW – 15kW) wind turbines can be pole or roof mounted.	Low maintenance/ongoing costs Minimum wind speed available Excess electricity can be exported to the grid	Planning issues Aesthetic impact and background noise Space limitations on site Wind survey to be undertaken to verify 'local' viability	No, not suitable on this site
Wind Turbine (Roof Mounted)	As above	Low maintenance/ongoing costs Minimum wind speed available Excess electricity can be exported to the grid	Planning issues Aesthetic impact and background noise Structural/vibration impact on building to be assessed Proximity of other buildings raises issues with downstream turbulence Wind survey to be undertaken to verify 'local' viability	No, not suitable on this site
Gas Fired Combined Heat and Power	A Combined Heat and Power (CHP) installation is effectively a mini on-site power plant providing both electrical power and useful heat. CHP is strictly an energy efficiency measure rather than a renewable energy technology.	Potential high CO ₂ saving available Efficient use of fuel Excess electricity can be exported to the grid Benefits from being part of an energy centre/district heating scheme	Maintenance intensive Sufficient base thermal and electrical demand required Some additional plant space required	No, not suitable on this site
Bio-fuel Fired Combined Heat and Power	As above.	Potential high CO ₂ saving available Efficient use of fuel Excess electricity can be exported back to the grid Benefits from being part of an energy centre/district heating scheme Income generated from Renewable Obligation Certificates (ROCs) and	Maintenance intensive Sufficient base thermal and electrical demand required Significant plant space required Biomass fuelled systems are at early stages of commercialisation Large area needed for fuel delivery and storage	No, not suitable on this site

West Midlands UTC - Expansion - Sustainability Report

Technology	Brief Description	Benefits	Issues/Limitations	Feasible for site
		Renewable Heat Incentive (RHI) scheme	Reliable biomass fuel supply chain required	
Bio-Renewable Energy Sources (Automated feed – wood-fuel boiler plant)	Modern wood-fuel boilers are highly efficient, clean and almost carbon neutral (the tree growing process effectively absorbs the CO ₂ that is emitted during combustion). Automated systems require mechanical fuel handling and a large storage silo.	<p>Stable long term running costs</p> <p>Potential good CO₂ saving</p> <p>Income generated from Renewable Heat Incentive (RHI) scheme</p>	<p>Large area needed for fuel delivery and storage</p> <p>Reliable fuel supply chain required</p> <p>Regular maintenance required</p> <p>Significant plant space required</p>	No, not suitable on this site
Fuel Cells and Fuel Cell Combined Heat and Power	Fuel cells convert the energy of a controlled chemical reaction, typically involving hydrogen and oxygen, into electricity, heat and water vapour. Fuel cell stacks operate in the temperature range 65°C – 800°C providing co-generation opportunities in the form of Combined Heat and Power (CHP) solutions.	<p>Zero CO₂ emissions if fired on pure hydrogen and low CO₂ emissions if fired on other hydrocarbon fuels</p> <p>Virtually silent operation since no moving parts</p> <p>High electrical efficiency</p> <p>Excess electricity can be exported back to the grid</p> <p>Benefits from being part of an energy centre/district heating scheme</p>	<p>Expensive</p> <p>Pure hydrogen fuel supply and distribution infrastructure limited in the UK</p> <p>Sufficient base thermal and electrical demand required</p> <p>Some additional plant space required</p> <p>Reforming process, used to extract hydrogen from alternative fuels, requires energy; lowering overall system efficiency</p>	No, expensive, emerging technology

Table 2. Summary of Renewable and Low Carbon Technology Energy Options

4.1 Solar Photovoltaic (PV) Panels

Solar photovoltaic panels convert solar radiation into electrical energy through semiconductor cells. They are not to be confused with solar panels which use the sun's energy to heat water (or air) for water and space heating.



Figure 2. Solar PV Installation

Photovoltaic panels are available in a number of forms including mono-crystalline, polycrystalline, amorphous silicon (thin film) or hybrid panels. Polycrystalline products offer the best combination of performance and cost at present. They are fixed or integrated into a building's un-shaded south facing façade or pitched roof.

It is essential that the panels remain un-shaded, as even a small shadow can significantly reduce output. This is not an issue on warehouse projects due to the uncluttered nature of the roof. The individual modules are connected to an inverter to convert their direct current (DC) into alternating current (AC) which is usable in buildings.

Photovoltaic technology may be feasibly incorporated into the building design with little/no maintenance or on-going costs. Installations are scaleable in terms of active area; size being restricted only by available façade and/or roof space.

A particular advantage of solar PV is that running costs are very low (requires no fossil fuel for operation) and, since there are no moving parts, very little maintenance is required.

It should be noted that the installation and connection of embedded generation equipment to the mains electrical utility grid (National Grid), including solar PV panels rated at more than 16A per phase, is subject to technical approval by the District Network Operator (DNO). This takes the form of a G99 agreement. The G99 is the regulation surrounding the connection of any form of generator device to run 'in parallel' or 'synchronised' with the grid.

The DNO are required (under the Connection and Use of System Code) to make a request for a Statement of Works (SoW) to National Grid Electricity Transmission plc (NGET) in relation to the potential impact of connection of embedded generation on the National Electricity Transmission System (NETS). As such, there is no guarantee that approval for the connection of embedded generation equipment will be granted.

4.2 Energy Monitoring and Water Use

As per the DfE's generic design brief requirements set out in Technical Annex 2H – Section 5 'In use Monitoring' and in order to record and benchmark the energy consumption and water usage, the design solution will be designed to allow 15 minute interval continuous monitoring and benchmarking data using iSERV methodology (or equivalent system) and allow data to be uploaded to the K2n national benchmarking database (or equivalent system) on at least a monthly basis, and preferably on a daily basis, to enable automated reporting against DfE targets.

The data will allow the School's facility managers to identify and remedy problems such as inadequate system control or incorrect default settings. These reports will help the school to manage their energy consumption and identify avoidable waste.

The iSERV (or equivalent) facilities and services spread sheet will be completed prior to financial close. The energy consumption will be identified in terms of gas and electricity as well as the individual end uses and this information will benchmark the new building against other similar schools. This may identify areas where energy is being wasted and identify where savings might be made.

The BMS shall be provided via an IP based system. This will allow the BMS to be interrogated via the internet from any device.

Graphics for each major plant item; menu driven for selection; monitoring and control of all major plant items; global and individual control and adjustment of operating times/temperatures for each operating zone; monitoring and reporting of fault/trip conditions and critical alarms

- Heating schematic; ventilation schematic; domestic hot water schematic; electrical schematic, sub-metering and energy graphic. All graphics to show live values and allow historical review of energy usage for the previous 2-weekperiod as a minimum. Automatic uploading of sub-metering,zone temperature and CO2 data monthly to the iSERV system to allow data analysis with feedback to School staff for monitoring and benchmarking purposes and to assist with the formal BPE reviews at 6 and 12 months following handover
- Web enabled to allow remote access to all data
- A BMS head end and a user interface display on the ground floor plant room control panel

5.0 Summary and Conclusions

In order to deliver environmentally responsible building stock, an exemplar approach is being proposed based on low energy design principles. In summary, this approach involves energy demand minimisation through effective building form and orientation to promote high levels of daylight, good envelope design and proficient use of building services such that the buildings themselves are being used as the primary environmental modifier.

It is worthy of note, that long term energy benefits are best realised by reducing the inherent energy demand of the building in the first instance.

Other LZC technology solutions have been discounted on the grounds that they are not technically feasible or economically viable for the development, as described in Table 2 of this report.

Type	Heating	Hot Water	Small Power	Lighting	Fans and Pumps	Cooling	Lifts	Total
OS Electrical Requirements	20	4	25	13	7	1	1	75
Electrical equivalent [kWh/m ²]	5.88	22.72	28.19	9.29	2.95	0.47	1	79.23*

*The assessment for hot water is higher in the D1 non-residential changing room NCM template throughout the weekday and also makes allowance for weekend activities. The school will not be using the sports facility for community use and therefore in real terms the hot water demand will be much lower than stated above.