



Energy Strategy Report
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Sandilands Primary School
PA1681

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Executive Summary

The DfE requires the production of an Energy Assessment which is structured according to an Energy Hierarchy and shows how the building is to achieve net zero carbon in operation. This Energy Assessment demonstrates how the building has considered these steps and that the net zero carbon in operation target is met by demand reduction in the first instance, clean energy sources, then by a series of renewable energies including a large PV array and ASHP.

The DfE benchmark of 52 kWh/m²/year will be achieved as a consequence of the design proposals. Based on the estimate energy load from the TM54, we anticipate this to be able to be reduced down to 51.86 kWh/m²/year.

These results show that by following the energy hierarchy the proposed scheme has been able to significantly reduce the energy use of the building and deliver significant reductions in energy use and CO₂ emissions before renewables were considered.

Net zero carbon in operation is a project requirement for the school and it has been estimated from the energy use shown above that up to 720m² of PV would be required on the project to ensure that net zero carbon in operation for the school, for school teaching hours only, would be achieved.

1.0 Planning

The following policies are relevant to this development and supporting energy statement.

These include;

- Local Planning requirements
- Building Regulations compliance
- Employer's Requirements

1.1 Local Council

For all major planning applications, the local council requires the planning submission to demonstrate how Climate Change has been considered in the design of the development and what adaptation and mitigation measures have been put in place.

Developments will be expected to minimise resource and energy consumption as well as carbon emissions through the inclusion of sustainable design and construction features where this is technically feasible and viable, with further consideration to be given to the whole-life carbon cost of development.

The council also state that consideration should be given to how developments can be future-proofed so that they are resilient and adaptable to future climatic changes, such as an increase in extreme weather events.

The main objectives relevant to the council is to promote a sustainable scheme, and limit the use of natural resources, reducing the need to travel and maximising the use of renewable energy.

1.2 Approved Document Part L2A Compliance

Approved Document Part L2A 2021, consists of five criteria but only three out of the five can be addressed during the design stage.

The building 'as designed' is considered to meet Regulation 17C as follows:

- Criterion 1 – The calculated CO₂ emission rate for the building should not exceed the target emission rate.
- Criterion 2 – The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency.
- Criterion 3 – The spaces in the building should have appropriate passive control measures to limit solar gains.

To achieve Part L2A compliance, the actual building emission rate (BER) needs to be better than Notional (Target) emission rate (TER).

1.3 Employers Requirements

The building must comply with the DfE Output Specification, specifically the Technical Annex 2H Energy & Technical Annex Sustainability Brief. Therefore, the design must follow the energy efficiency hierarchy of Be Lean, Be Clean and Be Green.

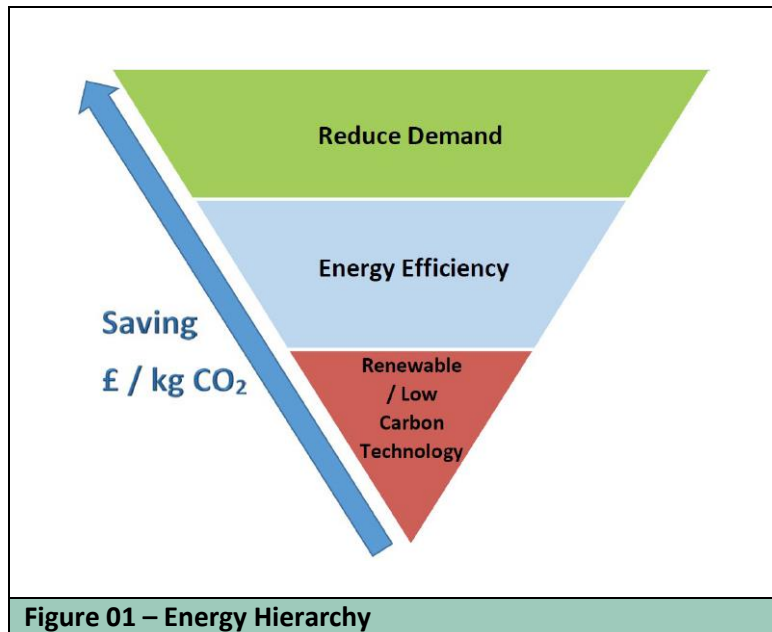
The school specific brief dictates that the new build elements of this project must achieve net zero carbon in operation.

It has been clarified that the net zero carbon in operation requirement refers to the new build teaching block only and includes only school use hours. Community use and EV charging are not to be taken into account.

2.0 Energy Strategy

In order to achieve net zero carbon in operation, the school will be designed in line with the energy efficiency hierarchy:

- Be Lean – use less energy
- Be Clean – efficient energy supply
- Be Green – renewable energy



The energy strategies discussed below will apply to the new teaching block.

2.1 Thermal Comfort

Thermal comfort will be a key driver in the project, with the aim to future proof the school against the risks of climate change.

The updated Technical Annex: Sustainability Brief introduces an alternative standard to the current overheating risk assessment criteria defined within Technical Annex 2F.

The new standard dictates that new schools are required to demonstrate compliance with the Overheating Risk Assessment (ORA) using a weather file that represents 2°C global warming above pre-industrial levels.

In addition, the requirement is for new schools to demonstrate how the school could adapt to achieve compliance with 4°C warming above pre-industrial levels. Proposed adaptation measures should not include changes to the superstructure of the building and shall not use active cooling.

These new standards are a significant upgrade to the requirements previously defined in Technical Annex 2F and passive design solutions such as exposed thermal mass and cross ventilation will now be a requirement to enable the building to meet the standards.

The following passive design elements will likely need to be incorporated into the building for it to achieve the requirements listed above:

- High floor to ceiling heights with exposed soffits to reduce internal air temperatures in classrooms.
- High thermal mass to help retain heat and reduce internal temperature fluctuations.
- External shading and low G-values to limit solar gains. Larger glazing areas may be required to achieve daylighting levels.
- Tall windows and central atriums/lightwells to achieve daylight levels.
- Cross ventilation & large window openings/louvres using the stack effect, to draw air through a building.
- Hybrid ventilation strategies
- Radiators/NVHR supplied via the ASHP
- Direct electric local hot water generation
- Passive cooling to the comms rooms

3.0 Demand Reduction (Be Lean)

The passive measures to be included within the design of the new teaching block at Sandilands Primary School, to reduce energy use and the associated CO₂ emissions are:

- Improved building fabric parameters over the proposed targets, where it is found to be technically, functionally and economically feasible to do so.
- Improved air permeability over the proposed target, where it is found to be technically, functionally and economically feasible to do so.
- High thermal mass throughout the building where possible to limit the risk of overheating during the summer period.

3.1 Building Form

The building massing and form, including the orientation, has been limited due to the site constraints, however where possible the internal spaces planning, location of windows have been optimised to minimise the impact to the environment.

In addition, the building has been sited to optimise the provision of external areas (Guidance Document, Building Bulletin 103, Part B: The Site externals) and the Trust's physical education curriculum.

As noted below, the thermal performance has been optimised to balance daylight and unwanted solar gains.

The server room has been positioned to minimise solar gains thereby reducing the need for additional cooling.

Roof lights will be avoided where possible to increase the area available for PV.

3.2 Building Fabric

The design has taken a fabric first approach. The performance of the thermal elements will be optimized to minimise heat loss during the winter and heat gains in the summer. This will lead to reduced heating & cooling loads, reducing the carbon dioxide emissions from the buildings energy sources to maintain the required indoor temperatures.

The following table sets out the proposed building fabric standards which are currently in line with DfE requirements. These will be improved on by the design team where it is found to be technically, functionally, and economically feasible to do so.

Element	DfE Targets	Proposed Targets
Roof	0.12 W/m ² .K	0.10 W/m ² .K
External Wall	0.15 W/m ² .K	0.11 W/m ² .K
Ground Floor	0.12 W/m ² .K	0.10 W/m ² .K
Windows	1.1 W/m ² .K	1.10 W/m ² .K *
Thermal Bridging	0.04 (y-value)	0.035 (y-value)

*Target U-value for windows is based on triple glazing.

Thermal Mass

The proposed structure shall consist of thermal mass, which shall be exposed in high occupancy areas such as teaching and learning spaces. This will help to limit the risk of overheating during the summer period. Thermal mass is used as a heat sink during the day where it absorbs the rooms heat gains and coupled with night-time cooling via the local hybrid ventilation units, releases the heat from the mass during the night.

Glazing

The glazing performance, properties and ratios, have been optimized to balance heat loss, natural daylight, risk of overheating and acoustics. The selected light transmittance and G value will allow for a good balance between achieving good daylighting whilst avoiding the risk of overheating.

The proposed G value of the glazing is subject to confirmation from detailed building modelling, however at this stage of the project a G value of 0.35 is a good target.

3.3 Air Tightness

The building is targeting an air permeability rate of 3m³/(h.m²) @ 50pa. Whilst this is low, it is an achievable target with modern construction techniques. This will be improved on by the design team where it is found to be technically, functionally, and economically feasible to do so.

3.4 Building Systems

High-efficiency plant, controls and equipment will be incorporated as follows:

LED Lighting

Internal lighting within all areas of the building will incorporate energy-efficient LED lighting throughout. Lighting controls will be provided to limit energy use.

Automatic presence detection will be included in appropriate areas. This form of control will ensure lights are automatically switched off during periods of non-occupancy.

Optimum glazing ratios and roof lights will be used to provide useful natural daylight to reduce the reliance on artificial lighting during daytime hours.

External lighting will be designed to incorporate energy efficient luminaires and an automatic lighting control system utilising daylight sensors and time clock control to ensure energy-efficient operation of the lighting.

Ventilation

Occupied spaces will be served primarily with local hybrid ventilation units or zonal MVHR units incorporating heat recovery to recover waste heat from the exhaust air. This is then used to heat the incoming fresh air and therefore reduce energy usage.

Mechanical ventilation will operate automatically based on CO₂ and room temperature readings. In the summer, the users will have local control to open the windows to boost the ventilation rates, subject to external noise levels.

Any air handling plant will have a low specific fan power to minimise the energy used by the fans.

Controls

The controls solution will allow operation of the plant to minimise the delivered energy to maintain the internal environment. Heating & ventilation services will be locally controlled to ensure that only the correct amount of fresh air or heat energy is provided in each space or area of the building.

Where separate rooms are fed from the same MVHR unit, such as in staff offices, units will be time controlled to ensure that air is supplied whilst the building is occupied and switched off to save energy when the building is not in use.

Plant Efficiency

Auxiliary plant such as fans and pumps will be variable speed. During the detailed design stage, delivery systems such as ducts and pipes, will be sized to balance operational efficiency and capital expenditure.

Metering & Demand Control

A comprehensive controls and metering package will be implemented and connected to a central building energy management system (BEMS). Using occupancy and air quality sensors, plus variable speed fans and pumps, the building systems will be optimised to match the buildings energy demand to the buildings energy consumption.

The BEMS will also record the energy consumption of the end use systems so that the school can validate their energy bills and use the data for educational purposes. The BEMS will be developed in line with Technical Annex 2H.

Power Factor Correction

The electrical system will incorporate power factor correction to achieve a whole building power factor of greater than 0.95.

4.0 Heating & Cooling Infrastructure (Be Clean)

The potential to serve the scheme from a district heat network has been evaluated. According to the Association for Decentralised Energy (<https://www.theade.co.uk/resources/publications/district-heating-installation-map>) there are no existing, future or potential extensions in the vicinity to connect to.

5.0 Renewable Energy (Be Green)

In order to achieve a net zero carbon in operation building a good mix of renewable energy technologies will be required to offset energy used within the building.

5.1 Feasibility Study

The section below details the various low carbon and renewable technologies which have been considered for Sandilands Primary School.

Photovoltaics (PVs)

A photovoltaic array on the roof of the new school building, canopy and car park canopies are available and are to be pursued if possible. A large-scale PV array of approx. 720 m² is highly likely to be the best way for the school to generate its own electricity and offset its electrical usage.

Solar Thermal

An array of solar thermal hot water collectors could be installed on the roof of the building, in a similar manner to the PV's.

Solar thermal hot water collectors are more expensive than PVs, but typically save more energy over their lifetimes, with payback periods generally below 5 years.

The solar thermal hot water collectors would produce low grade hot water that could pre-heat the domestic hot water used in the building, taking this load off the central plant, which helps to reduce energy use and in the building.

Solar thermal hot water collectors work great when they are installed in combination with traditional gas boilers. The energy produced by the collectors is offset against the gas boilers saving a high level of carbon.

Gas boilers will not be considered for the school as we are looking to achieve a net zero carbon in operation building and therefore the benefits of solar thermal hot water collectors will be dampened to some degree.

Wind Generation

Wind power or wind energy is the use of wind to provide mechanical power through wind turbines to turn electric generators for electrical power.

Land-based utility-scale wind is one of the lowest-priced energy sources available today, costing just a few pence per kWh to produce. A sole wind turbine built on the school's land would not be quite as competitive but would have the potential to generate a significant amount of energy and contribute to a net zero carbon in operation building.

Unfortunately, wind turbines are not well suited to urban environments as noise pollution can be difficult to control and for this reason planning permission for a wind turbine can be very difficult to achieve. Due to the fast-moving nature of this scheme, we would suggest that it is too late to consider this technology on this project.

Ground Source Heat Pump

A ground source heat pump (GSHP) system harnesses natural heat from underground by pumping water through it in pipes. The heat pump then increases the temperature, and the heat is used to provide heating or hot water to the building.

Although GSHP do provide the ability for passive cooling this technology won't be adopted on Sandilands Primary School.

Air Source Heat Pump

Air source heat pumps (ASHP) work in a similar way to GSHPs, but rather than recover the heat from the ground, they take the heat energy out of the air. ASHPs require much less space than GSHPs to be installed and are usually far cheaper to install.

For these reasons, ASHPs should be investigated and considered as an option on the project to provide to baseline and peak heat demand alongside resilience in line with the DFE output specification.

The estimated demand for the heat pumps on this project is 100kW, which includes redundancy.

As part of this review the GSHP was considered in terms of improved efficiency, site constraints, programme and costs.

Efficiency

A ground source heat pump (GSHP) system harnesses natural heat from underground by pumping water through it in pipes. The temperature below ground is fairly consistent and this means that GSHPs have higher seasonal COPs than ASHPs, which have to contend with the much higher temperature fluctuations of the air above ground level.

GSHPs can be expected to provide approximate savings of 25% (COP of 4.1 instead of the 3.1 for the ASHP) on the heating and domestic hot water services systems. For this building, this equates to a total demand of 11.3 kWh/m²/Yr, as per the Energy Strategy Report.

- Total consumption with ASHP – 25,996 kWh
- Total consumption with GSHP – 19,497 kWh
- Saving for utilising GSHP 6499 kWh

By utilising the GSHP to provide both the heating and domestic hot water the energy saving between this and the ASHP solution would be 6499 kWh. This would equate to a 7.5kWp PV array.

To provide a 7.5 kWp PV array, 19 PV Panels would be required, which would equate to an additional 38m² of PV.

As can be seen above, the GSHP is more efficient than the ASHP, but since the heating & DHW loads only make up a small portion of the buildings total energy use, the increase in efficiency could be offset by an additional 38m² pf PV.

Site Constraints

For Sandilands Primary School, a borehole array would be required to supply 140kW of heat to the new building to cover the peak heating and DHW loads.

The Bore holes are approx. 100m deep and the spacing between them can be up to 16m apart.

Each bore hole can deliver between 4-8 kW, which means on this site we would require approx. 24 boreholes. This is a large borehole array and would equate to up to 6200m² of space required on the school grounds.

Although this will fit on the site it would effectively cover the playing fields and present significant challenges when it comes to site logistics, including affecting where site cabins and temporary car parking could be placed.

The drilling of the boreholes uses a lot of heavy machinery which adds to the noise pollution and environmental pollution around the site, which has a negative effect on the existing school and neighbours.

In addition, extra plant space would also be required above the SOA allowance to install the main plant for the GSHP. This would likely be in the form of an external GRP type enclosure.

Programme

The GSHP borehole array also has a negative affect on the programme for the project.

The drilling of the boreholes will likely add time onto the programme for the project as this type of work can take many months to complete. Unforeseen ground conditions can often lead to extensive delays which would increase the risk to the project.

The drilling of the boreholes will involve digging up large areas of the existing playing fields, which would then have to be reinstated and returfed to be useful again. This could take some time and will potentially delay the schools use of these outdoor spaces.

Costs

We understand that the costs for a GSHP were included within the control option for the school, however GSHPs are significantly more expensive than ASHPs.

In addition to the monetary costs, the GSHP also has a carbon cost. There is a carbon cost associated to the digging and drilling activities, and also the carbon costs of the materials that make up the boreholes and pipework that link them together.

It is unknown how long the GSHP would need to be running to “offset” this additional carbon cost, which could be significant.

Taking all the above into account, it was decided that an ASHP solution with additional PV would be a better fit for the project and provide less risk to the programme.

Bore Hole Requirements



Combined Heat & Power (CHP)

A CHP unit is an energy efficient technology that generates electricity and captures the heat that would otherwise be wasted, to provide useful thermal energy which can be utilised elsewhere in the building.

A CHP unit is not well suited to this building, because although it can help to reduce energy use within a building, it uses natural gas to do so and therefore, doesn't contribute to reducing the buildings carbon emissions.

In fact, with the drop in the electrical grid carbon factor seen in recent years, a CHP unit would increase the carbon emissions of the building and therefore will not be considered for this project.

Fuel Cells

Fuel cells cleanly and efficiently convert chemical energy from hydrogen-rich fuels, into electrical power and heat via an electrochemical process that is efficient and emits water rather than pollutants, as there is no burning of the fuel like there is in a traditional CHP unit.

Because there is no combusting of fuel, virtually no harmful emissions are generated by the fuel cells.

However, fuel cell technology is still developing, and their availability is still limited to a small number of manufacturers whose ability to provide long term support in the UK market is still largely unproven.

When considering the recovered heat, the Fuel Cell can have an energy efficiency of over 80%, which is comparable to a traditional Stirling engine CHP as described above. However, most of the energy produced is electricity (around 60%) and the rest (around 20%) is waste heat energy that can be recovered and used in the building. This means that the fuel cell technology is more suited to buildings with high electricity usage such as offices, rather than leisure centres.

However, in a similar manner to the CHP above, a unit is not well suited to this building, because although it can help to reduce energy use within a building, it uses natural gas to do so and therefore, doesn't contribute to reducing the buildings carbon emissions.

Biomass Boilers

A biomass boiler works in a very similar way to conventional boilers, combusting fuel to produce heat which is then used to heat water. However instead of using fossil fuels they burn wood pellets.

Using wood in place of fossil fuels helps to prevent long-term climate change, since the carbon dioxide released during the combustion was absorbed while the tree was growing, so they are essentially carbon neutral.

However, there are a number of reasons which would cause the biomass boiler to be unsuitable for this project:

- Spatial issues due to the large boiler size and adjacent fuel store.
- Air quality issues due to the burning of wood pellet fuel
- Regular fuel deliveries and space needed for these.

For these reasons, Biomass Boilers have been deemed unsuitable for the project.

Earth Tubes

An earth tube is a buried ventilation duct which transfers fresh outdoor air to a building. The idea being that the soil surrounding the ducts will warm the ventilation air during the winter and cool the ventilation air during the summer.

Earth tubes can be very good at tempering incoming air, with air typically being cooled by 1 – 2 deg C as it travels down the tubes, but the amount of heat gained or rejected into the soil varies heavily on the length of the tube and how deep it is buried.

The heat provided by earth tubes would be additional to that provided by the primary heat source, such as the ASHP which would be needed to achieve the net zero carbon in operation requirement.

The additional heat provided by the earth tubes would also be gained before any ventilation heat recovery devices and therefore slightly reduces the efficiency of the ventilation heat recovery system. This would not be the case with heat provided by an ASHP system.

Earth tubes are becoming less and less common as issues with condensation and mold growth within the tubes are frequently reported.

The amount of earth works required to install a large earth tube system is extensive and would require the reinstatement of sports pitches to Sport England standards at a massive cost to the project.

The cost of installing the earth tubes would never be paid back and considering installation issues, maintenance issues, repair issues, contamination issues, proper sizing (both size and surface area/heat exchange properties), longevity issues (materials & site) earth tubes are deemed impracticable.

For these reasons, it is not proposed to utilise this technology on for the majority of the scheme.

It should be noted the feasibility brief does require a passive cooling measure to be adopted for the comms room to provide passive cooling.

Greywater Heat Recovery

Due to the water usage of the school being low the use of a grey water heat recovery system is not feasible.

Battery Storage

Battery storage has come a long way over the last few years, with many utility providers now using large scale battery storage plants and the cost of batteries reducing significantly every year, meaning these installations are becoming more and more common.

Battery storage could be used within the building to increase the percentage of electricity generated and utilised on site. Reducing the amount of energy that is sold to the national grid.

However, despite the constant decrease in battery costs, it would take a large capital outlay to install enough batteries to make a significant difference to the energy imbalance and the financial outlay would likely never be paid back.

Rainwater Harvesting

Rainwater harvesting is the collection and storage of rain for a variety of uses – but not for drinking. Although it is possible to use the collected water for supplying washing machines, or irrigating garden areas, the majority of systems in commercial buildings are used for the flushing of toilets.

Rainwater harvesting is frequently installed when a key driver of the project is to reduce water usage, such as when a project is targeting BREEAM 'Very good' or 'Outstanding'.

A rainwater harvesting system would not contribute to the reduction of carbon emissions and therefore on this project, it has been deemed that capital expenditure is better spent elsewhere.

5.2 Be Green Summary

The feasibility study above and the energy modelling completed on previous projects to date suggests that an ASHP should be the preferred solution for the buildings heat energy supply. With its low SCOP and ability to operate on grid supplied electricity or on-site generated electricity it is likely to be the most efficient and low carbon solution.

To achieve net zero carbon in operation the school must be capable of generating a large amount of electricity on site. In order to do this a large solar PV array will be required. This would need to be 720m² to generate electricity.

6.0 Energy Benchmarks

In line with DfE requirements, and to demonstrate a net zero carbon in operation design strategy, an assessment has been carried out to predict the total energy consumption and carbon emissions of the proposed new school building, which is a separate exercise from the standard Part L calculations.

Through the utilisation of CIBSE TM54 modelling methodology on typical rooms and applying several proven assumptions; a concept energy model has been developed to demonstrate the potential energy in use for each end system.

The energy assessment below is purely for the new school building and includes school use only. No community use or EV charging has been included.

6.1 Energy Use Intensity Targets

Technical Annex 2H Energy provides energy targets that must be achieved by all new school buildings, prior to the application of renewables.

The energy use intensity target for schools is 67 kWh/m².

The Technical Annex provides the following breakdown as an indication of how to achieve the overall EUI targets by end use system:

System	End Use Energy Benchmark (kWh/m ²)
Space Heating	8
Domestic Hot Water	5
Internal Lighting	8
Fans & Pumps	5
Cooling	Zero
Lifts	1
Building Related Services	2
External Lighting	6
Small Power	10
Server Room	Zero
Catering	7
Total	52

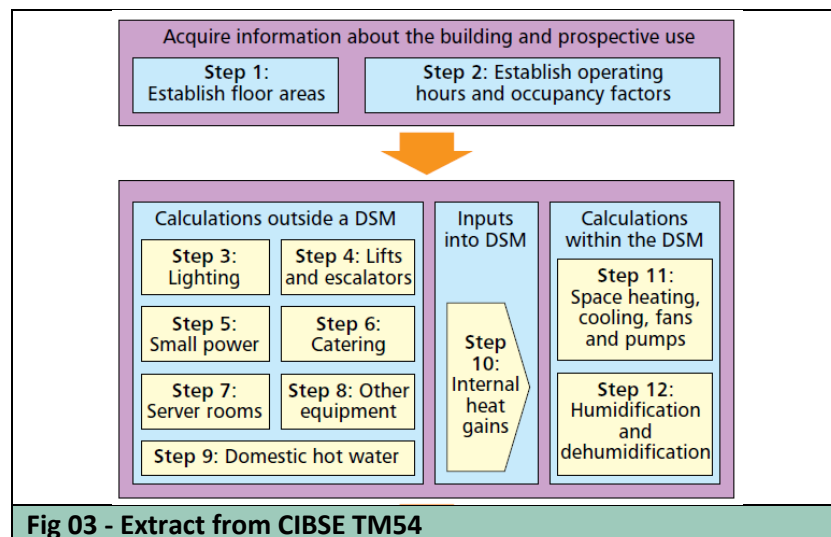
Once energy targets are met, net zero carbon in operation will then be assessed.

6.2 CIBSE TM54

The aim of the TM54 energy assessment is to help engineers, designers and, most importantly stakeholders, consider likely energy impacts of new buildings and to provide a methodology to undertake better informed calculation of energy use in operation.

The outputs of this assessment can be used to monitor the performance of the new buildings once completed and in operation while also providing useful data that can contribute to energy forecasting activities.

Figure 03 below shows the general approach adopted for the various components. Steps which are calculated outside of a 'DSM' (Dynamic Simulation Model) follow different calculation methodologies but are generally driven by CIBSE guides or similar. Calculations within a DSM are produced in thermal simulation software such as EDSL Tas or IES.



It should be noted that the DSM loads should not be taken from the Part L compliance modelling as this is not an accurate assumption of building energy use. The modelling inputs for a TM54 DSM assessment are much more comprehensive.

Certain components such as catering are excluded and assumptions around these exclusions are stated below.

Lighting

This step is based on Section 4 of BS EN 15193: 2007 (BSI, 2007) for calculating the energy used for lighting. This document has since been replaced with BS EN 15193:2017 Energy Requirements for Lighting, although the equation is the same.

This methodology is referenced in the SLL Code for Lighting (SLL, 2010) and is referred to as LENI (lighting energy numeric indicator).

The main variables are:

- Installed power
- Occupancy dependency
- Daylight dependency
- Usage hours

Lifting Equipment

This step is based on CIBSE Guide D for calculating the energy used by lifts.

The main variables are:

- Motor rating
- Number of starts per year

- Time taken to travel to the highest floor

Small Power

This step is based on simple manual calculations but utilises data from CIBSE Guide F (2012). This step has been used to calculate the small power usage of the following elements;

- IT workstations and screens
- Photocopiers
- Projectors
- Fridges
- Dishwasher
- Vending machines
- Hand Dryers

Server Rooms

This is a manual calculation based on a typical server rack power load, annual operations hours and a ratio of rated to operational power demand.

Catering

Estimates will be made using environmental and operational energy usage benchmarks per meal served.

Domestic Hot Water

This will be based upon a manual calculation considering usage per person, temperature rise and number of occupants. The manual calculation is based on data from CIBSE Guide G and Technical Annex 2H.

Point of use heaters can be used for remote applications.

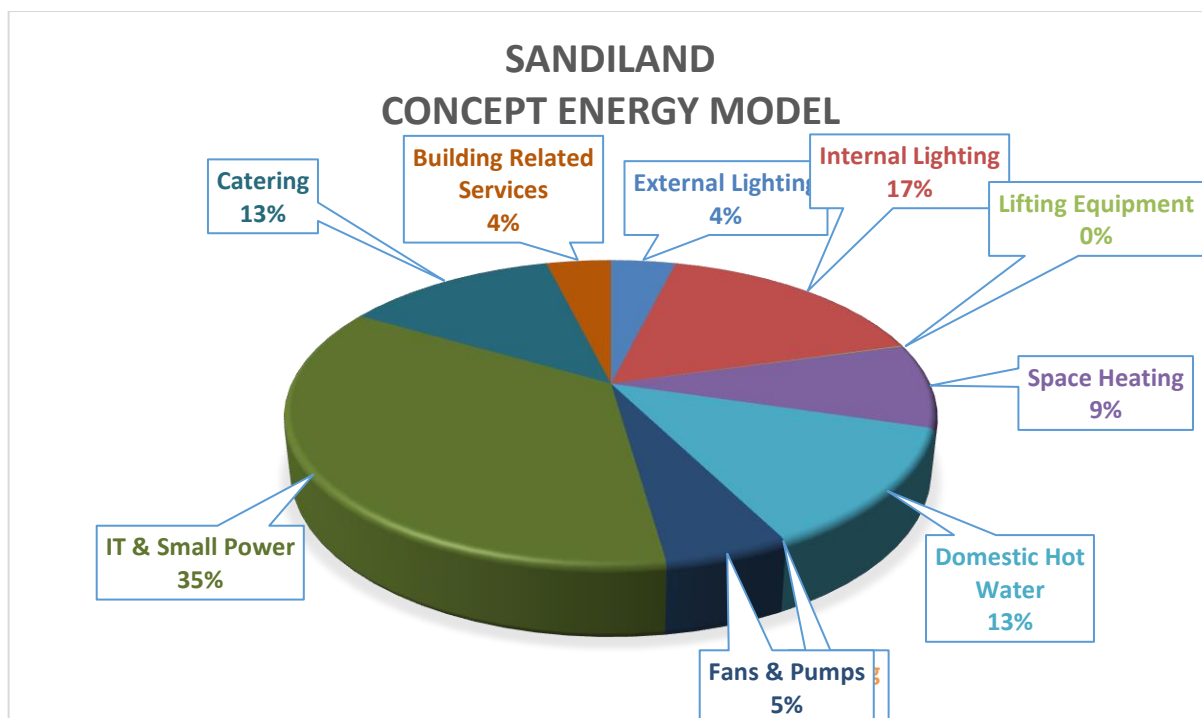
Space Heating, Cooling, Fans & Pumps

These components will be calculated using the dynamic simulation model produced for the scheme, using actual predicted gains and occupancy profiles rather than NCM templates.

9.0 Results

The energy performance results are broken down based on the different end use systems. It is important to consider these results have been based on professional assumptions and may change as the design develops.

The figure and tables below provide the energy breakdown for the various end use systems assessed.



System	Energy (kWh/year)	Energy (kWh/m2/year)
External Lighting	4,600	2.00
Internal Lighting	19,982	8.69
Lifting Equipment	85	0.04
Space Heating	10,695	4.65
Domestic Hot Water	15,301	6.65
Cooling	0	0
Fans & Pumps	6,279	2.73
Server Rooms	0	0
IT & Small Power	42,579	18.51
Gas Bunsen burners	0	0
Catering	15,163	6.29
Building Services	4,600	2.00
Total	119,285	51.86

The total electrical estimated load for Sandilands Primary School is 51.86 kWh/m2/year.

9.1 Benchmark Comparison

Whilst the data presented above is calculated through the concept energy model, and is subject to further design and development, it has been compared to the End Use Energy benchmark (taken from Technical Annex 2H: Energy). The table below provides a comparison against these different sources.

System	End Use Energy Benchmark (kWh/m2/year)	Sandilands Primary School Energy Model (kWh/m2/year)
External Lighting	6	2.00
Internal Lighting	8	8.69
Lifting Equipment	1	0.04
Space Heating	8	4.65
Domestic Hot Water	5	6.65
Cooling	Zero	0
Fans & Pumps	5	2.73
Server Rooms	Zero	Zero
Catering	7	6.59
Small Power	10	18.51
Building Related Services	2	2

9.2 In Use & Continuous Monitoring

A well designed, commissioned and fully functioning metering and monitoring system will enable the contractor and the school to compare actual energy usage against some of the benchmarks shown in the previous sections.

Data reliability and analysis are critical to the success of any monitoring and targeting process. Based on the energy estimation from DSM and TM54 for Sandilands Primary School, the contractor will be required to establish feedback mechanisms from metering in order to measure the energy and water consumption and be able to easily split energy used between the school and community use.

The information collected from the energy meters will allow 15 minute continuous monitoring of energy status, comparison of consumption to benchmark end use loads and discrepancy in energy consumption. Sub meters will be used to obtain more correct and accurate interpretation of results. The first year's annual operational energy consumption data will need to be uploaded on to Carbon Buzz.

In line with Technical Annex 2H, the contractor will develop a solution that allows the upload of energy data to the K2n national benchmarking database (or equivalent system) using the iSERV methodology to automatically monitor and report on the energy and water use of the school providing 15 minute interval continuous monitoring. Data should be uploaded 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 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 such as Trend IQ4 using an IQVision supervisor. This will allow the BMS to be interrogated via the internet from any device.

10.0 Building Performance Evaluations (BPE)

Building Performance Evaluations is developed by the DfE to identify the performance gap between the Contractor's design intent and the in-use performance of the building for newly completed and occupied school buildings.

The aim for the evaluations, as part of the normal procurement process, is to:

- Indicate the factors impacting on the operational performance of the building in use.
- Identify the root cause of performance issues.
- Inform action to improve performance.

BPE focus is on providing a structured and auditable procedure to uncover the poor performance of buildings but not to define the solution of any problems. Contractors and their designers are key players in unlocking good building performance. Therefore, the BPE methodology has been specifically designed to be used within the first year of operation of the school building whilst there is still a contractor responsibility with the school through the defects liability period.

The DfE's Output Specification contains a requirement for the contractor to ensure that BPE's are provided and is a specific contract deliverable.

Scope of BPE

1. To provide an objective understanding of what is successful and what are areas for improvement.
2. To monitor the result of fine tuning the building performance through seasonal adjustments to the building controls.
3. To establish across the range of schools where there are common issues to learn lessons for future school building projects.
4. BPE processes consists of various interrelated aspects which focuses on areas which could be improved and then suggest actions. It comprises:
 - Desk-top analysis of specific design and construction information before school visit.
 - School visit to gather information.
 - Review of BMS.
 - Second school visit on benefits of BPE which includes completion of two questionnaires i.e. Teaching staff and technical site staff.
 - Two BPE reviews will be carried out by contractor. Initial Review at 3-6 months and Final Review
 - at 9-12 months after handover in accordance with the Employer's Requirements Deliverables.
 - Compilation of a report on all findings, energy trends and observations from each school – issued to DfE and clear actions by Contractor provided using the DfE templates for Initial and Final BPE reports.
 - Compilation of short summary report for the school.

5. The BPE process will give meaningful output when suitable data monitoring and collection systems are effectively placed. Once the building is in-use these monitoring systems will be vital in providing the hard technical data used in the assessment of the building's performance.
6. There will be two stages of post-handover. The first stage will ensure the building is set up correctly to obtain accurate reporting for its ongoing performance. The second stage is more detail assessment of the overall building performance based on recorded actual figures.

11.0 Conclusion

The total electrical estimated load for Sandilands Primary School was shown to be 51.86 kWh/m²/year.

This is less than the End Use Energy Benchmark included in Technical Annex 2H, with some items such as the domestic hot water energy usage being significantly higher than that of the benchmark.

Net zero carbon in operation is a project requirement for the school and it has been estimated from the energy use shown above that up to 720m² of PV would be required on the project to ensure that net zero carbon in operation for the school, not including energy used for community use or energy used outside of normal school operating hours, would be achieved.

Appendix A TM54 Assumptions

Floor Areas

Floor areas were taken from architectural drawings and are based on Treated Internal Floor Area (TIFA).

Occupancies

It has been assumed that the main operating period Sandilands Primary School is 07:00 to 17:00, 5 days a week, with teaching hours of 08:45 to 15:15.

There has been no allowance made for extracurricular activities/community use as we understand that unregulated energy loads should only include for normal teaching hours activities associated with educational provision. Electric vehicle charging and community use are also excluded.

Lighting

Lighting loads have been assumed on a W/m² bases for various room types based on manufacturers data and recent school projects.

It has been assumed that lighting controls will be provided with areas such as toilets and storerooms having absence detection.

Other assumptions relating to maintenance factors, absence factors and daylight dependency factors are taken from Section 4 of BS EN 15193: 2007 (BSI, 2007) for calculating the energy used for lighting. This document has been replaced with BS EN 15193:2017 Energy Requirements for Lighting, although the equation is the same.

Judgements regarding the various factors have been made for each zone based on our best understanding.

Lifting Equipment

The assumptions made are:

- Elevator load is calculated based on the number of starts per year, rating of driver motor, time to travel entrance to highest served floor and standby energy used by a single lift in a year.
- Main assumption is based on 30 starts a day, 5 days a week. This represents a lift that will only be used by disabled staff & students and not for general circulation.
- 4kW lift motor load;
- 10 seconds to travel from ground to second floor.

Small Power

Small power energy load is calculated by considering workstations, photocopiers, projectors, fridges, dishwashers, vending, hand dryers and ring circuits/lab equipment.

Rated power demand for the small power equipment have been obtained from the ICT consultant and CIBSE TM54 to calculate the energy consumption. Workstations, photocopiers, projectors,

fridges and vending energy consumptions are obtained based on the numbers, average power demand during operation, operating hours and sleep mode power demand.

Dishwashers and hand dryer energy consumption is based on average energy use per cycle and no. of cycles per year.

Server Room

The server room has been excluded from this calculation as per the DfE Benchmark.

Catering

The assumptions made are:

- 288 meal covers each day over 38 weeks.
- Electricity energy use per meal has been assumed to be 0.27kWh/meal. This represents of a BSRIA report on a new build electric only kitchen for a secondary school which reported an electrical energy use of 0.27kWh/meal.

Space Heating, Cooling & Auxiliary

Space heating, cooling and auxiliary base data for the end use kWh/m² obtained from the DSM energy model multiplied with the building area.