AN ROINN OIDEACHAIS AGUS SCILEANNA | DEPARTMENT OF EDUCATION AND SKILLS

TECHNICAL GUIDANCE DOCUMENT TGD- 033

School Building Projects and Compliance with Part L of the Building Regulations 2017

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1. INTRODUCTION

1.1 GENERAL

The 2017 amendment to Part L (Conservation of Fuel and Energy) of the Building Regulations and the Technical Guidance Document L, for Buildings other than Dwellings, provide for the implementation of requirements of Articles 2,3 4, 6 (part of), 7, 8, 9(3,b) of the EU Energy Performance of Buildings Directive – EPBD (recast) (2010/31/EU of 19 May 2010).They provide guidance in relation to Part L of the Second Schedule to the Regulations as inserted by Building Regulations (Part L Amendment) Regulations (S.I. No. 538 of 2017).

Part L of the Building Regulations 2017 applies to buildings other than dwellings and was published on 22 December 2017.

This guidance document, TGD 033, sets out to the approach to be taken for school projects with reference to the Building Regulations 2017 Technical Guidance Document L – Conservation of Fuel and Energy for Buildings other than Dwellings.

1.2 DESIGN PHILOSOPHY & APPLICATION

The Guidelines are based on proven applications and solutions that work and best suit the school environment and not just on general design best practices.

In applying these guidelines to projects, School Authorities and Design Teams /Design Consultants will be obliged to comply in full with the prevailing versions of the Department of Education and Skills (DoES) Design Team Procedures (DTP) and the prevailing suite of Technical Guidance Documents (TGDs) issued by the DoES and Building Regulations parts A to M.

Compliance with these guidelines does not relieve Design Teams or Design Consultants from their normal design responsibilities including complying in full with the prevailing suite of DoES Technical Guidance Documents and with the Building Regulations parts A to M.

In all instances, the DoES shall have the final say in the application of these guidelines to projects where funding/grant-aid is to be sanctioned.

1.3 FURTHER INFORMATION

For further advice on these or any other matter, please contact:

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2. DESIGN PHILOSOPHY

2.1 STANDARDS

To ensure the longevity of these guidelines, specific mention of individual standards, which are continuously being updated, has generally been avoided.

Where standards are noted, it is the responsibility of Design Teams to ensure compliance with the prevailing version of that standard.

The design, installation, commissioning and handover of the project, including materials, products and workmanship shall comply with the relevant prevailing standards in the following order of preference: national standards transposing European standards, European Technical Assessments, common technical specifications, international standards, other technical reference systems established by European standardisation bodies or - when any of those do not exist - national standards, national technical approvals or national technical specifications relating to the design, calculation and execution of the works and use of the supplies and each reference shall be accompanied by the words ‘or equivalent’.

2.2 VALUE FOR MONEY

The Design Team shall ensure that all potential costs that could arise during the execution of the contract are included at the appropriate submission stage and in the appropriate manner, including all requirements for the building envelope and fabric improvements, and installation and operation of the photovoltaics system on the project.

3. THE BUILT ENVIRONMENT

3.1 Energy Efficiency

An integrated design approach provides opportunities for energy efficiency. The Design Team shall be aware that energy efficiency strategies can support each other or conflict and thus individual measures shall not be considered in isolation.

3.2 Passive Energy Measures

The use of passive energy measures to achieve a comfortable internal environment shall be employed where possible. The positioning of the building (allowing for site restrictions) should be developed to take account of the need to minimise energy consumption with particular emphasis on maximising the use of natural ventilation, daylighting, useful solar gain and minimising heat losses and unwanted solar gains.

3.3 Natural Ventilation & Overheating

Ventilation and provisions to reduce overheating shall be provided in accordance with the prevailing edition of TGD 020, General Design Guidelines for Schools (Primary and Post-primary). The final window design should prevent overheating in the space and should ensure that a minimum natural ventilation rate of 8 litres per second per pupil is achievable in the space. This rate will probably need to be higher to achieve the objectives outlined above in relation to overheating. If a specific room is accepted within the project brief as requiring demand based mechanical ventilation supply and extract with heat recovery, then 3 litres per second per pupil is acceptable to maintain air quality (not overheating) unless higher rates are dictated by the processes in the room.

3.4 Natural Daylight

All teaching spaces and habitable rooms shall have natural daylight as the principal source of light. The design factors of all elements and services relating to the adequate provision of natural daylighting shall be provided in accordance with the prevailing edition of TGD 020, General Design Guidelines for Schools (Primary and Post-primary).

3.5 Thermal Insulation

Thermal insulation standards shall be as outlined in this technical guidance document, whilst ensuring that the overall Maximum Permitted Energy Performance Coefficient (MPEPC) and Maximum Permitted Carbon Performance Coefficient (MPCPC) are achieved.

3.6 Infiltration & Airtightness specification

The Airtightness specification for all new schools and extensions is to be at least 3.0 $m^3/h/m^2$ of measured envelope area at a test pressure of 50Pa. Note this is a better specification value than the Part L 2017 backstop value for airtightness. Refer to Appendix 1 for full airtightness specification requirements and standards.

3.7 Materials

Materials shall be selected and all building elements designed to ensure that the building and all components are durable and low maintenance and do not present a hazard to the health and safety of the users.

In accordance with Part D of the Building Regulations all works shall be carried out with proper materials and in a workmanlike manner. “Proper materials” means materials which are fit for the use for which they are intended and for the conditions in which they are to be used, and includes materials which:

(a) Bear a CE Marking in accordance with the provisions of the Construction Products Regulation;

(b) Comply with an appropriate harmonised standard or European Technical Assessment in accordance with the provisions of the Construction Products Regulation;

Or

(c) Comply with an appropriate Irish Standard or Irish Agrément Certificate or with an alternative national technical specification of any State which is a contracting party to the Agreement on the European Economic Area, which provides in use an equivalent level of safety and suitability.

3.8 THERMAL BRIDGING, SURFACE CONDENSATION AND INTERSTITIAL CONDENSATION

There may be the potential for increased risk of condensation issues arising in modern highly insulated and relatively airtight school buildings which can have a high vapour load and are not continuously occupied and heated all year round. The Design Team must ensure that the heating, ventilation, air infiltration, building fabric (including thermal bridging details) of schools are designed and detailed to limit such risks. For further details refer to the DoES TGD 020 and the Building Regulations TGD Part L 2017 Section 1.3.3.

3.9 TRIPLE E REGISTER

The Triple E Products Register is a benchmark register of best in class energy efficient products. The European Union (Energy Efficient Public Procurement) Regulations 2011, SI 151 of 2011, state "a public body shall only procure equipment or vehicles which are (a) listed on the Register or (b) satisfy the published SEAI energy efficiency criteria for the equipment or vehicle concerned, and the public body shall specify this requirement in any documentation describing its procurement requirements".

Where applicable the Building Services Consulting Engineer shall ensure that all products or equipment included in mechanical and electrical tender documentation and installed in schools are listed on the Sustainable Energy Authority Ireland's (SEAI) Triple E lists of energy efficient equipment or are compatible with the criteria of the Triple E evaluation scheme.

4. GENERAL DESIGN APPROACH FOR SCHOOLS

4.1 OVERVIEW

This section deals with the general design approach to be taken in relation to school projects to achieve compliance with Part L of the Building Regulations 2017.

The proposed Design Team approach should be submitted to the Planning and Building Unit at each project stage using the Compliance with Part L of the Building Regulations 2017 reporting form as included in Appendix 2.

To assist in determining the appropriate approach, a number of school building types were modelled to evaluate options and performance. Results from two of these are included in Appendix 3 along with the SBEM inputs used.

4.2 NEW SCHOOL BUILDINGS & EXTENSIONS

To meet Part L 2017 requirements, new school buildings should:

- achieve an energy performance that exceeds the reference building set out in Part L 2017 (the reference building in Part L 2017 represents in the order of 50% - 60% improvement on the previous standards)
- have 10% of the regulated schools energy from on-site renewable sources with the Primary Energy usage reduced by a further 10%. Refer to section 4.8
- implement as a minimum the DoES backstop U-values as detailed in table 1 below
- have an air leakage performance of at least $3m^3/m^2/hr$.
- have lighting design based on LED fittings as specified in section 4.12
- have renewable requirements met by photovoltaics (PV)

Element	DoES Backstop U- values (W/m^{2}k)
Pitched roof, insulation horizontal at ceiling level	0.16
Pitched roof, insulation on slope	0.16
Flat roof	0.16
Wall	0.21
Floor	0.21
Glazing	1.6 / 1.4

Table 1 DoES Backstop U-values

It is expected that new projects entering architectural planning will achieve the reference values as stated in Part L (Table C.1, Reference Values, page 96) within the project brief.

4.3 TEMPORARY ACCOMMODATION

Temporary accommodation will need to comply with the requirements of Part L of the Building Regulations 2017 including the transitional arrangements.

4.4 REFURBISHMENT OF SCHOOL BUILDINGS

Refurbishment – where more than 25% of a building envelope is being upgraded a cost optimal energy performance upgrade will be required. The building envelope comprises roof area, external wall area and ground floor area and cantilevered external upper floor slabs. This applies from 1st January 2019 and should not require a planning application to be triggered once the proposed works “do not materially affect the external appearance of the structure so as to render the appearance inconsistent with the character of the structure or of neighbouring structures” (Planning and Development Act 2000 Section 4(h)). Cost optimal upgrade considerations include replacement of heating boilers and controls systems over 15 years old, replacement of mechanical ventilation over 15 years old, and upgrading general lighting systems over 15 years old, or with an average lamp efficacy of less than 40 lamp lumens per circuit Watt.

4.5 EXTENSION PROJECTS WITH ASSOCIATED UPGRADE OF EXISTING BUILDINGS

For extension projects with associated upgrade of existing buildings refer to sections 4.2 and 4.4 respectively.

4.6 LEASED BUILDINGS

Part L 2017 of the Building Regulations apply to new buildings, material alterations, material change of use and Major Renovations. Where existing buildings are leased and no works are required they are not impacted by Part L of the Building Regulations 2017.

4.7 PROTECTED BUILDINGS

Protected buildings are exempt from Part L of the Building Regulations 2017, however the mechanical and electrical building services upgrades may not be exempt.

4.8 RENEWABLES

Part L of the Building Regulations 2017 requires that 20% of the energy used by a school is produced from on-site renewable energy sources. It allows this figure to be reduced to 10% where the energy performance of the building model is 10% or better than that of the reference building in Building Regulations Part L 2017. In terms of school buildings it is more cost effective to reduce the energy use to this point and provide a 10% renewable contribution rather than to provide the 20% renewable contribution. Note also requirements with regard to SBEM and calculating the renewable energy generation on site as detailed in section 4.11.

Thus where the Energy Performance Coefficient (EPC) of 0.9 and a Carbon Performance Coefficient (CPC) of 1.04 is achieved a Renewable Energy Ratio (RER) of 0.10 represents a very significant level of energy provision from renewable energy technologies.

The Department has been using test schools to evaluate the suitability of renewable energy options for schools since 2002. Results from these projects indicate that currently photovoltaics are the most feasible renewable technology for schools. Based on the results of the studies the application of other renewables do not presently present a viable solution in schools due to a number of variables including hours of opening, lack of technical expertise on site, minimising operation and maintenance requirements, reliability and energy usage profiles, etc. A summary of these findings are included in Appendix 4.

Where the Design Team determine that the provision of PV may not be possible for specific reasons, the Design Team should highlight this to the DoES at Stage 1.

There is no requirement in Part L of the Building Regulations 2017 for energy used by a school undergoing major refurbishment to be produced from on-site renewable energy sources. However, Design Teams on these projects should consider the potential for applying PV on refurbishment projects that will require planning permission.

The system capacity should be sized to meet the base electrical load of the school (this is the maximum electrical load outside school hours). This review should be submitted to the Department for consideration and include all associated issues such as planning issues, suitability of the transmission grid for connection, capacity of the existing electrical services in the school, any associated electrical upgrade works, any supporting structures, roof weathering details and any maintenance provision.

4.9 PHOTOVOLTAICS (PV)

The application of photovoltaics to a school roof for a project that already has planning permission will require a revised planning application to be submitted.

The design of the PV system must be considered from project inception in relation to the overall project, roof design and materials.

The ideal orientation is south facing with an angle of inclination of 30 degrees; however, circumstances may require deviation from this ideal. This should be flagged at Stage 1 and proposals refined for Stage 2a. Panels are only to be installed on Easterly and Southerly orientations.

It is important that a balance is struck between the various elements such as angle of roof, planning requirements, roof build up and costs when developing the building design and deviation from this ideal maybe required.

The area of south/east facing roof designated for PV panels must be indicated on drawings from Stage 1 on. If there is likely to be a difficulty in achieving sufficient south or east facing roof this should be highlighted and raised at Stage 1.

There are likely to be school projects with existing planning permission that require (due to site commencement date) to meet the 10% renewable contribution. These school projects may not present sufficient roof space with an ideal orientation for the mounting of panels as they were not designed specifically with the intent of installing panels on the roof. These cases may require deviation from the ideal orientation and angle of incline.

Refer to Appendix 5 for specific design details for PV systems on school projects.

4.10 BIOMASS HEATING

There is a possible potential market for Energy Supply Companies (ESCO) to provide a heat contract to schools based on biomass heating, where the ESCO finances, operates and maintains the system and sells heat to the school (economies of scale will feature here). However this is a significant contractual issue for a school Board of Management with no certainty that an ESCO will be available at completion stage of the project. All boiler room installations and designs have been future proofed since 2008 to make provision for this and should continue to do so. Refer to Appendix 4 for specific details for design provision for possible future Biomass provision on school projects.

4.11 THE SIMPLIFIED BUILDING ENERGY MODEL (SBEM)

The existing SBEM has fixed criteria that do not reflect actual conditions in Irish schools, including occupancy and actual domestic hot water demand. The software is also limited in how it controls ventilation based on CO_2 loads. One could state that the limitations of the SBEM system cancel themselves out when comparing the actual final design building to the SBEM reference building to establish the level of improvement in energy terms. This is true; however, the SBEM results give an exaggerated final primary energy figure which impacts hugely when trying to establish the renewable energy provision to be produced on site or nearby.

The Sustainable Energy Authority of Ireland (SEAI) is revising SBEM to reflect Irish School data and is working on this with the British Research Establishment. This upgrade will be available in April 2018. In the interim, Design Teams will need to use the existing SBEM system and data for calculating the 10% renewable element. Design Teams are advised that, based on Department research, the existing SBEM renewable output is overestimated due to the points raised above. It is expected that as a result of the changes to the software the renewable requirement will reduce. Therefore once the updated software is available, Design Teams should revise the calculation.

4.12 LIGHTING

All lighting shall be surface mounted LED lighting where plasterboard ceilings are provided; the LED lighting may be surface or recessed where suspended grid ceilings are provided. The LED provision will reduce the primary power requirements and in turn the amount of renewable energy required.

The lighting design and controls shall be as per TGD 030 and TGD 031 respectively with the following amendments. The LED lighting shall meet the following performance specification.

Light Source	LED
Colour Rendering Index	>80
Colour Temperature	4000k
Minimum Luminaire Efficacy	125 lm/W
Median Useful Life (IEC 62717) Ta 25ºC (50,000 hrs)	L80 B50
Minimum Driver Lifetime (Max ambient temp 35ºC)	50,000hrs
MacAdam Step	3
UGR	<19

4.13 HOT WATER USAGE

Based on research and analysis of hot water needs in current schools designs, hot and cold water services are to be designed based on a maximum 43⁰C blended water temperature with a flowrate for a single blended percussion tap of 1.5 litres per minute for wash hand basins, commissioned for automatic shut off after 5 seconds. For sinks a 43⁰C blended water temperature with a flowrate of 3 litres per minute should be used. For Showers a maximum 43⁰C blended water temperature and flowrate of 5 litres per minute should be used, commissioned for automatic shut off after 3 minutes. Based on these design parameters, the hot water usage within the school should not exceed the range of 0.33 to1.0 litre /pupil/day based on the standard schedule of accommodation.

4.14 COST REPORTING

The additional costs arising from compliance with Part L 2017 should, during the transition period and until incorporated into a future revised Basic Building Cost, be included as an Abnormal Cost in the Cost Plan accompanied by a detailed breakdown of the abnormal cost on an elemental basis (i.e. floor, wall, roof, LED lighting, PV, etc.) as heretofore. It should also be recorded as noted in Appendix 2.

5. SCHOOL PROJECTS WITH PLANNING PERMISSION GRANTED OR IN ARCHITECTURAL DESIGN

5.1 OVERVIEW

This section relates to the general design approach to be taken in relation to new schools and extension projects with planning permission already granted or projects in architectural design so as to achieve compliance with Part L of the Building Regulations 2017 on site.

The proposed Design Team approach should be submitted to the Planning and Building Unit as soon as possible using the Compliance with Part L of the Building Regulations 2017 reporting form as included in Appendix 2.

5.2 MODIFYING THE ALREADY DESIGNED BUILDING STRUCTURE TO ACHIEVE THE PART L 2017 BACKSTOP U VALUES

5.2.1 ROOFS

The pre December 2017 DoES TGD's required a minimum roof U-value of 0.16 (W/m^{2}k), therefore any proposed roof structure should require no additional measures to achieve compliance with the Part L 2017 backstop value.

5.2.2 FLOORS

The increase of ground floor insulation is straight forward to accommodate and should only require a change in the specification to achieve the required U-value of 0.21 (W/m^{2}k).

5.2.3 WALLS

Solutions to achieving compliance with Part L 2017 backstop value for walls will vary depending on the existing designed wall system and cavity size. It should not be necessary to effect the wall thickness while complying with Part L 2017 wall backstop value. This can be achieved through the use of high performance insulation.

Walls with external insulation and a thin coat acrylic external finish may require an increase in insulation thickness depending on existing U-value.

5.3 GLAZING

The increase in window frame performance will only require a change in specification of the U-value required. Experience to date indicates that 1.4 to 1.6 U-values are being achieved within most school project budgets and will have already been specified for the majority of school projects.

5.4 INFILTRATION & AIRTIGHTNESS SPECIFICATION

The airtightness specification for all new schools and extensions is to be 3.0 m^3/h/m^2 of measured envelope area at a test pressure of 50Pa. Note, this is a better value than the Part L 2017 backstop value for airtightness.

This change is straight forward to implement where care and attention has been given to detailing and specification and should only require a change to the specified figure for air leakage.

School projects have routinely been achieving values at and below 3m^3/m^2/hr. The Design Team and Contractor will need to ensure that any potential for increased risk of condensation from a project achieving this and especially a higher airtightness result is provided for.

Refer to Appendix 1 for full Airtightness specification requirements and standards.

5.5 LIGHTING

All lighting shall be as detailed in section 4.12. For existing designed layouts, manufacturers have direct replacement fittings for the T5 range (the pre Dec 2017 minimum standard for schools) therefore lighting redesign can be avoided. The lighting design and controls shall be as per TGD 030 and TGD 031.

5.6 OVERHEATING ANALYSIS

The Design Team shall run the certified dynamic simulation model already established for the project using the updated U-values, air tightness, and lighting, etc., to confirm that any overheating is within the limit specified in TGD 020.

5.7 HOT WATER USAGE

Hot water provision shall be as detailed above in section 4.13.

6. CO_2 MONITORS

All teaching spaces shall be fitted with a CO_2 monitor that shall include a LED display. The single wall mounted self-contained unit shall consist of a CO_2 sensor enclosure and a large LED display and all associated electronics.

The unit shall be screwed to the teaching wall facing the body of the classroom. The display colour will be capable of changing from Green to Amber and Red to indicate CO_2 levels, thus providing easy visual indication as well as specific readings.

The LED colour indicator should be capable of being easily identifiable from the rear of the classroom with a minimum illuminated area of 25 cm^2. It should be either self powering from the ambient light in the classroom using an integrated PV panel or be connected to the mains distrubution system. It does not need to be connected to the BMS system.

The system will enable the teaching space users to be aware when the desired levels are breached so that the necessary intervention via opening windows for ventilation can take place to maintain the comfort levels and air quality.

A laminated A4 size label (screwed at the four corners to the wall) incorporating clear and simple advice and instructions on how the teaching space can be operated efficiently with regard to heating, lighting and ventilation during school hours shall be located in a suitable location near the door of each teaching space. It is paramount that all school staff are provided with full user training and demonstration of these systems as part of the handover requirements.

The parameters and sensor settings should be as follows;

Carbon Dioxide (CO_2) Traffic Light Display Indicator Ranges Optimum Range <1500ppm		
Green	Amber	Red
<1500ppm	1500 to 2000ppm	>2000ppm

7. CERTIFICATION

All school building projects must comply with the requirements of the Energy Performance of Buildings Directive (EPBD). This directive is part of Europe's strategy to meet its commitments to the international Kyoto Protocol which took the form of an agreement to limit emissions of greenhouse gasses.

Building Regulations Part L compliance calculations should be carried out in the Non domestic Energy Assessment Procedure early in the design process as the outputs of this calculation will determine the fabric construction and renewable requirements which will be required prior to planning.

SI 243 of 2012 requires all public buildings (>250m^2) to have an Energy Performance Certificate displayed in a visible location.

It is a requirement of SI 243 of 2012 that consideration be given to the provision of alternative energy systems in the design of any large building (>1,000m^2) for which a planning application is made, or a planning notice is published. To avoid unnecessary duplicated evaluations for each project which do not deliver any further benefit or insight, the DoES has produced standard guidance following evaluation of alternative energy systems for school projects. This is included in Appendix 4.

A Building Energy Rating (BER) of a minimum of A3 is achievable by demonstrating compliance with Part L 2017 as outlined.

8. VAMPIRE LOAD DESIGN STRATEGY

While not a requirement for compliance with Part L 2017, the following vampire load design strategy is to be incorporated on all school projects. This strategy has been piloted on a number of schools within the basic building cost and achieves a significant reduction in electrical energy costs.

For school design purposes, vampire load shall be considered as the electric power consumed by electronic and electrical appliances while they are either left on or in a standby mode during periods when a school is closed.

The objective of this approach is that all unnecessary electrical load is isolated when the school is shut. The design to achieve this should be developed as an integral part of the electrical system design and not as a single product or manufacturer supplied proprietary solution. As such the following should be considered.

Once the building's intruder alarm system is armed, after 15 minutes the BMS system shall remove all holding signals and allow all contactors to return to their normally open state, resulting in the disconnection of all non-essential services.

The shutdown relays are to be linked to the BMS to retain close control in the school.

The BMS will allow for a 15 minute delay after the intruder alarm is set before the vampire load strategy is activated. The alarm for the PE Hall and/ or GP Room (and ancillary) zone should be separately connected so that if the main part of the school has the alarm set at say 5pm but the PE Hall and/ or GP Room continues in use or at the weekend then the vampire strategy will activate in the part where the alarm is set.

Function shall be available to have the system automatically respond in specific pre-determined time schedules.

High quality suitably rated heavy duty contactors shall be installed in order to reduce the risk of failure; all contactors shall be a normally closed type.

Manual bypasses (Hand/Off/Auto) switches shall be installed in parallel to all dividing contactors so as to provide a manual override function in the event of BMS, intruder alarm or contactor failure.

Services deemed essential and non-essential may vary throughout different areas of each school. These must both be scheduled and agreed with the school at design stage.

It is important to design and specify that all school lighting, emergency lighting, communications, security and fire alarm systems shall always be supplied from an essential supply and shall never be disconnected.

It is important to check that the schools data equipment is appropriate for use with the above system. If schools use LED projectors then potential for deterioration to lamp performance by the vampire load cut off is reduced as LED projectors don't deteriorate if the power is cut to them unexpectantly.

All sub-distribution boards shall be divided into an essential and non-essential side. This shall be achieved by dividing the electrical bus bar into two separate sections, the upstream supply from the main distribution boards supply cable shall connect to the essential section of the board through a series of protective devices and isolation points. A dedicated connection shall then be taken from the essential bus bar, and run through a BMS controlled contactor again incorporating a series of protective devices and isolation points. Once passed through this BMS controlled contactor the supply cable shall connect to a non-essential bus bar. It will be from this point that all non-essential services shall be supplied.

The BMS System shall signal all of the aforementioned contactors, energising them once the building is occupied, thus allowing conductivity to the non-essential side of all the sub-distribution boards.

Within all sub-distribution boards a suitable quantity of essential services connection points shall be incorporated, to facilitate any future requirement to change the nature of a specific supply from non-essential to essential, including sufficient length on all cables entering the distribution boards to allow for transfer from one side to another.

All essential services shall be labelled and coloured appropriately at the field end (essential services to be installed in a contrasting colour to all other services) so as to eliminate any ambiguity. Essential services shall be indicated on the power layouts, elevations and teaching wall detailed drawings.

All essential services shall be demonstrated to both the design team and school management at project handover and all schedules of essential and non-essential services shall be detailed within the operation and maintenance documentation.

The local arrangement includes a “HOA” switch that allows the relay to be manually bypassed. This is an emergency feature so that if the system fails and incorrectly cuts power to an area of the school (for example a relay sticking) then the school can manually bypass the relay. This is a vital feature to ensure the school has the confidence to know that they can easily bypass the system if it does cause a fault.

The essential sockets should be identified in red on the drawings with essential services notation also provided, i.e. (ES). The specification should also note that all installed essential services outlets are to be of red colour finish so that the school users know that a red socket will always stay live and can be used accordingly.

Consider also taking advantage of the alarm link to the BMS by including some passive vampire strategies such as:

- Heating is forced off (but still allowed on early the next morning) this is done by ending the current time schedule
- Hot water heating and all pumps forced off (except if under frost control)
- Motorized valve power cut
- Circulation lighting power cut
- Windows closed (if any are motorised and connected – e.g. some circulation motors)

Note that a BMS alarm (and traffic light red) is triggered if water, heat or power use is larger than pre-sets when the alarm is set, and the BMS should be programmed to commence "out-of-hours" monitoring upon receipt of an arming signal from the Intruder Alarm System.

APPENDIX 1: AIRTIGHTNESS TEST REQUIREMENTS AND SPECIFICATION IN SCHOOLS

Building Performance and Compliance Testing

- The Airtightness specification for all new schools and extensions is to be less than 3.0 $m^3/h/m^2$ of measured envelope area at a test pressure of 50Pa.
- The required level of air permeability for the whole building must be clearly detailed within the specification, in units of $m^3/hr.m^2$ @ 50 Pa. The main contractor's responsibility for achieving the required level of specification should be clearly stated.
- The requirement to test the building at a suitable point in the programme by a competent specialist should be the responsibility of the contractor and included within the works requirements. An example of competence would be a contractor fully accredited by INAB (Irish National Accreditation Board) or UKAS (United Kingdom Accreditation Service) Accredited calibration laboratory to ISO 17025 for airtightness testing of commercial buildings in accordance with

  CIBSE TM23: 2000 'Testing buildings for air leakage',
  BS EN 13829:2001 'Determination of air permeability of buildings, fan pressurisation method'
  ATTMA TS1 'Measuring air permeability of building envelopes'
  DoES Building preparation as detailed below.
- Non Accredited test Certificates will not be accepted by the DoES.
- Measured envelope area shall be taken as the area of surfaces that make up the air seal boundary of the building.
- External envelope area = Detailed envelope area calculation as per ATTMA TS1.
- Contractor to provide Detailed envelope area and red-line drawings of measured area for agreement no less than three weeks before the date of air testing.
- The test must be programmed for a weekday and should be carried out at least three weeks prior to the planned completion date to allow remedial works and re-testing to be completed before handover if necessary. Sufficient notice must be provided to allow witnessing of the test by the Design Team and Employer's Representative.
- The airtightness testing specialist must not have any involvement with the supply and/or installation of any specialist products or involved commercially or financially with any of the specialist products installed on any school buildings. If the airtightness specialist is involved with any contract works within the building this is a conflict of interest and the test certificate will be deemed invalid.
- The project manager on the main contract team is to ensure a copy of the "airtightness compliance schedule for schools" (*copy at end of this Appendix*) is issued as part of the handover documentation.
- The test and recording equipment including the fan test rig and manometers must have a valid calibration certificate that is less than 12 months old on date of test.
- The contractor shall liaise with the local fire brigade to ensure that they are aware of the smoke tests and to avoid unnecessary call outs. Call out costs shall be the responsibility of the contractor if incurred and this shall be stated in the works requirements.
- The testing contractor shall designate a single person to supervise all aspects of measurements with regard to air tightness at a particular school. The designated person shall liaise with Employer's Representative and the school authority until the results are provided to the Employer's Representative. The supervisor shall inspect the school and ensure that all necessary provisions are made for temporary sealing up of openings where permitted by the standard.

Building Airtightness Testing Specialist

- The airtightness works will be carried out by a recognised building airtightness specialist accredited by INAB (Irish National Accreditation Board) or UKAS (United Kingdom Accreditation Service) accredited calibration laboratory to ISO 17025 as a testing laboratory for large commercial buildings. Their appointment will be approved by the Architect/Design Team.
- The specialist company must demonstrate prior experience of works on projects of similar size and complexity. The Design Team and Contractor are to ensure that a copy of the specialists INAB/ UKAS accreditation certificate is submitted to the Employer's Representative for approval before the airtightness specialist is appointed.

For suitable specialists refer to: www.inab.ie; and www.ukas.com.

Compliance Testing

SAMPLE ROOM TEST DURING CONSTRUCTION

While this test is good practice, it is at the discretion of the Contractor and should comprise one pressure test followed by a smoke test on the external envelope during construction. It is not possible to run a complete airtightness test on a single room as there will be no air seal boundary between the room and adjacent internal spaces, however the sample room test will give an early indication of weaknesses that may be replicated throughout the building.

This pressure test should be a positive test, pressurising the room from one door opening. Air intake/leaks along the external wall, floor and service points can be established thereby facilitating improved sealing techniques as the project is progressing. This test should be considered at a very early stage in the project and preferably witnessed by the Employer's Representative.

WHOLE BUILDING ACCREDITED AIRTIGHTNESS TEST

A preliminary site meeting must be held with the approved accredited specialist at the start of the project to discuss airtightness detailing, approach, programme and testing schedule.

Following this a detailed envelope area calculation shall be undertaken and issued to the Design Team before test date.

To ensure the building is properly prepared for the test, a pre-test site inspection by the Accredited Airtightness testing company must be undertaken 2-3 weeks prior to the final test date.

This final test will comprise an accredited airtightness test as detailed above with subsequent smoke tests should the specification requirements not be reached.

All further airtightness tests and smoke tests required to bring the building up to the required airtightness to be at the contractor's expense.

Building Preparation for Test

The building preparation works are not to be carried out by the airtightness testing specialist as it is deemed a conflict of interest. Preparation work is the full responsibility of the contractor.

Before the final testing the contractor should ensure the following attendances and preparations are complete.

Contractor to provide an estimate of measured area and the capacity of the proposed test rig for review by Employer's Representative no less than one week before the date of air testing.

- All external windows, trickle vents, smoke vents and doors must be closed and <u>not</u> artificially sealed with tape.

- If there are hit and miss vents for ventilation purposes, they have to be installed for the test and closed, they should not be artificially sealed with tape.
- All internal doors must be wedged open.
- All drainage traps must be filled with water. If traps have not been fitted then drainage pipes must be sealed with tape.
- All heating and mechanical ventilation systems must be turned off and intake/exhaust louvers closed up with plywood/ MDF board and sealed with tape/polythene or similar. This is most effectively achieved by sealing the intake and exhaust louvers for each system.
- Any combustion appliances within the airtight building envelope should be turned off and their flues sealed including fume cupboards.
- The ground floor internal and external area within 5 metres of the fan equipment/doorway must be level, clean and clear of all loose material with vehicular access to entrance doorway area.
- The vent at the top of the lift shaft where applicable must be closed but not artificially sealed with tape.
- The contractor must ensure that no external doors/windows/trickle vents are opened for the duration of the test.
- Some temporary minor carpentry works may be required to the doorway in which the fan equipment is mounted to accommodate the fan equipment.
- Notices must be posted at all entry and exit points to the building; *''AIRTIGHTNESS TEST IN PROGRESS DO NOT OPEN''.*
- Suspended floor tiles and ceiling tiles (where applicable) around the perimeter of the building are to be removed for the test
- The contractor shall advise the Design Team of the proposed test date one month prior to the test date; weekend days may not be acceptable. An agreed date should be sought to enable the Employer's Representative to be present during the test, and to inspect any defects.
- Note that the air test can only be carried out during appropriate weather conditions (particularly wind speeds that must be less than 5 metres/second during the test), contractor to check weather forecast on the day before the test is due and confirm that local forecasted conditions are appropriate.

Airtightness Compliance Schedule for Schools page 1of 2

Airtightness Compliance Schedule To be Signed/stamped by Main Contractor and Airtightness Specialist and issued before Project Completion.	
Name of School & Roll Number	
Address	
Building Architect/ Employer's Representative	
Building Contractor	
Contracts Manager	
Airtightness Specialist:	
INAB/UKAS Registration Number:	
Copy of Certification	
1: Preliminary Site Meeting Date:	
Notes:	
2: Date of review of Architectural Details	
Notes:	
3: Date of Sample /Prototype Room Test	
Notes:	

Airtightness Compliance Schedule for Schools page 2 of 2	
4: Date of Site Inspection during Construction	
Notes:	
5: Date of detailed snagging of Building	
Notes:	
6 Final Airtightness Test Date	
Result ($m^3/hr/m^2$) @50Pa	
Temporary Sealing (if Any)	
Notes:	
Note company names not acceptable on their own	
Signed (Main Contractor) **Date:**	
Signed (Airtightness Specialist) **Date:**	
Stamped (Airtightness Specialist) **Date:**	
Witnessed and Signed by Employer's Representative	
Name of School & Roll Number	

APPENDIX 2: COMPLIANCE WITH PART L OF THE BUILDING REGULATIONS 2017 REPORTING FORM

Compliance with Part L of the Building Regulations 2017 Reporting Form page 1 of 4

To be completed and submitted to the Planning and Building Unit at each project stage to demonstrate the design approach & compliance with Part L of the Building Regulations 2017.

School Name	
School Roll No	
Address	
Project Stage	
Has planning permission been granted for this project?	
If yes, does it this include for the required area of PV Panels?	

The following are to be developed and appended to this report:

ITEM

Updated Lighting Schedule:

Design Team to append updated lighting schedule detailed in the following format with specific fitting data completed.

LED Light Source	Fitting type 1	Fitting type 2	Fitting type 3	Etc.
General Locations				
Fitting Supplier				
Fitting specific model number				
Colour Rendering Index >80				
4000K Colour Temperature				
125 LM/W Minimum Luminaire Efficacy				
Median Useful Life L80 B50				
Minimum Driver Lifetime (Max 35ºC) 50,000hrs				
Macadam Step 3				
UGR < 19				
Recessed or Surface				

Updated Overheating Room Schedule:

Design Team to append updated schedule of rooms overheating analysis formatted as per section 5 (r) of TGD's 030 & 031 respectively.

Compliance with Part L of the Building Regulations 2017 Reporting Form page 2 of 4

Provisional BER Certificates:

Building Regulations Part L compliance calculations should be carried out in the Non Domestic Energy Assessment Procedure early in the design process as the outputs of this calculation will determine the fabric construction and renewables requirements which will be required prior to planning. Design Team to append copy of provisional BER Certificate to this completed form.

Cost Report:

Design Team to append copy of cost report at all stage submissions, detailing all additional costs in relation to compliance with Part L of the Building Regulations 2017 on an elemental basis, including any fabric upgrades, airtightness, lighting, equipment and PV with associated electrical works, any supporting structures, roof weathering details and any maintenance provision.

These additional costs should also be included under " Abnormal Costs" in the Cost Plan, accompanied by a detailed breakdown of the abnormal cost on an elemental basis (i.e. floor, wall, roof, LED lighting, etc.) as heretofore.

Primary Energy

What is the calculated Primary Energy for this School?	

Energy Performance Coefficient & Carbon Performance Coefficient

What is the calculated Project Energy Performance Coefficient?	
What is the calculated Project Carbon Performance Coefficient?	

PV Design Details *(to be completed)*

Required PV output to achieve 10% Renewable Energy Ratio kWh/m^2/yr.	
Required area (m^2) of PV panels.	
Proposed location, angle and orientation of PV Panels.	
Has the Design team confirmed in writing the grid transmission system capacity & protection systems required for the PV connection*****.	
Has the Design team received a grid connection offer for the PV System from ESB Networks*.	
*****If No, please detail the status/ issues involved.	

Table 15b of Part L calculations for the Part L Regulatory Impact Assessment provides an example model for 105 RER.

Calculations are available at:

http://www.housing.gov.ie/sites/default/files/public-consultation/files/report_to_calculations_for_part_l_2017.pdf.

Compliance with Part L of the Building Regulations 2017 Reporting Form page 3 of 4

Name of Schools & Roll Number		
Metric SBEM inputs used	Minimum Recommended solution for compliance with Part L 2017	Design Team criteria used to ensure compliance with Part L 2017
Roof U value (W/m^2k)	0.16	
Wall U value (W/m^2k)	0.21	
Floor U value (W/m^2k)	0.21	
Window U value (W/m^2k)	1.4 / 1.6	
G Value (%)	50	
Light Transmittance (%)	71	
Glazing Area (%)	30%	
Thermal Bridging	As per table 2 *	
Air Permeability (m^3/m^2h)	3	
Lighting Luminaire (lm/circuit watt)	Actual figures from design	
Maintenance Factor	Actual figures from design	
Lighting Type	LED Lighting throughout	
Occupancy Control	Auto Dimmed	
Daylight Control	Photoelectric Switching Standalone	
Lighting Metering Provision	No	
Heating System	Central Heating with Radiators	
Fuel	Gas	
Heating Efficiency (%)	95	
Metering Provision	Yes	
Hot Water System	Direct Gas Fired Water Boiler	
Hot Water Efficiency (%)	95	
Cooling System	Natural Ventilation	
Rooms with Exhaust (process exhaust excluded i.e. dust extract)	Toilets / Changing, Servery / Kitchenettes, Data Communication Centre, Daily Living / Home Economics, etc.	
Toilet Exhaust Rate (ach/hr)	Toilets – 10 ach, Changing – 12 ach, Other – 6 ach	
Terminal Unit SFP W/(L/s))	0.3	
Supply Fan	No	
Variable Speed Control of Fans & Pumps	Yes	
Power Factor	0.9 - 0.95	

* From SEAI published Domestic Energy Assessment Procedure (NEAP) Proposed Changes for 2017 Part L Public Consultation

Compliance with Part L of the Building Regulations 2017 Reporting Form page 4 of 4

Name of Schools & Roll Number	

We confirm that the design of the above named school project complies in full with Part L of the Building Regulations 2017 requirements, based on the criteria as outlined in the tables above and our appended documents as ticked below.

Design Team appended documents:	Tick if included
Lighting Schedule	
Updated Overheating Room Schedule	
Provisional BER Certificate	
Cost Report	

Consultant	Name	Signature	Date
Architect			
Building Services Engineer			
Quantity Surveyor			
Structural Engineer			

APPENDIX 3: SBEM RESULTS & BER CERTIFICATES

A number of school building types were modelled to evaluate options and performance. The following table details the SBEM inputs used.

Metric	Part L 2017 Reference Building	Minimum Recommended solution for 2017 regulations
Roof U value (W/m²k)	0.15	0.16
Wall U value (W/m²k)	0.18	0.21
Floor U value (W/m²k)	0.15	0.21
Window U value (W/m²k)	1.40	1.4/ 1.6
G Value (%)	50	50
Light Transmittance (%)	71	71
Glazing Area (%)	40	30%**
Thermal Bridging	As per table 2	As per table 2*
Air Permeability (m³/m²h)	3	3
Lighting Luminaire (lm/circuit watt)	65	Actual figures from design
Maintenance Factor	0.8	Actual figures from design
Lighting Type	-	LED Lighting throughout
Occupancy Control	Auto Dimmed	Auto Dimmed
Daylight Control	Photoelectric Switching Standalone	Photoelectric Switching Standalone
Lighting Metering Provision	No	No
Heating System	Central Heating with Radiators	Central Heating with Radiators
Fuel	Gas	Gas
Heating Efficiency (%)	91	95
Metering Provision	No	Yes
Hot Water System	Direct Gas Fired Water Boiler	Direct Gas Fired Water Boiler
Hot Water Efficiency (%)	91	95
Cooling System	Natural Ventilation	Natural Ventilation
Rooms with Exhaust (process exhaust excluded i.e. dust extract)	Same as Actual	Toilets / Changing, servery / Kitchenettes, Data Communication Centre, Daily Living / Home Economics
Toilet Exhaust Rate (ach/hr)	Same as Actual	Toilets – 10 ach, Changing – 12 ach Other – 6 ach
Terminal Unit SFP (W/(L/s))	0.3	0.3
Supply Fan	No	No
Variable Speed Control of Fans & Pumps	Yes	Yes
Power Factor	0.9-0.95	0.9-0.95

* From SEAI published Domestic Energy Assessment Procedure (NEAP) Proposed Changes for 2017 Part L Consultation

** This was the actual %modelled, design team to include actual glazing area as applicable

Post Primary School evaluation and results

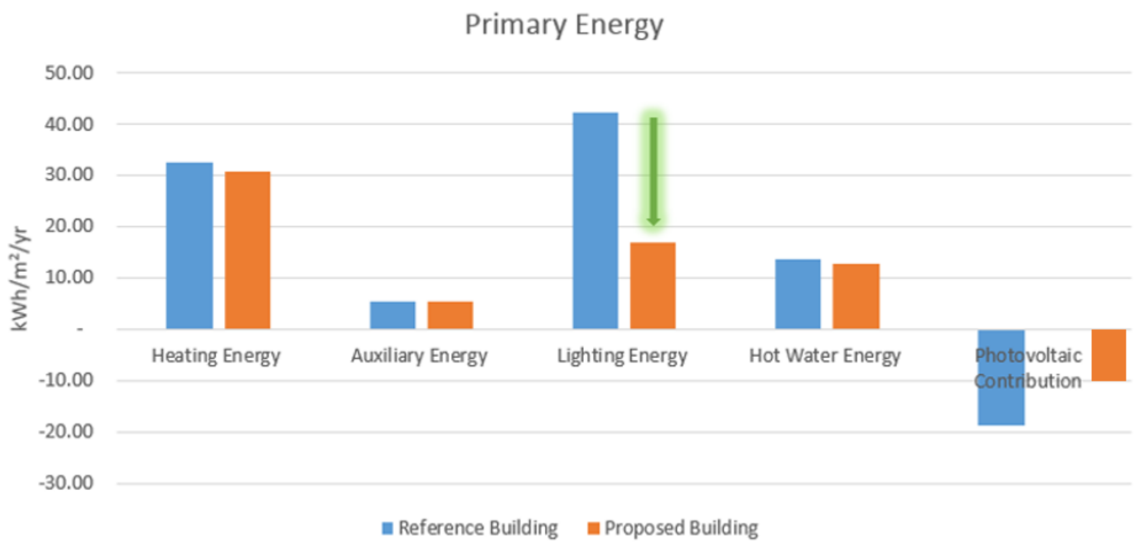
The following graph shows the Primary Energy breakdown for a typical Post Primary school reference model and compares it with that of a post primary school that applies the recommended measures as follows:

- The U-Values are set to the DoES backstop values
- Infiltration is $3m^3/m^2/hr$
- LED lighting is provided
- PV is provided to achieve 10% of the Primary Energy from on-site renewable sources.

The proposed building energy usage is 20.3 % below that of the reference building, allowing the use of the 10% renewable energy target.

The backstop values for opaque elements are less than those of the reference building; however, the heating energy is lower in the actual building due to differences in efficiencies and areas of glazing used in the reference building. The difference between the backstop values and the reference values for the opaque elements represents a 4% difference in primary energy. This figure is very small, as the proportion of heat loss through these elements is low in a school building.

The Energy Performance Coefficient achieved on this Post Primary School Project is 0.80, the Carbon Performance Coefficient achieved is 0.86.



Element	Reference Building Primary Energy $kWh/m^2/yr$.	Proposed Post Primary School Building Primary Energy $kWh/m^2/yr$.
Heating Energy	32.68	31.64
Auxiliary Energy	5.53	5.53
Lighting Energy	42.37	16.83
Hot Water Energy	13.82	12.84
Sub Total	94.40	66.84
Photovoltaic Contribution	-18.88 (Reference building always 20%)	-6.68
Total	75.52	60.15

Primary School evaluation and results

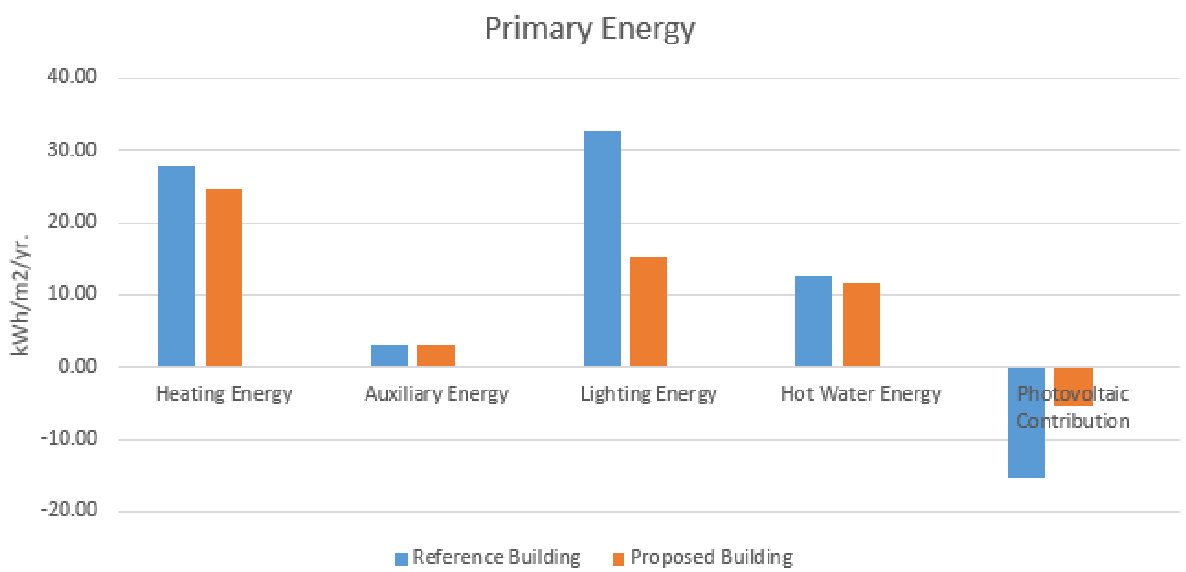
The following graph shows the Primary Energy breakdown for a typical 16 Classroom Primary school reference model and compares it with that of a primary school that applies the recommended measures as follows:

- The U-Values are set to the DoES backstop values
- Infiltration is $3m^3/m^2/hr$
- LED lighting is provided
- PV is provided to achieve 10% of the Primary Energy from on-site renewable sources.

The proposed building energy usage is 18.5 % below that of the reference building, allowing the use of the 10% renewable energy target.

The backstop values for opaque elements are less than those of the reference building; however, the heating energy is lower in the actual building due to differences in efficiencies and areas of glazing used in the reference building. The difference between the backstop values and the reference values for the opaque elements represents a 4% difference in primary energy. This figure is very small, as the proportion of heat loss through these elements is low in a school building.

The Energy Performance Coefficient achieved on this Primary School Project is 0.81, the Carbon Performance Coefficient achieved is 0.89.



Element	Reference Building Primary Energy $kWh/m^2/yr.$	Proposed Primary School Building Primary Energy $kWh/m^2/yr.$
Heating Energy	28.02	25.40
Auxiliary Energy	2.87	2.87
Lighting Energy	30.45	15.22
Hot Water Energy	12.64	11.74
Sub Total	76.25	55.23
Photovoltaic Contribution	-15.25 (Reference building always 20%)	-5.52
Total	61.00	49.71

Until such time as the Primary Energy Factors are updated in the 2008 regulations SBEM model, it will not be possible to generate an accurate BER certificate that matches the tabulated results as the Primary Energy Factors are not updated in the 2008 regulations SBEM model. This will be resolved with the updated SBEM package which is due in April 2018.

APPENDIX 4: RENEWABLE ENERGY IN SCHOOLS

The DoES keeps under review the application potential of renewable technologies in school buildings with respect to technical, environmental, economic feasibility and operational issues. A significant number of the Departments Energy Research Projects have featured renewable technologies and the outcomes of that research is overviewed below.

In the interest of sustainability, the potential of renewable energy should be maximised in school design. It is however important that renewable applications are properly suited to the school's needs and not just applied for the sake of having a renewable tag on a school. It is also critical that the demand for energy is minimised before investing in renewable energy applications.

Low energy design has been incorporated in school design on a hybrid basis by maximising natural resources and utilising technologies.

Maximising natural resources involves focusing on areas such as passive solar design, good natural daylight, natural ventilation, airtightness and low loss air infiltration. The DoES has focused on utilising technologies in a number of areas including heating, lighting, water efficiency and air tightness testing; these are incorporated into the DoES suite of Technical Guidance Documents (TGD's).

Within the renewable sector, technology and financial parameters are an evolving area, as such the use of renewables in schools will continue to be monitored and researched to ensure optimum applications that are properly suited to the school's needs.

Solar Water Heating

Solar power for hot water generation is not considered an optimum design solution for schools due to the school's operating profile (closed during summer months, mid-terms, etc., short days and closed at weekends, and the minimum and irregular hot water demand.

Schools for pupils with special educational needs that may have a significant hot water demand for therapeutic baths can present opportunities for solar hot water to assist in meeting this demand. This needs to be reviewed on a specific project basis.

Biomass Fuel for Heating

Biomass fuel is considered carbon neutral (excluding transport impact) provided the fuel is sourced from short rotation crops, waste from managed forests and waste from parks management and is viewed as compliant in terms of minimum regulatory carbon saving commitments.

In 2006 the DoES commenced a unique project in relation to biomass energy use in schools to evaluate the suitable application and performance and compatibility of biomass systems. The evaluation process included school heating requirements in terms of heating demand characteristics, controls, reliability, fuel storage and maintenance and operation and customer satisfaction.

Based on the above study biomass heating in schools cannot be deemed an exact fit and will need further development to target this area. It is also considered that it may prove difficult to match the small schools in the country with biomass heating on an operational and costs basis unless a feed in tariff opportunity exists.

There is a potential market for Energy Supply Companies (ESCO) to provide a heat contract to schools based on biomass heating, where the ESCO finances, operates and maintains the system and sells heat to the school; again economies of scale and any feed in tariff opportunities will feature here.

Provision of a Biomass Heating Plant

Research by the DoES has shown that biomass systems can require a significant amount of management input on site at times to ensure that they operate at optimum level and provide reliable heating to the school. This research indicated that this time input may not always be available in schools particularly schools where the Principal is a teaching principal or where there is limited caretaker engagement on site.

To allow flexibility for a school to consider at construction stage or in the future either funding a biomass installation or sourcing renewable heating from an Energy Supply Company (ESCO) the issues below should be allowed for at the design stage. (An ESCO is a company that designs, finances and supplies, operates and maintains the heating plant and sells the heat to the school at a price that is cheaper than the school's fossil fuel options.). If site constraints or the site location mitigate against the above this should be identified at pre-Stage 1.

The boiler room should be located such that a packaged renewable energy plant and an associated storage facility can be located adjacent to the boiler room without causing any disruption to the school or needing any changes to the existing school access infrastructure. This area should be identified on all Stage 1 site plan drawings as well as on all subsequent site plan drawings. It should be kept sterile from the point of view of underground and over ground services. The sterile area required for a biomass boiler and fuel storage unit should be based on the size of the school's potential biomass base heating load and not the total heat losses for the school. Biomass boilers are at their most efficient when operating on full load all the time.

A typical solution is generally based on containerised plant, which is a choice of a 4.5m x 4.5m or 6m x 6m storage area (dependant on boiler size and delivery frequencies) and a standard 6m or 12m container to house the heating plant and associated equipment.

By way of guidance the following should be considered:

School base heating load (kW)	**Area* (Width x Length)**
Up to 100 kW	4.5m x 4.5m storage (60m^3) plus 6m container
100 – 200 kW	6m x 6m storage (100m3) plus 6.1m container
200 – 300 kW	6m x 6m storage (100m3) plus 12.19m container
> 300kW	6m x 6m storage (100m^3) plus 12.2m (container) but also based on plant dimensions requirements

Typical arrangement is the container plant room located behind the fuel storage area and the fuel storage area would be located with direct access to the school hard surfaces.

The Building Services Consulting Engineer shall liaise with the other members of the Design Team and ensure that the hard surface access route to the boiler plant is capable of supporting solid fuel delivery traffic. Deliveries may normally be by means of an articulated lorry on larger sites; the Design Team will need to take this into account as a Stage 1 requirement within the External Works Allowance.

Schools will need to be aware that access to the biomass plant by an ESCO supplier should be facilitated at all times.

Suitably sized valve connections shall be provided on the boiler room headers to facilitate the connection of the school heating installation via a multi-plate heat exchanger to any future packaged renewable energy plant. Also required in the school boiler room (as part of the ESCO package) will be a calibrated heat meter to record actual heat delivered to the school and not that supplied from the boiler. The heat meter should report to the school's heating controls system.

Sufficient space should also be allowed in the layout of a boiler room to accommodate a future multi-plate heat exchanger and heat meter in the event of a school progressing with an ESCO.

The Design Team should discuss the ESCO option in full with the school at pre-Stage 1 design development.

Photovoltaics

As detailed in Appendix 5.

Wind Generation

The operation of an appropriately sized wind turbine for a school requires significant local operation and maintenance on a day to day basis. There are significant Health & Safety issues with turbines: these are further exacerbated when coupled to school sites with highly occupied playgrounds. These risks can be diluted but not eliminated by using a restricted exclusion zone around the turbine. This again adds potential management issues for the school and reduces available space for general school use.

Wind turbines are generally installed in locations that are not regularly frequented and where the risk to the public from any failure is low. Where wind turbines are installed in highly frequented public locations the risk of injury or fatality resulting from a wind turbine failure increases by several orders of magnitude.

Even among good quality small wind turbines, there remains the potential for a sudden catastrophic failure due to extreme wind conditions, poor maintenance or unpredicted component failure. In order to minimise the risk where small wind turbines are installed in highly frequented public areas, the enforcement of an exclusion zone around small wind turbines that exceeds the maximum distance for tower collapse or rotor blade throw would in most instances preclude a wind turbine being located within school grounds.

Given the above it is the DoES position that a school would be better to consider purchasing wind generated electricity from one of the wind generating companies than to attempt on-site generation.

Combined Heat and Power Systems

Combined Heat and Power (CHP), also known as cogeneration, is the use of a heat engine or power station to simultaneously generate both electricity and useful heat.

All power plants emit a certain amount of heat during electrical generation: this can be released into the environment via cooling towers, flue gases and by other means. By contrast CHP captures some or all of the by-product heat for heating purposes either very close to the plant or as hot water for district heating.

To be viable a good base load for electrical demand and heat demand must exist. Such base loads arise where building occupation or process activities are extended or continuous in operation, this is not the case in primary and post primary schools.

A CHP unit cannot provide a school's complete heating energy due to the imbalance between the school's electrical and heating loads, and the fact that a significant proportion of the school's load is required at a time when there is no matching electrical demand in the school.

During warmer months the schools heating requirement drops to an extent where the waste heat provided by the CHP unit cannot be used for building heating and hot water usage.

The application of CHP is considered not to be viable in schools for the above reasons.

District or Block Heating or Cooling

There is no requirement in primary and post primary schools for cooling and therefore district block cooling does not need consideration.

If a school is being developed in an area with district or block heating then consideration should be given to the potential for connection of the school.

Schools can provide a useful load to district heating systems for periods where residential demand is not at a peak. The viability of the district heating will depend on the proximity of the school to the district heating, the terms of supply of heat and the proven reliability of the district heating scheme or back up provision of the system.

Heat Pumps

A geothermal heat pump system is a heating and/or cooling system that uses the earth's ability to store heat in the ground and water thermal masses. These systems operate based on the stability of underground temperatures; the ground a few feet below surface has normally a very stable temperature throughout the year, depending upon location's annual climate.

Geothermal heating to be efficient in a schools environment must be operated using night rate electricity. Thus just like with the electrical night rate storage heaters of old, this heat must be generated during the night and stored for distribution during the course of the day. This is normally done using under floor heating in a concrete floor.

The DoES has tested a geothermal heating installation; results indicate that the compatibility of the system with the schools passive solar design strategy and operational requirement has been very poor.

The slow response time of the under floor heating has led to overheating in the classrooms when there is good passive solar heat available to the school and also problems with the quick provision of heat if for technical malfunction the heat pump failed to operate the night before.

The use of air to water heat pumps has also been considered and some were installed by schools (since replaced by boilers). There are a number of factors that indicate that these are not the optimum heating solution for a school. These include the school's operating profile and intermittent need for responsive heating to offset heat losses and ventilation load, lower temperature heat supply compared to oil and gas boilers, so larger radiators are needed, heat pump response time and need for additional buffer storage tanks, higher operating costs compared to gas boiler installations, reduced operating capacity in lower external temperature, less efficient in winter due to low Coefficient of Performance (COP) levels, need to maintain hot water storage temperatures in schools at 65ºC thus also effecting the COP. Electric fan type heat emitters can maximise the potential of these low temperatures but these are not appropriate for use in schools due to maintenance, noise and localised control issues.

It is the DoES opinion that given the above factors a secondary source of heating would still need to be maintained in a school, therefore duplicating capital and maintenance costs, in addition a hybrid heating system could lead to unnecessary complications for the school compared to a single source heating system.

The Schools Maximum Import Capacity would also have to increase substantially thus presenting schools with increased standing charges in relation to their electricity bills.

It is therefore the conclusion that while suitable for many other applications, heat pumps are not presently appropriate for use in schools as they do not economically match the particular requirements for schools in terms of responsive systems to adequately service intermittent occupancy patterns.

APPENDIX 5: DESIGN & INSTALLATION OF PV SYSTEMS IN SCHOOLS

General

The PV system shall be a building integrated and grid-connected system and operate in parallel with the grid network. If the PV supply is less than the demand, the grid supplies the balance to ensure security of supply; if the PV supply is greater than the school demand, and where the ESB Networks connection agreement has a zero or limited export capacity, an export limitation system controller will signal the inverters to limit their production by ramping the output to match the school demand and export capacity. Design and specification of the complete system shall be the Design Team responsibility with appropriate input on locations, planning permission, electrical services, structures, health and safety and cost control as required.

The Design Team is also responsible for obtaining confirmation at Stage 1 of the project (or at initial reporting stage on achieving Part L compliance for existing projects post Stage 1) regarding the capacity of the grid transmission system for connection, the required protection systems and thereafter the required grid connection offer for the PV System from ESB Networks.

As this document is published, the Commission for Regulation of Utilities has placed the entire system for export applications on hold, it is however possible to make 'microgeneration' applications (via ESB NC6 application form - up to 6kW single phase, and 11kW three phase) and non-export applications (via ESB NC5 application form - greater than 6kW single phase, and 11kW three phase). These two types of applications should be considered based on the scale of the required PV system and the system designed to facilitate dual applications in practice if deemed viable based on the market conditions and tariffs at the time of design.

The system shall be tendered in the Building Services Mechanical and Electrical Consulting Engineers documentation with associated provision in the other consultant tender packages.

The tender documentation will require the contractor to complete data sheets which will be submitted on request for review for acceptability by the Consultant. These data sheets shall detail the following values at the standard test conditions:

- Proposed PV modules, detail the following values: Module Peak Power (Wp), Peak Power Tolerance (%), Efficiency (%), Maximum Current (A), Short Circuit Current (A), Open Circuit Voltage (V).
- Proposed inverters, detail the following values: Peak Power (kW), Efficiency (%), Power Factor, Maximum Power Point Tracking, configuration, DC and AC protection.

PV System & Warranties

The PV Array is to be installed on the south facing school roof where possible with an acceptable peak power rating required to achieve the 10% renewable requirements of Part L of the Building Regulations 2017. The system shall comprise a traditional PV system configuration, i.e. a DC string design which connects PV modules (panels) in series on DC circuits back to DC/AC inverters.

Alternative installation options other than roofs can be considered such as within internal court yard areas, provided they are not accessible from ground level or adjoining structures and not prone to vandalism from within or outside the school site. It is not appropriate to install PV at low level due to risk of vandalism, nor as brise soleil as a fixed brise soleil impacts on daylighting and does not optimise daylight potential. Over shading and under shading frequently occur with fixed solar shading.

The PV Panels shall be required to have a 25 year performance warranty and a 10 year product warranty as a minimum. The maximum annual power loss under the warranty after the first year must be less than 1%. Linear warranties based on a uniform decline in performance each year are preferred to those with step changes in warranty conditions after the first year of installation.

Modules shall have a power warranty of at least 90% after 10 years and at least 80% after 25 years as a minimum. The modules shall have a positive initial power tolerance (i.e. +3%/-0%).

Inverters shall be required to have a 10 year product warranty at a minimum.

Positioning and Fixing

The PV installation shall not compromise the integrity of the roofing system with respect to structure, material, U-value, water tightness, air tightness, condensation risks and aesthetics as well as any product guarantee by the roof panel/ membrane manufacturer/ suppliers/ installers. The installed mounting system must not compromise the safety of the building or users in any way. Full consideration must be given to shading from roof fixtures such as vents, aerials, etc., adjacent structures and buildings, telecom masts and trees now and when they grow higher in future.

The design of the PV system and roofing system must be considered from project inception in relation to the overall project, roof design and materials. The requirement to use roof mounted panels will impact on the choice of roofing system.

The ideal orientation is south facing with an angle of inclination of 30 degrees; however, circumstances may require deviation from this ideal. This should be flagged at Stage 1 and proposals refined for Stage 2a. Panels are only to be installed on Easterly and Southerly orientations.

There may not be sufficient roof area available with an ideal orientation for the mounting of panels in school projects that were not designed specifically with the intent of installing panels on the roof. These cases may also require deviation from the ideal orientation and angle of incline.

The following table shows the percentage of electrical energy gathered by altering the panel angle from the ideal. For example, mounting panels flat would require a 10% increase in panel area and mounting them facing South East at an angle of 30 degrees would require a 4% increase in panel area.

	Tilt Angle	Angle from south						
		0	15	30	45	60	75	90
Horizontal	0	90	90	90	90	90	90	90
	10	96	95	95	94	93	91	90
	20	98	98	97	96	94	91	88
	30	100	100	98	96	94	90	86
	40	100	99	98	96	92	88	84
	50	97	97	96	93	89	85	80
	60	93	93	92	89	86	81	76
	70	87	87	86	84	80	76	70
	80	80	80	79	77	74	69	65
	90	71	71	71	69	65	62	58

Performance, Testing and commissioning

The Design Team shall specify the peak DC rating (kWp), the specific yield (kWh/kWp/annum) and the Performance Ratio (P.R., %) of the system.

The Design Team shall allow for full testing and commissioning including string testing, to show that the DC circuits have been connected correctly, and acceptance tests which show that the system is producing the expected power output (given the solar irradiance) over a short period (minimum 10 days). A 'reference cell' or irradiance sensor will need to be specified to achieve this. All testing shall be performed in accordance with IEC 62446 "Grid connected photovoltaic systems – Minimum requirements for system documentation, commissioning tests and inspection". The acceptance test shall show that the actual output of the PV system (measured at the AC output of the inverters), over the test period is aligned with the theoretical output of the system over the same period (measured from the reference cell), considering the Performance

Ratio. The Consultant shall be satisfied as to the methodology for this performance test calculation and agree any thresholds for the test for low irradiance periods.

Maintenance

PV systems are low-maintenance, but not zero maintenance. The Design Team must consider fully all maintenance requirements including appropriate and safe access for cleaning to maintain their performance.

The PV monitoring system

The PV monitoring system must allow for the accurate recording of energy generated. This can be through the inverter meter, or a separately connected PV meter. The PV monitoring system must be capable of connection and access via the BMS recording the PV system operation and performance. The PV monitoring system must measure kW, kWh and status alarms from inverters and embedded generation interface protection (EGIP) relays.

A visible alarm light in the Principal's office should also be provided to ensure that in the event of a fault the PV system will not sit producing no electricity until faults are detected.

The PV system will also include a LED indoor digital display, located in a public area of the school (to be agreed at design stage with the School Management). This display will indicate to students, staff and visitors the yields, power and the amount of avoided greenhouse gas emission, from the PV system. The monitor shall have a minimum size of 500mm x 400mm with large illuminated symbols capable of being viewed from at least 8 meters away.

Fire considerations

Designers shall consider fire risk within the design of the PV system. This will include compliance with any current fire regulations, and any requirements of the local fire officer. Design considerations relating to fire will include:

- Selection of PV system architecture (module optimiser, micro inverter, traditional string inverter)
- Control of live voltage on the roof and within cable routes when main electrical supply is removed from the school
- Installation of a fire-switch
- Installation of signage.

PV System modules, fixings and cabling

Solar PV modules must be certified to the appropriate European and Irish Standards and shall be CE marked. Modules must be provided with datasheets that state all relevant test parameters under the standard test conditions defined by the relevant standard.

The Solar Photovoltaic (PV) system shall include the following main components, PV Modules, Module Mounting System, provision for safe access, Cabling DC and AC, Connectors, String Combiners, Inverters (power optimisers), Switch-disconnectors (isolators) DC and AC, Electrical Protection and Monitoring System.

As required, for the protection of individual modules or strings, string fuses or electronic protection must take account of the manufacturer's maximum module safety fuse as defined in the standard: IS EN 61370:2007 Photovoltaic (PV) Module Safety Qualification. String Fuses will be required if any fault current could exceed the manufacturer's safety rating.

The module mounting system including all fittings selected shall:

- be suitable for the particular environment and local conditions to which it will be exposed, including the degree of exposure to wind or to a corrosive environment (e.g. salt and windblown sand in coastal sites)
- provide for appropriate physical connection of the PV solar panels to the roof structure

- maintain the integrity of the existing roof with panels securely connected to the roof structure to ensure that the panels are orientated correctly, both initially and in the future
- be fixed without drilling of roof surfaces / tiles for mounting systems
- be fabricated to be corrosion proof, using either stainless steel, anodised aluminium or hot dipped galvanised steel, all compatible to avoid galvanic corrosion
- be recyclable at end-of-life through normal recycling channels
- chosen to match the particular location and mounting surface and must be compatible with the module frame dimensions and structural loading points
- be chosen to best suit the mounting surface and minimize potential leakage from installation requirements
- have materials that must be resistant to local weather and atmospheric conditions, including corrosion from chemical exposure and marine environments
- have adequate fire-resistance in accordance with building regulations
- have structural strength and integrity to withstand the effect of wind and snow loading, be rigid and resistant to wind gusts up to 150 km/h (IS EN 1991) and to corrosion environments equal to or higher than C4 (ISO 9223); the Design Team must produce a wind loading report to show that the system can withstand the maximum wind induced forces for the location
- have supporting structure and fixing materials that are aluminium or hot dipped galvanized steel; the installation procedures must ensure anti-corrosion protection, including any access doors, trays, bolts, nuts, washers and fixing elements in general
- ensure that all the parts of the supporting structure must be correctly assembled, must fit with each other and must be compatible to avoid galvanic corrosion and allow every single module to be accessible for periodic inspections
- be such that PV modules are rigidly fixed to the supporting structure with appropriate clamps and/or bolts and nuts according to the PV modules manufacturer specifications
- not impede quick rainwater run-off.

Cabling on the array side of the PV system must be adequately protected from abrasion and cuts, maximum temperatures of 80^0C and provide UV and water resistance over the system lifespan. Drilling of the roof surfaces / tiles for cable access is not acceptable.

Double insulated solar cable to the HO7NF standard may be used, as well as single insulated cable enclosed in a stainless steel conduit or multi-core SWA steel-wire-armoured for longer distances and mechanical protection. Cables shall satisfy IS EN 50618:2014 Electric Cables for Photovoltaic Systems. DC cable cross-sectional areas must be sized to limit the voltage drop along the cable to less than 2.5% of the open-circuit string voltage.

In the absence of string fuses or electronic protection, string cables must also be sized to withstand any fault currents on a continuous basis. AC cables shall be sized according to standard practice to maintain a voltage drop of less than 1%. All cables shall be delivered to the site for installation in complete coils or reels with the manufacturer's name attached, indicating cable and type of insulation.

DC connectors must be fully electrically compatible (as verified by a test certificate) as well as mechanically compatible. Ideally only identical connectors from the same manufacturer shall be used. Connectors must be designed for Solar PV use and be protected against water ingress and UV exposure and touch-safe to IP21. Connectors shall satisfy IS EN 62852: 2015 Connectors for DC-application in Photovoltaic Systems – Safety requirements and tests. Connectors must not be removed from modules and AC connectors for inverter connection must be touch safe.

All connections in the DC circuit other than approved plug and socket connections must be inside non-conductive weatherproof enclosures that segregate positive and negative connections to prevent short circuits.

Junctions Boxes shall satisfy IS EN 50548:2011 Junction Boxes for Photovoltaic Systems and IS EN 62790: 2015 Junction Boxes for Photovoltaic Modules – Safety requirements and tests.

Larger arrays shall use purpose constructed string combiner boxes. These may be integrated into monitoring systems and may also enclose string fuses.

Inverters and Protection Relays

All inverters and protection relays are to be designed for grid-connected operation and shall comply with ESB Networks Embedded Generation Interface Protection (EGIP) standards including any modification to the main electrical connection to the school (including Neutral Voltage Displacement and Reverse Power Protection where specified by ESB Networks).

Installed inverters must not compromise the safety of the electrical infrastructure in any way and should be housed taking into account overheating, access, etc. Inverters shall be installed indoors and be easily and safely accessible.

Where the ESB Networks connection agreement has a zero or limited export capacity, an export limitation system must be installed to maintain the export at zero or the specified limit, while continuing to maximise useful energy production and use of the solar PV system. The selected inverters must be compatible with the export limitation system controller and respond to signals sent to it which will trigger the inverter to change the mode of operation, potentially turning it off, on, or ramping the output up or down.

The inverters, or protection relays where required by ESB Networks, shall have a mechanism to verify that the grid parameters are within their defined tolerances and must disconnect from the grid within a specified time if any of the tolerances are exceeded.

The inverter specifications must be provided in detail in the manufacturer's datasheet and be supported with comprehensive installation and user manuals. Inverter data sheets and nameplates must satisfy the IS EN 50524:2009 Data Sheet and Name Plate for Photovoltaic Inverters. A type-test approval certificate must be submitted for each inverter to verify this behaviour as required to the CER or EN50438 standard or additionally in larger systems incorporated within a grid-protection relay operating to the same standard.

Inverters must connect to the Grid via a dedicated medium-voltage interface unit, whose specification must be agreed with the network provider. Inverters must be sized to match the array characteristics in respect of maximum voltage and current limits, acceptable power sizing ratio, maximum power tracking voltage range and compatibility with module type. The inverters shall operate properly at their nominal power, with an ambient temperature TA=50^0C.

In order to preserve the quality of the general electricity service, the inverters shall comply with IEC 61000-6-2 and IEC 61000-6-4 (EMI), with EN 50178 (Grid quality requirements) and also with particular national codes. The inverters shall include anti-islanding protection with automatic shutdown of the inverter once a grid power outage is detected in accordance with standard IEC 62116. Inverter-on after grid voltage and frequency restoring shall be delayed between 1 to 3 minutes.

The inverters shall include protection against inverse polarisation in its DC input, short-circuits in its AC output, over-voltages (operative surge arrestors) in both input DC and output AC, insulation failure with output to relay. The inverters shall include detection and protection in case of lack of insulation in accordance with the requirements of standard IEC 60364-7-712.

The inverter shall include an emergency stop device, it shall be easily accessible, but not to students or members of the public.

As a minimum the inverters must satisfy the requirements of: IS EN 50530:2010 Overall Efficiency of Grid Connected Photovoltaic Inverters. Both the maximum conversion efficiency and the Euro-weighted efficiency shall be provided from the manufacturer's test results.

Safety requirements of: IS EN 62109:2010 Safety of Power Converters for use in photovoltaic power systems and the Anti-Islanding requirements of: IS EN 62116:2014 Utility-interconnected Photovoltaic Inverter Inverters shall have the following minimum specifications:

Efficiency (%)	98%
Harmonic Distortion (% THD)	<2.5
Standby Losses (W)	<20
Power Factor	>0.99
Output Voltage	400/230V +1%
Output Frequency	50Hz + 1%

END.