An Roinn Oideachais
Department of Education

March 2022.

Summer Works 2022 Heating Upgrade Decarbonisation Pathway Pilot project requirements

The need for a flexible and tailored approach to heating decarbonisation of schools is critical to enable the school sector to achieve its 2030 and 2050 climate action targets. The decarbonisation of schools cannot be mapped out in one distinct approach, given the size, age and diversity of school buildings flexibility is required as there is no one size fits all plan that can be applied to all schools.

This school's heating upgrades works under summer works 2022, has been selected for inclusion in a pilot project.

The decarbonisation pathway pilot objective is to install and evaluate a heating system where the heat pump is provided and designed to address a portion of the heating load and a high efficiency gas boiler (which has 30 to 39% lower carbon emissions than oil) makes up the remaining load (this is known as a bivalent heating arrangement).

This decarbonisation pathway pilot will dovetail with the existing electrical infrastructure capacity of your school utilising available building electrical capacity known as the maximum import capacity (MIC). The appointed lead consultant will need to evaluate the potential capacity and apply to the ESB Network noting how much extra capacity they want without triggering a meter/ cable change. I.e. above 49 kVA in typically medium size schools.

This approach will optimise the heat pump with supporting / back up heat from the high efficiency boiler. This will enable heat pumps to heat the school during frequent moderate heating season temperatures, where heat pumps operate most efficiently and enable the most effective use of the investment and minimise the running costs to the school.

This approach will support the phased integration of air source heat pump (ASHP) systems in the school in a risk controlled and reliable manner, enable existing grid electrical infrastructure to be maximised early, enable future suitable phasing of heat loss reduction programme while ensuring school operation continue.

It will also enables optimum return on embodied carbon in existing infrastructure, improved comfort levels for teaching and learning with greater system reliability, controls and response time, and will be compatible with this maturing industry's developing supply chain and ability to deliver in conjunction with appropriate future phasing of a heat loss reduction programme while ensuring school operation continues.

The lead Consultant will be a Chartered Buildings Services Engineer and will be required to buy in all/any additional services deemed necessary including Architectural, PSDP and QS, if not available in-house in order to deliver the projects.

This document provides a briefing on the requirements of the pilot covering additional requirements and should be viewed in that context with all other SWS and TGD'S still applying.

The lead consultant is to consider provision of heat pump as part of the SWS heating upgrade pathway pilot in your school as follows:

Maximum selected heat pump output to be:

1. Based on a maximum of 55 W/m^2 of school heated area;

   and

2. Compatible with the existing school electrical infrastructure, without the need to upgrade the existing electrical infrastructure to the school, the maximum import capacity (MIC) capacity may be increased to the available maximum capacity from the network;

   and

3. Be compatible with the existing heating distribution system unless the project includes for a new distribution system.

Full design considerations and requirements for this decarbonisation pathway pilot are included in Appendix One below.

The design review questionnaire in Appendix Two will need to be addressed in full by the lead consultant and submitted to DoE when requested.

Appendix One:

Design considerations and requirements for this pathway pilot.

The lead Consultant will consider provision of heat pumps as part of the SWS heating upgrade in this pathway pilot. This document gives guidance on the process and approach that must be followed in full. The lead Consultant will be required to submit their design and tender documentation electronically to the Department Planning and Building Unit, to engage in two online meetings with the Department and also to complete pre and post contract design checklists.

1.0 Heating Sizing and Selection

1.1 Heat Pump Selection

Regardless of whether or not the heating distribution system and radiators are being replaced, the maximum selected heat pump output shall be:

1. Based on a maximum of 55 W/m^2 (total fabric and ventilation heat losses) of school heated area at -3°C outside design temperature

   and

2. Compatible with the existing school electrical infrastructure, without the need to upgrade the existing electrical infrastructure to the school, the Maximum Import Capacity (MIC) capacity may be increased to the available maximum capacity from the ESB Networks. A single application may be made to ESB Networks for 3 different increases in MIC which relate to heat pump capacities up to 55W/m^2.

   and

3. Be compatible with the existing heating distribution system unless the project includes for a new distribution system in which case it shall be compatible with the new distribution system

1.2 Heating Components Arrangement

Bearing the criteria in 1.1 above the lead Consultantshall review options and propose the most cost optimum arrangement with respect to number of ASHP units and a cascade LPG boiler configuration for operation and some redundancy. (The boiler cascade should in kW be no greater than (the total calculated heat losses with no margins – heat pump thermal output/2).
For example total calculated heat losses = 300kW
Heat Pump thermal output 60kW
Maximum cascade boiler output = 300 – (60/2) = 270kW

Run and standby provision is not required on the LPG boiler or heat pump installation. For example, if the calculated peak heating load is 300 kW, 300 kW of boiler capacity should be installed, plus heat pump capacity as criteria 1.1 above.

2.0 Provision of Domestic Hot Water

The lead consultant should consider the provision of domestic hot water within the school. For this pathway pilot hot water if centrally generated should be provided outside the heat pump envelope, by the gas boiler.

3.0 Heating Design Considerations

3.1 Bivalent heating

Heat pumps are usually sized below the maximum building heat demand when heat pumps are used in combination with boilers, such that during cold weather some of the heating load is satisfied by fossil fuel boilers. The extra heat which the heat pump does not provide is called the bivalent heat.

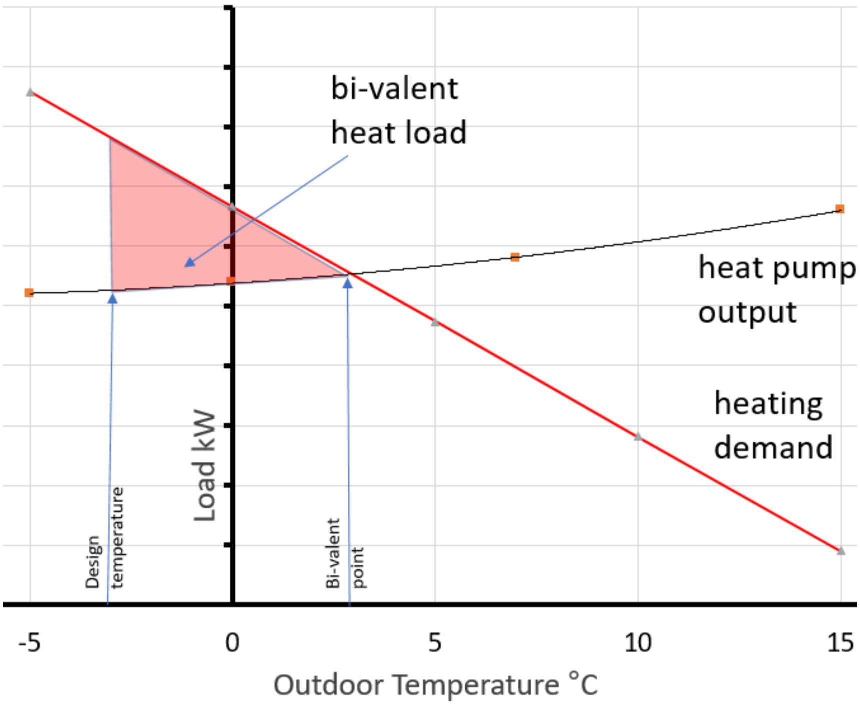


Figure 1 Heat pumps and bi-valent point

3.2 Modes of Operation

Modes of operation can be categorised according to how bivalent heat is provided.

Monovalent	Heat pump only. No boilers. Bivalent point is at or below the design temperature.
Parallel	Heat pump provides all the space heating down to a “bi-valent” outdoor temperature, then, below that temperature boilers run to ASSIST the heat pumps.
Switch	Heat pump provides all the space heating down to a “bi-valent” outdoor temperature, then the heat pumps are off and boilers run on their own.
Switch/Partial Parallel	A combination of the above.

For this pilot the chosen operating mode depends upon the relative sizes of loads between full load and the heat pump size.

3.3 Heat Pump Temperatures

EN 14825 defines heat pumps by temperature as shown below, which are for units with a fixed water flow rate and fixed ΔT:

Temperature Designation	Flow °C	Return °C	ΔT °C:
Low	35	30	5
Medium	45	40	5
High	55	47	8
Very high	65	60	10

3.4 Effect of Water Temperatures on Radiator Output

The lead consultant must take into consideration how the capacity of the radiator and heat distribution system varies with temperature. This is particularly critical where the existing radiator and heating distribution system is to be reused. Figure 2 shows a graph of correction factors for a typical radiators based on EN442.

The ΔT in the X axis is calculated according to EN442.
Required Room Temperature =20˚C
For high temperature heat pumps
Flow Temperature=55˚C, Return Temperature=47˚C
Mean Water Temperature= (T Flow + T Return) / 2= (55+47)/2=51˚C
ΔT = Mean Water Temperature – Required Room Temperature=51˚C-20˚C=31 ΔT˚C

In the example, a pre-existing radiator in a room was designed for 80/70°C water and a room temperature of 20°C, yielding 55 ΔT˚C and a correction factor of 1.127, shown by the red lines in Figure 2. The green lines show its performance heated by typical “high temperature” heat pumps with the same room temperature and with a correction factor of 0.55. The radiator heat output is reduced by over half, therefore a radiator which was designed to output 3 kW will output (3*0.55/1.127) 1.46kW heated by this heat pump system. In other words, the radiator output is approximately halved if used at high temperature heat pump temperatures.

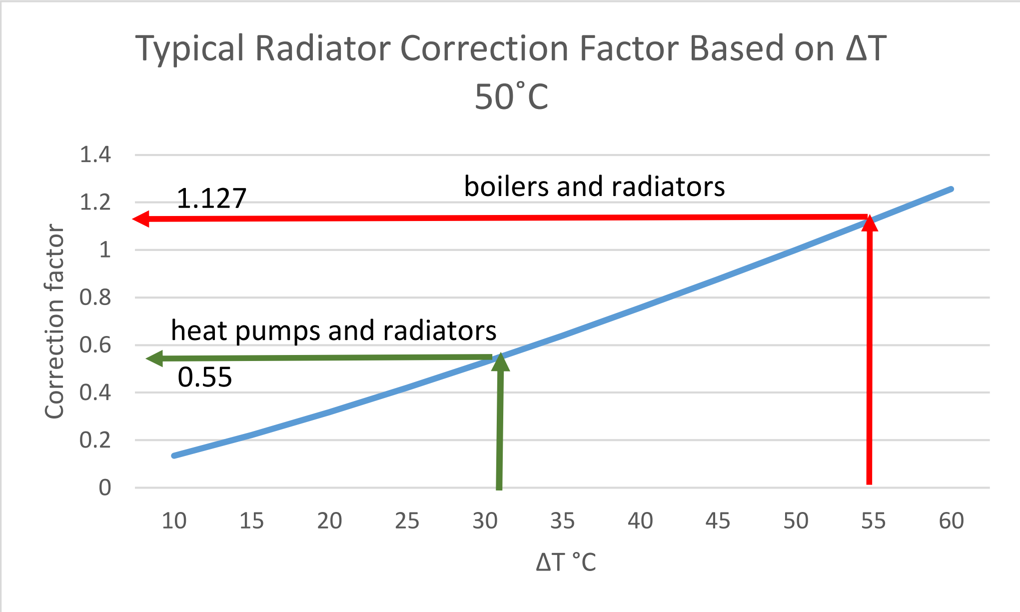
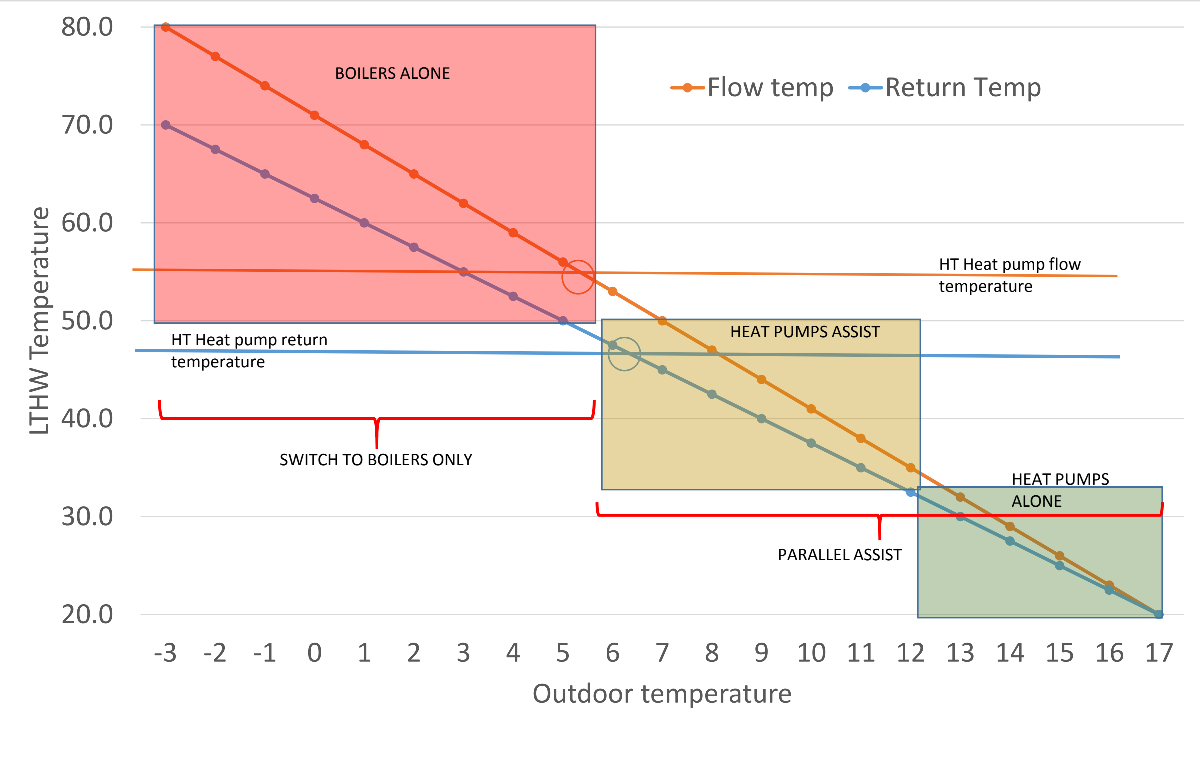


Figure 2 Indicative typical radiator output correction factor

3.5 Existing Heating Distribution System

A simple control method for central heating plant is weather compensation based on outdoor temperature. This assumes a linear relationship between load and outdoor temperature. Flow (and return) temperatures drop as the weather becomes warmer, and loads also decrease. Radiator output also decreases, but the decrease in radiator output tends to approximately match the assumed linear decrease in load.

For these Summer Works projects, weather compensation shall be set up to provide 80°C heating flow at **-3°C outside**, and 20°C at **17°C outside** temperature. Analysis shows that at 7°C outside air temperature the flow temperature would be 50°C and the return temperature would be within reach of high temperature heat pumps i.e. below 47°C and that this would be at about 50% of the full load of the building. The lead consultant shall allow for and write into the specifications that the above weather compensation curve shall be adjustable and shall be adjusted gradually should the school be found to be too cold. The intent is shown below.



Reading off the above chart conservatively, when the flow temperature is calculated to be 50°C or lower, the heat pumps shall be enabled and shall be controlled to maintain 55°C in their buffer vessel. The boilers shall operate to top up the heating to maintain the calculated flow temperature, the amount of heat provided by the boilers at low load depending on the heat pump output. The heat pumps shall be sized in accordance with the rules laid previously.

When the flow temperature is calculated to be above 50°C, the heat pumps shall be disabled. The boilers shall operate to maintain the calculated flow temperature.

The above is called "switch/partially parallel mode".

3.6 New Heating Distribution System

Where a new heating distribution system is proposed as part of the approved SWS funding , the design should be based on the following;

1. Heating pipework and associated services where being replaced should be designed to satisfy the worst case of:

    a) LPG boiler sized at the capacity of the calculated design heating load taking into any fabric improvements made to the building.

    b) "High temperature" heat pump compatible at a capacity of 55W/m2 irrespective of the proposed heat pump capacity which may be less than this. Any piping installed should be of correct size and location to avoid alteration for foreseeable future heat pump works. 55W/m2 is assumed to be the load that heat pumps alone will satisfy after a future deep retrofit project, without boiler assistance. Heat pumps operating alone in future implies a distribution system temperature difference of 8°C (55-47).

2. Radiators where being replaced should be sized based on the following and the worst cases scenario used as the design intent:

   a. Higher flow temperatures, EN442 ΔT= 37°C (heating flow temp. 67°C / return temp. 47°C and room temp. 20°C) taking into account existing fabric heat losses and natural ventilation heat losses. This will often govern radiator sizes. This is to allow for running the heat pump capacity in parallel mode at all load conditions.

   b. Lower flow temperatures used by "high temperature" heat pumps, EN442 ΔT= 31°C (flow temp. 55°C / return temp. 47°C and room temp. 20°C), fabric heat losses plus ventilation losses (these can be covered by future mechanical heat recovery ventilation), totalling 55 W/m^2.

3.7 Buffer Vessels

Buffer vessels will be required to:

1. Provide a heat source for heat pump defrost
2. Minimise compressor cycling.

Evaluate size of buffer tank to reduce HP cycling and allow a heat source for coil defrost.

A rule of thumb is for the buffer vessel to be 10 to 15 litres/kW of heat pump thermal output. The use of a correctly sized buffer vessel should eliminate the need for an electric element in the heat pump for defrost, and heat pumps with electric elements should not be used. Specifications should specifically prohibit built in electric heater elements.

It may not be cost effective to use a buffer vessel to smooth out the heating load, such as eliminating peak morning warm-up load. Heat pump manufacturers might be consulted on buffer vessel sizing, but lead consultant s must make their own decisions. Any buffer vessels sized to smooth out loads must be justified by showing a reduction in installed heat pump capacity, a reduction in MIC, and with no significant impact on school energy use.

Ensure vessel is piped so that system operates at peak efficiency.

Losses from the buffer vessel during weekends, the Christmas break, etc. must be taken into account.

Boilers should on the load side of any buffer vessels, partly to avoid fossil fuels being used to defrost heat pumps.

The schematic must be carefully considered, and the location and types of pumps, low loss headers, and any additional heat exchangers etc. should be determined and shown.

3.8 Maintenance and Spare Parts

Systems must be specified for which there is a proven track record of delivery of a maintenance and spare parts services by the manufacturer.

Suppliers should either have been supplying and maintaining heat pumps for at least 10 years, or be a large widely known company, preferably a company with a long track record involving refrigerants. Ideally the supplier would have maintenance services available from two or more locations across the country.

3.9 Controls

The controls strategy must compliment decisions made about how the heat pump system interacts with the gas heating.

It is critical from a control viewpoint that the heat pump is well integrated with the heating system so that it operates at peak efficiency and deliver a good proportion of the annual heating load from the heat pump commensurate with their size. Refer to TGD-030 and TGD-031 for controls, as well as TGD 030 section 34 for energy monitoring.

The design and specifications must provide:

1. A points list
2. A sequence of operation
3. A list of graphics to be presented, including monitoring

It must not be left up to the BMS firm to determine these items as they have no stake in the school's energy efficiency.

3.10 Effect of Water Temperature and Outdoor Temperature on Air Source Heat Pump Output

The lead consultant shall consider the impact of both water temperatures and of outside air temperatures on the output of air source heat pumps. An example graph is shown below. The higher the water temperatures and the lower the outdoor temperatures, the lower the heat pump output.

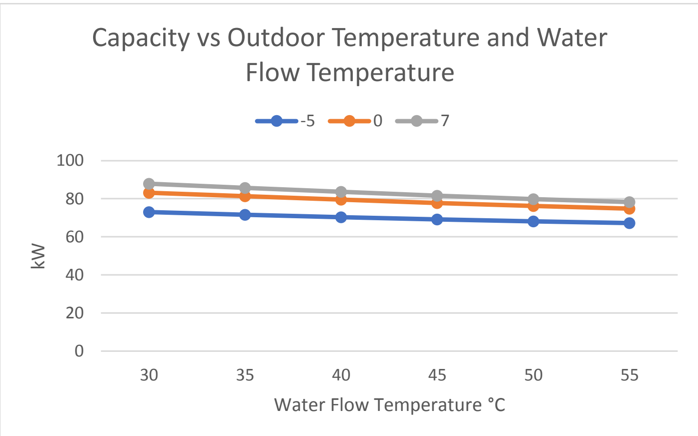


Figure 3 Output of heat pumps versus temperatures

One goal is to reduce the school's carbon emissions. The electricity grid presently has a carbon intensity of about 0.295 kg CO_2/kWh. If a heat pump has an instantaneous COP of 2, the useful heat it produces will have a carbon intensity of 0.295/2=0.148 kg CO_2/kWh. It is unlikely that a heat pump's COP will drop below 2, and since that carbon intensity is lower than the carbon intensity of all fossil fuels, it is always worth running a heat pump from a carbon prospective. However, maximum import capacity costs and charges and other factors must also be taken into account.

3.11 Maximum Import Capacity (MIC) and Demand Charges

The installation must be compatible with the existing school electrical infrastructure, without the need to upgrade the existing electrical infrastructure to the school, the Maximum Import Capacity (MIC) capacity may be increased to the available maximum capacity from the network.

A CT amp test on the peak current passing through phases may be useful at peak demand time in determining the electrical demand and thus maximising the potential for reduce heat pump capacity in this project, this would also need to take seasonal adjustment into account for peak loads in winter months.

Calculate running costs. Running costs must also take into account all demand charges.

Since school running hours are very short, the impact of demand charges on total electricity costs can be significantly higher than buildings occupied for longer hours. Usually there are at least two components to demand charges on electricity bills, and all components must be understood and included in cost analyses. The lead consultant must obtain electrical bills from the school and use cost from the latest bills and not from any other source.

As noted earlier but important to reinforce here the installation must be compatible with the existing school electrical infrastructure, without the need to upgrade the existing electrical infrastructure to the school, the Maximum Import Capacity (MIC) capacity may be increased to the available maximum capacity from the network if required.

3.12 Air-Source Heat Pump Location

Size the heat pump outdoor compound only for 100% heat pump heat supply based on 55 W/m^2 building heat load.

The location of the outdoor units must be agreed with the school.

Heat pump area shall be enclosed and not accessible by students or the public.

Noise generated from heat pumps can be significant, refer to SDG 02-05-03.

The outdoor units of air source heat pumps generate noise and can be fragile. They must be located at a position which does not impact adversely on noise at the school or at neighbouring properties. Refer to SDG 02-05-03.

Be cognizant of heat pump protection from possible ball damage etc. Smaller units may have plastic meshes over air intakes or exhausts which may break easily. Larger units may have exposed evaporator tubes and fins which must be protected from damage. Protection must be provided where necessary. Outdoor unit noise performance must be specified.

Outdoor units in or near maritime locations will need to be specified appropriately for this environment and may require special anti-corrosion coatings to fin and tube heat exchangers etc.

Moisture will condense onto the heat pump condenser. Defrost will also result in meltwater. Outdoor unit drainage must be considered such that water runs to a drain without wetting accessible surfaces or causing a slip-hazard e.g. due to frozen water in any area.

The need for planning permission should also be considered.

3.13 Electrical Considerations

All electrical design to be compliant with the Departments Technical Guidance Documents.

Existing electrical infrastructure should be retained and reused, but if change is required due to age of system internal electrical distribution infrastructure should be sized to supply predicted electrical current to possible additional heat pumps. As well as underground ducting to avoid further digging in future.

Possible installation of electric vehicle charging should be factored into maximum school supply capacity. For guidance see Energy Conservation and Mechanical and Electrical Building Services Design Note 202001.

3.14 Attic and Cavity Wall Insulation

If applicable the lead consultant should consider any attic and cavity wall insulation works.

Cavity Wall Insulation

Contractors of cavity wall insulation must be approved by the NSAI Agrément and must agree to carry out the installation to the standards required by this approval and certification.

Materials to be used in the insulation of a cavity wall must be certified by the NSAI Agrément.

The objective is to in as much as is physically and economically possible, maximise the U-value for external walls.

The product must be suitable for use in masonry cavity walls so that it does not compromise the property’s ability to resist internal fire spread within the structure as per the current version of the Building Regulations (Amendment) Regulations 2006 (Part B).

The insulation must be installed as per the system supplier and manufacturer guidelines, the product will not affect the property's ability to resist weather and ground moisture (Building Regulations – Part C). It must also meet the Building Regulations requirements for materials and workmanship (Part D).

Correct installation will also satisfy the Building Regulations (Part J1) on the maintenance of an adequate air supply for the efficient working of any flue or chimney after installation work.
The insulation system shall conserve energy in keeping with Part L of the Building Regulations in as far as is practicably possible.

The installation of fibre, foam or bead insulation systems into the voids of Hollow Block Walls will not be supported by the scheme. The funding agency is specifically excluding this practice from support through this scheme. The system must also be suitable for use on a property and meet the ventilation requirements in the Building Regulations.

All products used in this application must have appropriate Irish Agrément Board certification for use in the insulation in cavity wall construction with cavities ranging from 50mm to 110mm.

Approximately 50% of the Republic of Ireland experience a driving rain index of greater than $5m^2$/sec/year as indicated on the NSAI Driving Rain Map. Therefore in areas with a driving rain index above $5m^2$/sec/year the installation of cavity fill insulation in unrendered brick and blockwork is deemed unsuitable and consequently is not supported.

It is critical in areas with a rain index less than $5m^2$/sec/year given the porous nature of unrendered brick exterior walls that the proposed product complies in full with respect to resistance to weather and ground moisture, assessment of exposure based on the topography factor of the school site and the minimum cavity width and height of the school.

The lead consultant shall include the appropriate specifications in their tender documents including but not limited to the following.

All cavity wall insulation must be installed in accordance with the specifications laid out by the system supplier and in accordance with the relevant system's NSAI Agrément certificate.

A survey of the walls must be carried out prior to the installation by a trained surveyor. A complete survey, including a boroscope survey, report is required and must be provided. This is to ascertain the suitability of the property for the recommended insulation system.

Any defects recorded in the survey, which may affect the performance of the insulation system when installed, should be notified to the Department and may be rectified with or without the involvement of the Contractor before installation work commences.

Installation must be carried out by the system supplier or manufacturer or a Contractor approved by the system supplier/manufacturer.

Cavity filling with expanded polystyrene should not be carried out where PVC-sheathed electrical cables are passing through the cavity but are not protected within electrical conduits. If the cavity is uncapped, it must be closed at the top of the wall and at the top of any opening in order to comply with the Building Regulations Technical Guidance Documents.
Particular attention should be paid to ensuring that gas, oil and solid fuel appliances are correctly ventilated as per the system supplier's specifications and the Building Regulations (Part J).

Ventilation openings must be checked to ensure there are no obstructions due to the insulant.

All flues must also be checked for obstructions using an appropriate test (e.g. smoke test).

An NSAI Agrément Certificate or supplier guarantee must be issued to the school where applicable. Certification is valid once the conditions outlined in the certificate are met.

Care must be taken in considering blowing insulation into cavity wall construction which already have partial fill insulation present so that this is not compromised or does not create cavity bridging and voids from displaced insulation boards etc.

The design and installation of the recommended works must not compromise the ventilation, air quality, humidity (and the potential for condensation) and quality of school internal environment in the school. Particular care must be given to the potential impact on the school internal environment in the school resulting from any measures installed under the Scheme.

Ceiling Attic Insulation.

The lead consultant shall include the appropriate specifications in their tender documents including but not limited to the following.

Where a product is covered by an NSAI Agrément Certificate it must be installed in accordance with this certificate and by such qualified people as specified.

Materials to be used in the insulation of an attic at ceiling level must be manufactured to a relevant Irish and European Standard.

All attic insulation should be quilted type insulation, blown insulation of any type is not permitted nor will not be funded by the scheme.

Where insulation already exists in the attic this may be added to, if the existing insulation is not fitted correctly between the roof joists then the contractor must allow for refitting this properly before applying additional new insulation on top. Finished attics should contain an overall minimum depth of 300 mm of insulation.

The installation must have Rockwool only over corridor areas and over areas of special fire risk such as kitchens etc. to supplement any existing fire barriers that may exist in these areas.

The target U-value for the scheme for attics insulated at ceiling level is, in as much as is physically and economically possible, 0.13 W/m^2K. Other NSAI Agrément-certified products may also be used.

The insulation must be suitable for use so that it does not compromise the property's ability to resist internal fire spread within the internal linings and internal fire spread within the structure as per the Building Regulations (Amendment) Regulations (Part B).

When installed as per the system supplier's guidelines, the system should meet the Building Regulations requirements for materials and workmanship (Part D).

The insulation should also be suitable for use on a property and meet the ventilation requirements in the Building Regulations (Part F).

Correct installation should also satisfy the Building Regulations (Part J) where the installation does not increase the risk of the property catching fire through the use of a heat producing appliance.

The insulation system shall conserve energy in keeping with Part L of the Building Regulations.

To maintain a high level of insulation under any flooring in the attic, where limited flooring is required or is being retained by the School then consider installing floor joists on the existing joists at right angles to allow the required thickness of insulation to be laid, with the floor installed above this.

It is essential that any heavy-duty cables (e.g. for cookers and showers) are not covered by the insulation material and should instead be left on top of the new insulation, provided there is sufficient slack to do so. Where this is not possible, a gap of at least 75mm should be left either side of the (heavy duty) cables for their entire length within the attic area.

The insulation material shall be retained at a minimum of 75mm from all electrical apparatus penetrating the ceiling, for example recessed lighting fittings. Where necessary a permanent physical restraint shall be used.

Recessed down-lights should be protected in such a way that the insulation does not cover them and that they are adequately ventilated. The lead consultant must advise the School of the need to keep the recessed lights clear of insulation.

All pipe-work and water storage vessels should be insulated.

No insulation material should be laid below water storage tanks located in the attic space where the underside of the storage tanks is less than 300mm above the finished level of insulation. Where this is the case, the insulation around the water storage tank should continue down to the finished level of the attic to form a skirt around the tank.

If the water storage tank is greater than 300mm above the finished level of the insulation, the insulation should be installed below the tank and the underside of the tank should also be insulated.

The installation is to include for insulation to the attic access hatch. The insulation is to be fitted to the same thermal value as the main attic and securely fixed to the attic hatch.

Where attic access ladders are fixed to the hatch it is recommended to use insulating hoods or a lightweight insulating box where possible.

The design should include draught proof attic hatches.

In every roof space where cold water tanks or other fitted appliances occur, the works should include a permanent boarded walkway from the roof access point to the tank ball valve position and / or the appliance location.

The boarded access walkway shall be constructed of minimum dimensions of 50x50mm soft wood battens laid across rafters, notched over pipes and cable crossings, said battens to be securely screw fixed in place to rafters. 19mm thickness by 450mm wide flooring grade chipboard to be fixed to battens base with screws.

This walkway should be supported above the first layer of insulation to prevent any compaction of insulation below the walkway.

Where the attic is used for storage it is strongly recommended that alternative methods for preserving storage space while maintaining high levels of insulation are explored with the School. This would include insulated storage spaces or the provision of storage spaces over rooms least likely to suffer from reduced levels of insulation.

4.0 Energy Performance and Commissioning

The Consultants will complete the commissioning requirements as established in the TGD’S. Particular attention should be paid to the following requirements also.

Carry out seasonal commissioning for the first year of operation (Appointed Consultant to allow for 4 site visits to witness the performance every 3 months) and report on differences in the predicted operational performance of the building and actual operational performance (final payment will be released upon issue of final commissioning report and the report on operational performance).

4.1 Energy targets review:

The commissioning engineers as well as the Building Services Consulting Engineer shall return to the school following a full year of operation of the system and in conjunction with the control company and contractor reassess the targets set and confirm that they are correct and match the school’s energy usage profile. If they do not, then remedial action shall be undertaken to ensure proper targets are being met and that the system operates correctly. Where necessary any measurements and remedial adjustments should be applied. This must be completed prior to release of final retention.

4.2 Maximum import capacity (MIC) Post Works:

The Building Services Consulting Engineer and Contractor shall return to the school following a full year of operation and compare the metered electricity consumption against the design target.

They shall advise the school authorities:

- If the target set is reasonable and the applied tariff is correct.
- If there are any benefits to be gained by a lower monthly MIC charge where the MIC is less than the agreed Maximum Demand and where subsequent penalty charges can be avoided.

4.3 Post-occupancy energy information form:

The Building Services Consulting Engineer shall re-visit the school after it has been occupied and in use for a minimum of 12 months and complete a post-occupancy DoE Energy Information Form based on actual readings. He shall also prepare a commentary highlighting the changes if any that have been made to the controls and commissioning settings.

A hard copy of these shall be handed over to the school authority for its records.

A second copy of the completed form shall be forwarded to the DoE for record purposes at:

poedpp@education.gov.ie.

- As Built Mechanical Drawings (in .dwg and PDF format format): The drawings shall clearly show all systems, plant, valves, dampers, etc. All plant & valves shall be clearly referenced and be readily identifiable and show a legend for all colour-coded services.

- The Candidate and his Contractor shall ensure that any services or systems, which are buried within the structure, or underground, are precisely located on the drawings, along with the precise position of entry of services to the building, isolating valves and cocks.

- Sample digital images for each key item of Mechanical, Electrical and Lift installations for use as cross reference photos within the various sections of the O&M Manuals.

5.0 Summary Checklist

The lead consultant must:

1. Understand how selected heat pump COP and output is affected by outdoor temperatures, flow temperatures, flow rates, and loads.
2. Carry out full building heat loss calculation with no rules of thumb.
3. Consider the impact of flow and return temperatures at varying operating conditions on radiator output, radiator sizing, and pipe sizing.
4. Consider the impact of 55°C flow and 47°C return temperatures on seasonal COP.
5. Correctly size any buffer vessel.
6. Consider future installation of mechanical ventilation with heat recovery, and its impact on heating loads and electrical loads.
7. Domestic hot water to stay outside of heat pump envelope.
8. Ensure that heat pumps do not use electric heaters for defrost.
9. Prepare full heat losses. (Must be made available when requested. Rules of thumb not acceptable).
10. Prepare schematics and drawings of systems.
11. Provide a performance specification for the heat pumps, buffer vessel, etc. for tendering and contract administration including equipment schedules and written descriptions.
12. Determine and specify a suitable sequence of operation and points list for the BMS.
13. Specify monitoring such that seasonal performance of equipment can be determined including installing energy meters.
14. Ensure maintenance services and spares will be available for future years.
15. Ensure outdoor units are appropriately located.
16. Submit electronically design and tender documents to Planning and Building Unit.
17. Complete design check lists.
18. Complete post contract requirements as outlined.

Appendix Two: Design Review Questionnaire

The following questions on the project will need to be addressed in full and submitted to DoE when requested.

Question	Answer
1. Name of School	
2. Floor Area M^2	
3. Age of School Building(s)	
4. No of Pupils	
5. Are the heat pumps in a secure enclosure, or open to students? Outline the location please.	
6. Could condensate from heat pump units freeze and cause a trip hazard, or does it go direct to a drain?	
7. Has noise of heat pumps been addressed?	
8. How are noise limits specified? This is both relative to neighbours and to school interior.	
9. Describe the control strategy of the heat pumps and back up boiler so that the heat pump is maximised to its full potential	
10. What is the total kW output of the boilers? How many boilers?	
11. What is the total kW output of the heat pumps? How many heat pumps?	
12. What are the design flow and return temperatures to the radiators when heated by heat pumps?	
13. Are the secondary flow and return temperatures to the radiators kept relatively low at all times, or do they increase in colder weather? Please explain.	
14. What logic is used to calculate flow and return temperatures, if they are variable?	
15. Are secondary pumps supplying radiators expected to vary in flow rate, and if so, what influences the flow rate and how are the pumps controlled?	
16. What is the logic controlling the pumps?	
17. In the coldest weather, do the heat pumps run, or just the boilers?	

18. At what external temperature will the heat pumps utilise their full output?	
19. Are the boilers sized to meet the full load at -3°C? If not, what percentage of full load do they supply?	
20. Is the heat pump design specifically based on a night set back temperature (other than frost protection), or just on optimum start?	
21. What is the night setback temperature, if any?	
22. Is metering specified such that the heat pump instantaneous and seasonal efficiency can be monitored?	
23. Is a meter, linked to the BEMS, provided to monitor the space heating from Heat Pump alone?	
24. Is a meter, linked to the BEMS, provided to monitor the DHW from the Heat Pump alone?	
25. Is a meter, linked to the BEMS, provided to monitor the electricity into the heat pumps?	
26. Can boiler instantaneous and seasonal efficiency be monitored?	
27. Is there a buffer vessel?	
28. What size is it (litres)?	
29. How was it sized?	
30. If a buffer vessel is present, what temperature will it be maintained at? 31. If a buffer vessel is present, what is the flow and return temperature from the heat pump?	
32. Do the boilers feed into the buffer vessel?	
33. Do the radiator sizing comply in full with section 3.4	
34. Do the tender documents contain a controls points list?	
35. Is the control logic fully specified in the tender documents i.e. is the logic associated with each sensor and actuator explained?	

36. Does the controls strategy fully reflect the schematic drawings and points list?	
37. Are the specifications fully tailored to suit the bi-valent LPG boiler/heat pump solution? 38.	

39. Fabric over view of School Building as utilised in calculated heat losses.

Element	**Age if known**	**Conditions Bad Fair Good**	**U Value W/m2K**	**Any other comment**
External walls				
Flat roofs				
Pitched roofs				
Windows type 1 **Windows type 2** **Windows type 3** **Windows type 4** **Windows type 5**				
External doors				
Roof lights				

40. Fabric Improvements overview if applicable

Was attic insulation works completed? Total cost Cost per m^2		
Was cavity wall insulation works completed? Total cost Cost per m^2		

41. Running costs Overview

	Tender Stage	Evaluation 12 Months after installation
Annual pre works heating demand kWhr		

Pre works installed boiler power kW		
Pre works annual heating costs		
Total Building calculated project heat losses kW		
Calculated project heat losses w/m^2		
Post project installed boiler output kW		
Expected annual heating running cost LPG/ NG		
Expected annual heating running costs Heat pump, incl. MIC charges etc. €		
Total expected annual heating costs €		
Total expected annual heating costs €/m^2		
Total annual heating costs €/pupil		