Renewable Space Heating

Renewable space heating can be achieved in a number of ways; biomass heating and heat pumps are commonly considered as potential alternatives to fossil fuel heating.

Both biomass and heat pump systems have been assessed and trialled in schools through the Department of Education Energy Research and Demonstration Programme. Heat pumps continue to be assessed through the national Schools Retrofit Pilot Scheme.

These technologies are not a direct swap-in technology to replace oil and gas fired boilers and require significant enhancement of the building fabric, heating distribution systems and associated services in older schools.

This research programme for renewables in a school environment identifies that these systems do not present a cost optimal solution for inclusion nationally in school buildings at this time. This results from the increased operational and management requirements along with the potential for increased running costs and significant increase in capital costs.

As detailed further in this factsheet, newly constructed schools are future proofed for third parties to offer renewable heat options to the school should they be deemed viable. The Department is very open to this approach and makes allowances for this in all new school designs via the Technical Guidance Documents, thus ensuring that there are no barriers to an energy services company (ESCO) being developed on a new school site. This approach will see any such schools looking to engage with ESCOs via the support scheme for renewable heat having the necessary basic infrastructure already in place to do so.

Schools who do consider these technologies should review the advice below and contact the Department of Education before proceeding with any renewable heat conversion projects.

The Department continues to review its design policies through research and, under the 2019 energy retrofit pilot, completed an oil to air source heat pump / LPG boiler hybrid installation along with associated building fabric improvement works. The system is monitored and evaluated to inform the Department policy.

Biomass Heating

Biomass boilers burn wood as an alternative to fossil fuels to generate heat. As biomass fuel (e.g. trees) absorbs CO_2 from the atmosphere when growing, the burning of the fuel is close to “Carbon Neutral”. Naturally this depends on the source of the biomass, which needs to be certified as sustainable to be considered a renewable heat source.

Wood pellets

There are a number of biomass fuel types; for general applications the options are wood pellets and wood chip. Wood pellets are a processed form of wood biomass fuel and are more typical for smaller biomass boilers. Wood chip is a less processed, and hence cheaper, fuel which requires more complex fuel handing for storage and within the boiler itself. Wood chip is typically used for large boilers.

Important considerations:

- Wood pellets and wood chip are cheaper than oil at the time of publication. https://www.seai.ie/publications/Commercial-Fuel-Cost-Comparison.pdf can provide current comparative costs.

- Biomass boilers are more expensive than oil or gas boilers. The payback period (time it takes for savings in terms of expenditure on energy to pay for the investment) for a biomass boiler plant is dependent on fossil fuel prices. Due to the short running hours of schools, the payback period (without grant support) will usually be quite long and can exceed the life expectancy of the boiler.

- SEAI’s Support Scheme for Renewable Heat (SSRH) will provide a payment over 15 years for certain biomass boilers that meet the conditions of the scheme. This will reduce the payback on a biomass boiler installation. The introduction of this support may mean schools are contacted by companies offering biomass boilers, or Energy Services Company (ESCO) type heating supply arrangements (see below). Further details on the scheme are available at https://www.seai.ie/business-and-public-sector/business-grants-and-supports/support-scheme-renewable-heat/.

- Biomass boilers are physically much bigger than oil or gas boilers and may need a new larger boiler room to accommodate them. However, they can be supplied as a ready to go packaged plant room (e.g. within a shipping type container).

- Large fuel storage space is required; larger for wood chip than wood pellet. The fuel store can be supplied as part of a packaged plant room.

- Access for fuel deliveries needs consideration and can be challenging, particularly for urban schools.

- Typically, more maintenance and parts replacement are required due to the larger number of moving parts.

Biomass boiler in pilot school

Biomass deployment pilot programme

In 2006 the Department of Education 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. The evaluation of the 14 sites that formed the Biomass Deployment Pilot Programme from 2007 to 2009 met the overall objective in that it trialled a number of boiler types for integration into a representative sample of the Irish Educational Building stock which included both new and existing structures.

The project was assessed by independent consultants. The pilot highlighted the positive and negative aspects in the challenges of successfully integrating biomass into the school stock. This was not achieved without some issues and the overall level of satisfaction was rated at approx. 56%. The study found that biomass boilers can provide an efficient and renewable form of heating in schools but cannot be deemed an exact fit. It is also considered that it will prove difficult to match the small schools in the country with biomass heating on an operational and costs basis. As reflected in the satisfaction rating, the study found that biomass systems can require a significant amount of management input on site 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 undertakes a teaching role or where there is limited caretaker engagement on site.

One outcome from the project highlighted the potential market for 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. This is facilitated in all new school designs through the Technical Guidance Documents, which ensure schools looking to engage with ESCOs via the support scheme for renewable heat have the necessary basic infrastructure already in place to do so.

These ESCO arrangements may be long-term contracts (>10 years), and the school should carefully consider these contracts, and obtain legal advice on it. Issues to consider in these contracts are break clauses, guarantees of availability of heat provision, arrangements for insolvency of the ESCO, insurance, and ownership of the plant at the end of the term.

Recommendations:

- 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 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. Therefore, an ESCO Biomass boiler installation should be sized on the base heating load of the school (i.e. the average daily heat demand) and given priority to sell heat to the school over heat from fossil fuel sources. The school's existing boilers can supplement this heat during really cold days when the heating demand is increased.

Heat Pumps

Heat pumps extract heat from the surrounding environment (air, water, underground/geothermal). They work in the opposite way to a fridge, which extracts heat from inside the fridge to cool the internal fridge space. Heat pumps may have very high efficiencies (300-400%) due to the nature of the thermal cycles they employ. This may mean you get 3-4 units of heat per unit of electricity. The effectiveness of heat pumps in schools has been kept under review in relation to their viability for schools since 2002.

Types of Heat Pumps

The most common forms of heat pumps are geothermal (ground source) and air source.

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 consistency 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.

An air source heat pump system is a heating system that uses heat extracted from the external ambient air. The air temperature changes a lot throughout the year so the performance of the heat pump will need to vary to supply the heat demand in the school.

Air Source Heat Pump

In general, a number of building blocks need to be put in place nationally regarding heat pump delivery in Ireland. A standard for the installation of heat pumps is available from NSAI and details of registered installers and heat pump assessors is available on the SEAI website.

Natural gas and LPG supply has the potential to increase its renewable content; research and technology advances regarding the future role of hydrogen highlight the potential for phasing gas boilers to hydrogen boilers in the future.

Heat Pumps with underfloor heating

To be most economical in schools, heat pumps must be operated using night rate electricity. Thus, just like with electrical night rate storage heaters, 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.

Underfloor heating connected to a geothermal heat pump has been tested in an Irish school. Results showed that the compatibility of the system with a school's passive solar design strategy and operational requirement has been very poor.

The slow response time of the underfloor heating has led to overheating in the classrooms when there is good passive solar heat available to the school. When the heat pump failed to operate the night before, there have been problems with the quick provision of heat due to the thermal lag built into the system. When this system required replacement the school decided with their Consultant Engineer to install a gas fired heating boiler plant.

Heat Pumps with low temperature radiators

Where underfloor heating is not possible to install, low temperature radiators may be used but the heat pump will now need at times to operate using day time electricity rates.

The use of air-source (air to water) heat pumps has also been considered and some were installed by schools (but in many cases these have since been replaced by boilers). There are a number of factors that indicate that these are currently not the optimum heating solution for a school.

Important considerations for retrofitting a heat pump into a school:

- A renewable heating sustainable solution must:
  - involve the matching of a sustainable resource with the end users' needs and not just the application of that resource, and
  - provide a benefit to the school and not become either a management, operational or financial burden on the school.

- Heat Pumps in schools are not a direct swap-in technology to replace oil and gas fired boilers and require:
    - significant and diverse changes to the fabric of older buildings to make the school compatible. The building may also not be air tight to maintain a comfortable temperature given the lower operating temperature of heat pumps systems. This would normally involve at least the retrofitting of insulation to walls and roofs and possibly replacing glazing and doors,
    - the provision of classroom mechanical heat recovery ventilation systems with associated plant spaces (not easily available in older schools). This is due to the inability of heat pumps to respond to quick heat up when required where there is only natural ventilation available, and
    - the replacement of older heating distribution systems as the lower operating temperature of the heat pumps typically require newer more efficient and better performing modern radiators.
- For larger heat pump systems (typically greater than 30kW), an upgraded electrical supply system to give additional capacity will be required which will result in adding to the school's electrical costs with additional Maximum Import Capacity charges (MIC).
- The school's operating profile (i.e. 5-day week with morning to afternoon occupancy) and intermittent need for responsive heating may not work economically or practically with a heat pump. Given these operation hours, the high occupancy rates and resulting daytime heating demands, the benefit of night rate electricity cannot be fully realised (for example, as in a nursing home). Therefore, the economic value of energy savings is less beneficial, and may not offset the additional MIC costs.
- Heat pumps have a slow response time and need additional buffer storage tanks, or a backup heat supply from a fossil fuel boiler.
- Heat pumps, particularly if installed in a building with poor insulation levels and poor airtightness, may result in higher operating costs compared to high efficiency condensing gas boiler installations, albeit they will likely contribute less emissions through their operation. The payback period is also likely to be lengthy and may exceed the life expectancy of the heat pump.
- Heat pumps are less efficient in winter due to low coefficient of performance (CoP) levels, so realistic seasonal CoP should be considered when evaluating this technology.
- There is a need to maintain hot water storage temperatures in schools at 65ºC, this also impacts the efficiency of heat pumps.
- Electric fan type heat emitters can maximise the potential of heat pump low temperatures, but these are not appropriate for use in schools due to maintenance, noise and localised control issues.
- Given the above factors, if installing a heat pump, a secondary source of heating may need to be maintained in a school. This would duplicate 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.