South Hill Park – Summary of Heating and Hot Water Options / A

Introduction

The peak heat loss from a typical mid-position dwelling (No. 82) has been calculated using EDSL TAS 9.5.6 software in order to establish the requirements for alternative heating systems, most notably Air Source Heat Pumps (ASHP).

The peak heat loss for No. 82, assuming thermally improved roof; completely new windows and doors to the street façade and existing Double Glazed Units (circa mid 2000's) at the rear of the property is 12.5kW. This is to achieve an internal air temperature of 21°C, for an external air temperature of -1.7°C and an air infiltration rate of 1 air change per hour over the whole volume of the dwelling (in reality, we would expect the air infiltration rate to be lower).

The peak heat loss for No. 90 will be in the order of 15kW, taking into account the greater area of exposed wall. For the duplex houses, we expect the heat pumps to be in the order of 6-9kW each. The precise split depends on the area each individual dwelling occupies within the overall volume of the building.

As with all calculations, we have made assumptions about the thermal performance (U-values) of the existing envelope, and there may be some variance between actual and calculated U-values owing to moisture content, material batches, workmanship during construction etc.

Space Heating Options

We understand that the dwellings are typically heated using gas-fired boilers. A move away from natural gas is attractive to reduce the overall Carbon Dioxide (CO_2) Emissions of the properties.

Although hydrogen replacement for natural gas has previously been much hyped, the prospect of individual homes being heated using hydrogen is very unlikely https://committees.parliament.uk/committee/135/science-and-technology-committee/news/175146/hydrogen-is-not-a-panacea-for-reaching-net-zero-warn-mps/

Heat sources that use electricity are therefore favoured when considering alternatives to gas-fired boilers.

The most common electricity driven replacement heat source is the air source heat pump (ASHP). These extract heat from the outside air and use a refrigerant based vapour compression cycle to "amplify" the heat to a temperature useful within buildings. The heat is then most typically distributed via water around the property. Since ASHP's extract heat from the outside air, they operate most efficiently when the temperature rise is low. A heat pump is typically selected to provide heating water at 45°C (upper performance limit 55°C), rather than 80°C for a gas boiler.

Because the operating temperature is lower, a larger surface area of heat emitter is needed to achieve the same heat output in a room. In new buildings, underfloor heating is favoured due to the large heating area available. In existing buildings, the existing radiators and, often, the existing pipework will need to be replaced for rooms to be heated effectively.

Heat pumps are driven by compressors, which require a minimum system water volume and minimum water flow rate to avoid cycling of the compressor between on and off (cycling leads to premature failure of the compressor). Most heat pumps therefore require a buffer vessel of some description to ensure the operating parameters of the compressor are met. Space inside the property is needed to accommodate the buffer vessel, which can range from wall mounted to large and heavy, floor standing units, depending on the capacity, manufacturer and model of heat pump selected. It should be noted that a buffer vessel is not the same as a hot water cylinder, and would be required however the hot water might be generated in the property.

Direct electric heating is the alternative to air source heat pumps in some circumstances.

Although direct electric heating boilers are available, significant improvements to the building fabric are needed to overcome the high “primary energy” factors associated with these.

Whereas a heat pump typically delivers 3kW of heat for every 1kW of electricity, direct electric boilers operate on a 1:1 ratio. If replacing a gas boiler with direct electric heating, although CO2 emissions would reduce, the impact on the electricity network would be detrimental. For instance, a 12.5kW heat pump would typically draw 4.2kW electricity at peak load – similar to a modern electric oven. But a direct electric heater would use 12.5kW of electricity at peak load – an extremely large load if operating for extended periods.

The Building Regulations therefore require any project considering direct electric heating to have a heating demand of no more than 25kWh/m2 per year (Approved Document L Volume 1, 2021 edition, 5.5). In context, even with the improvements to the façade and roof, the existing properties will having a heat demand in the order of 70-80kWh/m2 per year, depending on occupancy profiles and heating set points.

For South Hill Park, air source heat pumps appear to be the only viable option at this moment in time and for the foreseeable future.

Domestic Hot Water Options

Gas-fired combination boilers have negated the need for hot water storage tanks, thanks to their ability to heat water rapidly at high temperatures. As noted, heat pumps do not have this capacity, and therefore require a larger surface area to raise hot water for showering and taps to a suitable level.

We understand that in some properties, hot water cylinders still exist, but where combination boilers have been installed, there will be a requirement to re-introduce hot water storage to each dwelling, or moving over to electric showers and sink/wash hand basin heaters.

For a typical two person occupancy dwelling, a domestic hot water cylinder of 200 litres is likely sufficient. This would require internal space of approximately 500-600mm diameter in floor area and a clear height of 1800 to 2100mm. If replacing a gas combination boiler, unless it is located in the same position as the boiler, the distribution pipework would also need to be replaced.

An alternative to this, perhaps in those properties where hot water cylinders have been replaced by combination boilers, is a phase change hot water storage heater.

These use heat generated by either a heat pump, solar PV or electricity to store and release heat as salt based materials change phase between liquid and solid. These have the advantage of being far more compact than hot water cylinders, while being able to deliver similar performance.

A 200 litres equivalent Phase Change Store is in the order of 575mm deep x 365mm width x 870mm high

An example of the space difference is shown in the image above.

The disadvantage of the phase change stores is cost and weight. They typically weigh in excess of 120kg (when "dry") and are therefore complex to locate on upper floors. They are also approximately two times more expensive than an equivalent hot water cylinder.

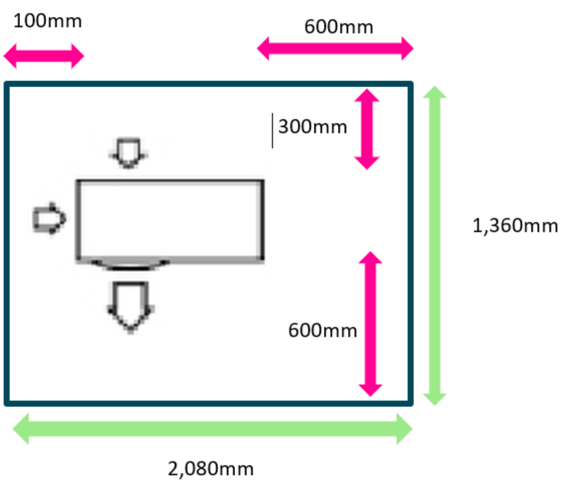
Air Source Heat Pump Options

To assist Citizens Design Bureau develop plans for the planning application, we have considered four different manufacturers of Air Source Heat Pump, and have used the largest overall dimensions and sound rating to develop a robust scheme. This approach provides some flexibility for each household when choosing suppliers at a later date.

The options considered are based on a 12.5kW peak heat load with a supply temperature of 55°C (that being the most realistic for retrofitting existing properties).

Each manufacturer has different parameters for "free space" around their units to permit unrestricted air paths and not compromise performance. Similarly, each manufacturer has different space requirements for maintenance of the units.

The diagram below shows the worst case for each for "free space" only, based on the offerings from Daikin, Mitsubishi Electric, Grant and Samsung UK. The highlighted data in the tables indicates the dimensions used.



Additional maintenance access will be provided to the front elevation (discharge fan position) by either hinged or removable panels, according to the orientation of the units and the locations of accessible components. The enclosure is assumed to have no roof.

Consideration of safe access also needs to be given for initial installation and future replacement of the units. The units will all need to be transported to roof level and, due to component weight, external lifting equipment may be the only practicable solution to achieve this.

Manufacturer	Model	Width	Depth	Height*	Weight	SPL@1m
Grant	HPID17R32	1024mm	403mm	1418mm + 100mm	101kg	49.8dB(A)
Mitsubishi Electric	PUZ-HJWM140VHA	1020mm	379mm	1350mm + 100mm	132kg	53dB(A)
Samsung	HHSM-G600016-1	940mm	384mm	1420mm + 100mm	110kg	52dB(A)
Daikin (Monobloc)	EDLA16D3V3	1380mm	460mm	870mm + 100mm	149kg	54dB(A)
Daikin (Split)	EPRA18DV3	1270mm	460mm	900mm + 100mm	146kg	48dB(A)

*Each of the units will be supported on 100mm feet to maintain distance between the floor and underside of the unit