

## **Appendix 2: An explanation of the proposed heating and power technologies**

### **Combined Heat and Power (CHP)**

CHP is a highly efficient process that captures and utilises the heat that is a by-product of the electricity generation process. The plant will be automatically controlled to act as the lead when there is both a heating and electrical demand within the building. The CHP will be sized to meet the base heating load of the building, as this ensures that it will be run almost continuously with little to no heat wastage. Running the CHP system for as long as possible also improves the efficiency of the engine and therefore its financial payback time. The CHP will be served by a gas engine with gas boilers providing top up only during the coldest days.

### **Ground Source Heat Pump (GSHP)**

The majority of the heating energy being supplied to the Hub will look to come from a Ground Source Heat Pump serving underfloor heating. Ground Source Heat Pumps offer efficiencies higher than gas boilers, they also have the benefit of being able to reverse cycle to be able to heat or cool the building. This means that instead of heat being supplied to the Hub, it could also be extracted in the warmer months, helping to cool the building down and decrease the amount of overheating occurring.

Ground Source Heat Pumps can either be open or closed loop and work by extracting heat from the ground, upgrading it using a compressor and then transferring the heat to the building's heating system. There are two main types of GSHP, vertical bore holes or horizontal trenches. Vertical bore holes may be required to go down to depths of greater than 100m and therefore a ground survey is required to determine their suitability. Whereas horizontal trenches will typically be laid only a few metres under the ground but will require a large horizontal run to ensure sufficient heat is exchanged.

The Ground Source system can also be reversed cycled, extracting heat from the building instead of the ground. This helps to cool the building down during the winter months and reduces the amount of overheating occurring. With a number of ground source heat pump units combined in series the relative heating and cooling energy required by the Hub can be shared between the units. Put simply, if one area of the Hub is too hot then this heat could be extracted and moved to an area that is too cold. This exchange of energy between different parts of the building is extremely efficient and can increase the COP of the GSHP considerably.

### **Battery storage and how it works**

Electricity demand and supply is balanced on a second by second basis to maintain secure electricity supplies. If electricity supply is insufficient to meet demand, or exceeds what is needed, the system can become unstable, ultimately leading to blackouts.

The use of battery storage to offset the use of peak cost grid-imported electricity using energy stored before the peak is an innovative use of a proven technology. An additional benefit of using a storage technology is that it also provided

protection against short-term network outages when IT equipment and other sensitive plant can be protected against unexpected loss of power.

Variations in demand are predictable. Therefore, electricity suppliers can work out in advance what they need to purchase from the generators, using a mix of long term contracts and short term trades, to balance out most the changes in demand in different seasons of the year or at different times of the day. This is the wholesale market which is effective at matching anticipated demand with supply but it is unable to deal with the smaller and less predictable differences that occur in real time.

There may be an imbalance in demand and supply, e.g. a supplier may have misjudged the demands that its customers will make on the system at a given time or a power station may break down or otherwise be unable to generate the amount of electricity it had anticipated. In these cases, the System Operator has the responsibility of bringing the system back into balance. It does this by paying for power stations to ramp up or down their supply or customers to change their level of demand in real time through the balancing market. Through a contract, this becomes income for those building operators that can avoid drawing from the grid at times of imbalance. Battery storage allows this to happen.

### **Solar photovoltaics**

Solar power generation is now a mature technology and is becoming commercially viable without the need for financial incentives to invest. The generation of power offsets the importation of electricity from the grid. Power can also be stored where battery technology is combined with solar to allow the power to be used on site beyond the usual profile of solar generation.