Solar Recovery with Ground Source Heat Pumps V2

There are three main types of inter-seasonal storage systems:

- Passive or low temperature systems – these rely on highly insulated properties which are designed to use heat/energy naturally stored in the surrounding ground to heat the building.
- Warm temperature active systems – these use systems such as solar thermal to maximise the energy available from the sun and deposit this in the surrounding ground of the property for use in winter.
- High temperature active systems – this type of system also uses solar capture systems but deposits the energy into highly insulated storage devices which can result in high temperatures being stored.

This factsheet only discusses warm temperature active systems as these systems are becoming more common in combination with ground source heat pumps. These systems basically work by taking surplus (or dedicated) solar energy during the summer and depositing this in the ground, raising the temperature. This energy is then reclaimed at a later date by a ground source heat pump increasing its efficiency.

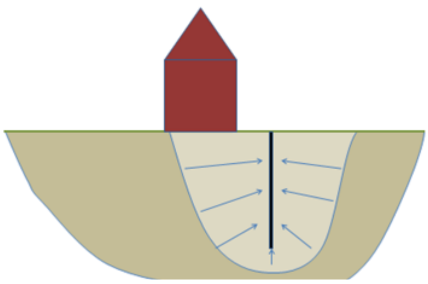

Fig 1 Heat Extraction from the ground- winter

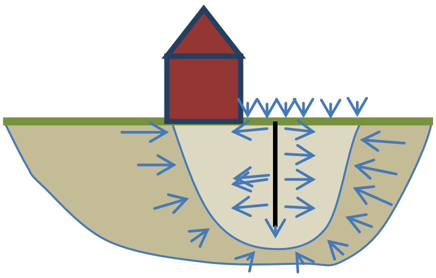

Fig 2 Solar assist - summer

If the ground array is sized correctly then the ground should recover back to its original temperature for the start of the next heating season without any solar recharging.

One area where solar recharging might have a benefit is within the diurnal periods of the year, i.e. early spring and autumn. At these times energy is deposited within the ground during the day while the sun shines. This energy is deposited locally around the ground array pipes. As the sun goes down and the heating turns on, the deposited energy is still held locally and is absorbed back into the system improving the CoP and hence efficiency of the system.

Facts at a glance:

Solar Energy—Approximately 100W/m2 of solar energy falls in the UK.

Rain—Additional energy can be leeched away by rainfall percolating through the ground.

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Evaluating the amount of solar energy that can be reclaimed

Looking at the diurnal periods only, the amount of solar power that falls on a m2 in the UK is approx. 100W/m2. For a 3m2 solar panel system with efficiency of say 80% and 8hrs of sunlight the amount of solar power is approximately 3 x 100x 0.8 x 8 = 1.92kWh/d. If 80% of this can be reclaimed by the ground source heat pump, the amount of energy that is provided by the solar recharging is approximately 1.5kWh/d
While this is not enough to run the heating system completely, for a well- insulated property it can be a proportion of that nights heating requirement and therefore can help increase the overall efficiency of the heat pump.

For a well-insulated property with a Heat Loss Coefficient of approx. 140, and with an ambient temperature of 6C, the peak heat load required will be 2.1kW. If the heating is on for 4 hours in the evening, the solar deposited in the ground could provide approx. 18% of the heating at this time of the year.

The cost of a 3m2 solar panel system installed plus associated piping is approx. £3000, (without the cylinder). If solar recharging operates for 4 months of the year at 4hrs a day (evening only), the number of hours the system is working at a COP of 18% greater (based on 1800hrs heating season) is approx. 480. i.e. a quarter of the heating season is within the diurnal period where solar recharging will affect the performance of the heat pump. In monetary terms, the increase in COP for the periods where the solar does assist results in a slight lowering of running costs, however basing it on the figures above, this reduction is slight.

The conclusion is that solar recharging systems do have an effect directly on the efficiency of ground source heat pumps, however this is limited to the diurnal periods and the heating distribution/profile has a much greater effect. Theoretically solar recharging works but the systems are currently not really commercially viable. Where solar recharging systems do have an effect is in assisting the ground to recover to its original temperature, however if the ground arrays are correctly sized then this should occur naturally.

1800 hours for the heating season.
480 hours at the higher COP. (assume 3.2 standard, hence plus 18% = 3.78)

Based on a 4kW system with solar assist, running costs are:-
1320 hours @3.2 = ((1320 x 4)/3.2) x 0.12 = £198
480 hours @3.78 = ((480 x 4)/3.78) x 0.12 = £61.
Total running costs = £259

Without solar assist, running costs are:-
1800 hours @ 3.2 = ((1800 x 4)/3.2) x 0.12 = £270
Therefore savings in this example - £11.