Explanation to SPF in EED

In the EED calculation, SPF controls how the load input values are represented towards the ground.

In the base load input form, you have three columns:

heat cold ground

You cannot access directly the third (ground) column.

As EED is intended for the use by HVAC engineers and not by geothermal specialists, we decided that the heating and cooling load of the building would be the most appropriate and familiar design parameter for them. This should be typed into the first two columns, either as a monthly value (typical for large projects) or as the annual value with monthly distribution (a simplified way suitable for smaller projects, like residential houses).

Now in a GSHP system, the heat pump covers the heating load of the building. The evaporator capacity (heat input to evaporator) always is lower than the heating output, as the compressor activation energy, usually electricity, is also transferred into heat in the heat pump. This fact is described in the COP (Coefficient of Performance). With COP = 3, you will have an evaporator capacity of e.g. 6.0 kW, and a heating capacity of 9.0 kW. With a COP = 4, the evaporator capacity for 9.0 kW heating capacity will be 6.75 kW.
The formula is:

$$\frac{heating\ capacity}{COP} * (COP - 1) = evaporator\ capacity \qquad [1]$$

The SPF is nothing else than the COP aggregated over a whole heating or cooling season, i.e. the average COP over that season. Thus EED does the following calculation:

$$\frac{heating\ load}{SPF} * (SPF - 1) = evaporation\ load \qquad [2]$$

You can check the calculation easily by setting the base load form to "monthly values", typing in the heating load (e.g. 9 MWh) in the heat column, with 0 in the cold column, and you will get the evaporator load in the ground column (6.75 MWh for SPF = 4). Only this part of the heat load affects the ground, the rest comes from the power grid and is not to be considered for the design.

In the cooling mode, the idea is similar. Here the condenser of the heat pump (chiller) works towards the ground, thus the formula is:

$$\frac{cooling\ load}{SPF} * (SPF + 1) = condensor\ load \qquad [3]$$

So for a cooling load of 10 MWh and a cooling SPF = 4, the condensor load (heat to the ground) would be 12.5 MWh. Again, you can check that with setting heat load to zero, type in 10 in the cooling load column, and you will get -12.5 in the ground column (a negative value in the ground column shows heat injection into the ground, a positive value heat extraction from the ground).

In case you have heating and cooling in the same month (e.g. in May or October), the ground column only contains the difference.

The same is applied to the peak load values, with the SPF you state in the base load form. However, the ground values are not shown here for reason of space, and the peak heat and cold loads are treated separately, not influencing each other.

To give one average SPF for heating and cooling for the whole year has some limitation, as this value may change during shoulder and peak seasons. So we are working to include some heat pump model, that will calculate the monthly SPF from the ground temperature and a given heat/cold supply temperature, or at least to allow different SPF for each month.

You can already have the latter feature by using the SPF = 10000. In this case, the heating and cooling loads typed into the respective columns are transferred almost unchanged to the ground. If you use the example above, the heating load 9 MWh would result in 9 MWh (in fact, 8.999... MWh) in the ground column and 10 MWh of cooling will result in –10.001 MWh to the ground. By calculating the ground values (evaporator in winter, condensor in summer) directly with different SPF for each month, you can account for the changing SPF over the year, if you have enough information. The feature with SPF = 10000 is also very handy for direct cooling (e.g. cooling ceilings), where no heat pump or chiller is used.

So the resulting temperatures in a project design indeed will vary with changing SPF, because the heating and cooling load on the ground side will vary accordingly (see formulas [2] and [3]).

Burkhard Sanner, May 18, 2005