The FSC procedure, a powerful design tool

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In the framework of Task 26, a new method has been elaborated to characterize solar combisystems[1] (SCS) in a simple way, allowing to compare systems built in different locations, with different collector areas and delivering heat to different space heating and domestic hot water loads. The idea is to compare the actual Savingsfractional energy savings of the system with the maximum theoretical fractional energy savings.

Two slightly different target functions have been defined by Task 26 :

- the fractional thermal energy savings $f_{sav,\,th}$, which gives fractional energy savings based on the saved fuel input of the solar combisystem compared to the reference heating system. This reference system includes a domestic hot water tank with annual heat losses equal to 644 kWh, and a boiler with an efficiency of 85 %.
- the extended fractional energy savings $f_{sav,\,ext}$, which also takes into account the parasitic electricity used by the system (pumps, valves, controller, burner,…)

FSC definition

Let us consider the example given in the following table : in the first line, we found the total heat demand of the house, including store and boiler losses (so-called "reference consumption"), and in the second line, the solar irradiation available on the collector area.

(kWh)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Reference consumption	2659	2131	1477	989	412	320	237	226	359	1230	1905	2494	14415
Solar irradiation available	716	991	1477	1740	1989	2017	2335	2183	1769	1230	663	558	17668
Usable solar energy	716	991	1477	989	412	320	237	226	359	1230	663	558	7943
												FSC	0.57

If the two curves of the total consumption and of the solar irradiation available on the collector area are superimposed, various zones appear (figure 1):

① : energy consumption of the building, that exceeds the solar potential
② : energy consumption of the building, which could be saved by solar energy. It is called 'usable solar energy' ($\mathbf{Q_{solar,usable}}$)
③ : solar energy in excess in summer time

Dividing the usable solar energy ② by the total reference consumption of the house ① + ②, a new parameter, called **Fractional Solar Consumption (FSC)** is defined.

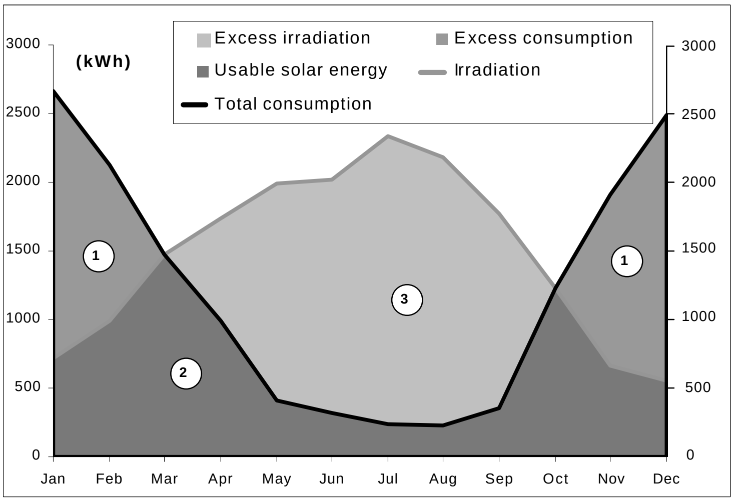

Fig. 1 : definition of FSC

FSC is a dimensionless quantity simultaneously taking into account the climate, the building (space heating and domestic hot water loads) and the size of the collector area, in a way that doesn't depend on the studied SCS. FSC is calculated on a monthly basis in a simple way, using the solar collector area **A** (m^2), the monthly global irradiation in the collector plane **H** (kWh/m^2) and the monthly reference consumption without solar combisystem $\mathbf{Cons_{ref}}$ (kWh) :

[1] SCS description can be found in : **SUTER J.-M., LETZ T., WEISS W., INÄBNIT J,** SOLAR COMBISYSTEMS in Austria, Denmark, Finland, France, Germany, Sweden, Switzerland, the Netherlands and the USA; overview 2000 ; IEA SHC – TASK 26, Bern, 2000, 42 p.

$$FSC = \sum_{1}^{12} \min(Cons_{ref}, A . H) / \sum_{1}^{12} Cons_{ref}$$

In the previous example, the calculated FSC is given at the bottom line of the table. We get FSC = 0,57.

Relation between f_{sav} and FSC

Simulations made in the framework of Task 26 have shown that the real fractional energy savings (thermal or extended) can be linked with FSC with a very simple parabolic relation :

$$f_{sav} = (a . FSC^2 + b . FSC + c)$$

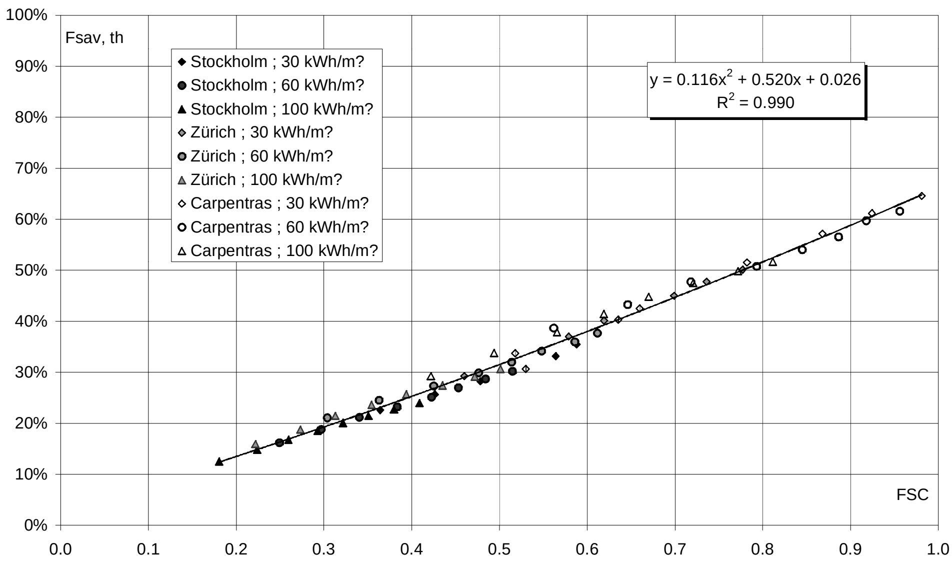

Fig. 2 : f_{sav}. according to FSC

Figure 2 gives an example of the relation between f_{sav} and FSC. Points have been calculated for the 3 reference climates and the 3 reference houses defined by Task 26, and for several collector sizes. It can be seen that the different points are closed to the mean parabola. Such diagrams have been drawn for 9 SCS simulated in framework of Task 26.

How to use the FSC concept ?

With the FSC approach, each target function is defined by its specific data set (**a**, **b**, **c**), that characterizes the global behaviour of the SCS, taking into account the quality of the solar collector, the efficiency of the auxiliary boiler, the insulation of the heat store, the behaviour of the controller,…

As it is easy to calculate the **Fractional Solar Consumption** of a SCS from the meteorological data, the heat load of the house and the collector area, the presented method gives a simple way to calculate quickly the yearly performance of a SCS, provided that the house is occupied continuously all over the year.

The FSC approach can also be used to compare quickly and graphically different SCS, with the diagrams presented in figures 3 and 4.

Figure 3 gives the ranges for collector areas and storage sizes allowed for the different combisystems simulated by Task 26.

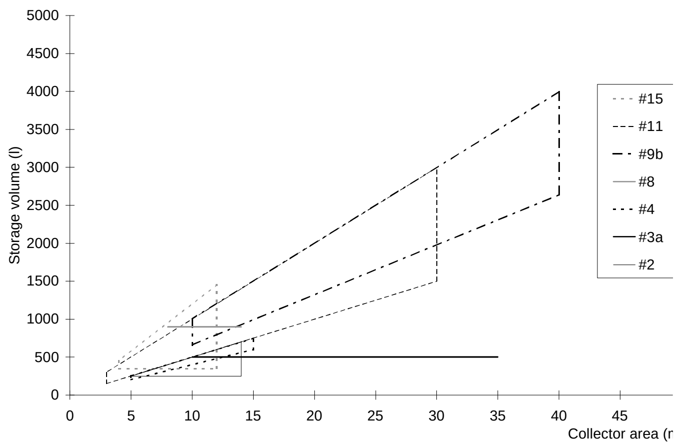

Fig. 3 : Sizes of simulated systems

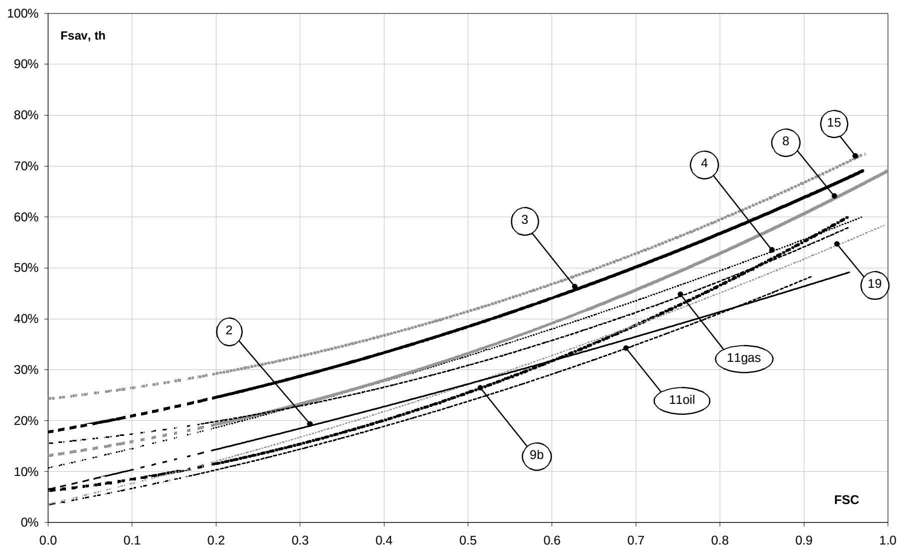

Figure 3 gives the characteristic curves obtained for combisystems simulated in the framework of Task 26. In order to get curves only related to the hydraulic scheme and the control strategy, a common reference solar collector has been defined and used for these simulations. In the same way, a common reference boiler has been taken for combisystems not including the auxiliary boiler. Therefore, combisystems from the market may have slightly different performances compared to those presented in Figures 3 and 4.

Fig. 4 : Sizes of simulated systems

Detailed analysis of these curves will be given in the design handbook, which will be published next year, when Task 26 is completed.

Conclusion

The FSC concept provides an easy tool to compare SCS, in order to have a quick idea of their performances according to main dimensioning parameters. A simplified design tool based on this approach will also be available next year, when Task 26 is completed.