ONLINE MONITORING OF SDH SYSTEM PERFORMANCE

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Abstract – The website solvarmedata.dk displays real time monitoring of solar heating system performances. To improve the user experience, increase the usefulness for plant owners/operators and other users, an extensive upgrade of the website and the database behind it has been carried out. The upgrade includes among other things more information on each included solar system, improved quality assurance of data, an alert option in case of odd looking data, more user-friendly display of daily solar yield (incl. comparison with other plants), and the possibility of checking the performance against calculated expectations. Whereas the website/database was previously limited to Denmark, a new international domain name has been established to open up the features to any solar heating system complying with the requirements for being part of this "solar heat community". The international equivalent of solvarmedata.dk is *solarheatdata.eu*.

1. INTRODUCTION

Solvarmedata.dk has published real-time and historical solar heat production from an increasing number of Danish district heating plants for almost a decade. Now an extensive upgrade of the website has made it more user friendly, added more features and introduced an international "twin version" called *solarheatdata.eu*. With this international version the geographical boundaries of Denmark has now been removed and international stakeholders with large scale solar heating systems are invited to connect their system to the website.

2. NEW FEATURES

2.1 How was the site before?

The website solvarmedata.dk has always had some general information on each connected plant and the option of downloading solar heat production data (as well as the corresponding solar radiation at the collector surface) in different time steps is not something new either. However, evaluating the solar heat production and system efficiency required a user to download data and manually handle these to analyse the variations in the yield over time and/or to compare with other plants. The download option is kept, but the solar heat production day-to-day can now be compared graphically directly on the website. Besides this, the evaluation options was limited since the only data gathered continuously was the solar heat production and solar radiation. By changing the data requirements for the upload to the database, new evaluation options arise, which makes it possible to monitor the system performance in more detail.

2.2 Comparison of yield

By performing the calculations in a central database, the website can provide a comparison of the plant's solar yield (e.g. day-by-day) with the plant's own historical data and/or with the average of the other solar systems. The yield is displayed in input/output diagrams showing the yield as a function of the irradiance. Figure 1 shows an example of such an input/output-plot. The green line represent the plant's own trendline for data points above 3000 Wh/m^2 per day. The blue dotted lines indicate an "error band", i.e. an upper and lower limit for the data points. Within this error band, deviations are considered acceptable which indicates normal operation. As seen in figure 1 the error band represent the trendline +/– 500 Wh/m^2 per day for most data points. For low solar radiation values, the upper limit is however made as a straight line between the coordinates (0 , 500) and (3000 , EB_{upper}), where "EB_{upper}" is the error band upper value at a solar radiation level of 3000 Wh/m^2 per day. Besides this, the lower limit is never negative.

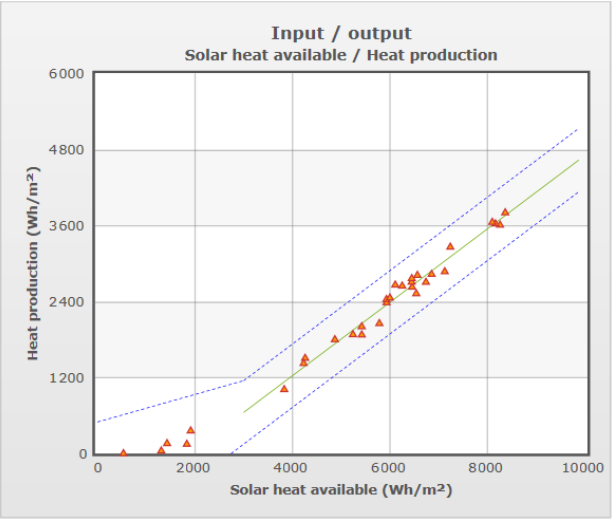

Figure 1. Example of input/output plot for one month of daily values incl. trendline (green) and error band (blue upper and lower limit).

By means of a "mouseover" feature, the exact values for the input and output can be seen for each single data point (i.e. irradiance onto the collector surface and solar heat production respectively).

2.3 Temperature level

In case a plant owner wonder why the performance of the solar system is lower or higher compared to other systems, he might want to compare the temperature levels to see if that might be a reason for the difference. A plot of the mean temperature supplied by the solar system (at the secondary side of the heat exchanger) during operation shows the temperature level compared to the average of the other systems in the database.

2.4 Solar plant login

Each plant owner gets their own login, which gives access to more options for their own plant. This includes:

- Edit of both the general plant information and solar system details.
- Manage the contact information for the person to be alerted if there is something to notice about the system performance or if the database detects odd data values.
- View the solar yield compared to the expected performance.

2.5 Solar fraction

The solar fraction is displayed in a separate plot. For a district heating plant with their own solar collector field, the plot shows the solar heat production, the total heat production at the plant and the ratio between these. Since the solar heat *production* is monitored and not the storage heat losses, it is not possible to calculate the solar fraction based on heat *demand*. Besides this, a heat storage is often used by several different production units, and the losses therefore relates to all of these. Hence, the chosen method corresponds to the solar fraction on the production side excl. storage.

2.6 Performance check

For the systems already connected to solvarmedata.dk an increased amount of data has to be uploaded continuously to the database in order to perform a check of the solar system performance. These include temperatures in the solar collector loop, ambient temperature, solar radiation onto the collector plane, fluid flow and heat production (both solar heat and total heat production in order to calculate the solar fraction). This is used to check if the *actual* performance of the system meets the *expected* performance calculated by means of the entered solar collector efficiency parameters. Until the setup is changed at a given plant, the additional features will simply be omitted for this system.

The check is performed similar to the performance check described in (Nielsen and Trier, 2016) which only use data points generated at somewhat stable and close to optimum conditions. The result is a plot of data points defined as measured yield vs. expected yield (which ideally would be identical). This means that a plant owner can monitor the system performance continuously and identify sudden deviations in the performance and/or if there is any degrading over time.

2.7 Quality assurance of data

A list of parameters are checked continuously and an error message can be sent to the chosen contact person if the value is greater than the specified maximum, less than specified minimum or the data feed is constant over 24 hours. The reason for the last check is that if the exact same solar radiation level is seen for 24 hours, this must mean that there is an error somewhere in the system. The data point is marked with a red exclamation mark (**!**) for any user to be aware, that the reliability of this data is uncertain.

2.8 Miscellaneous

Besides the above-mentioned improvements, some non-technical improvements are introduced such as customised mobile phone version of the website for improved access “on the go” and a “general information subpage” with links to relevant solar thermal related websites to guide visitors to further information on the topic. Besides this, the layout has been upgraded. An icon for each system shows roughly the irradiation level on the website front-page map (i.e. if the weather is sunny, cloudy, partially sunny or if it is night-time). If the zoom level of the map (chosen by the user) makes it hard to distinguish the plants from one another, because the towns are located close to each other, the website will group the icons together and show a “multiple layer of solar collectors icon” as seen in figure 2. By clicking the icon, a list appears with the names of the associated solar systems. Alternatively, the user can zoom in until the icon splits itself into separate systems.

Figure 2. Two examples of icons at solarheatdata.eu and solvarmedata.dk. The one on the right indicates more than one solar system in the area.

Another small detail is that it is now possible to see the present total solar heat produced from all the connected systems in real time on the website front-page. As the peak heat production grows with the number of connected solar plants, this indicates the increased significance of large scale solar heating.

3. NO LONGER LIMITED TO DENMARK

Where the website was previously limited to Danish plants, it is now expanded to include other countries as well. An international website link *solarheatdata.eu* is the access point for the international approach. From this map, it will be possible to zoom in on the country of interest to investigate their solar plants in detail. (In the

case of *solvarmedata.dk*, the zoom level will still directly show the map of Denmark.)

4. FINANCING THE WEBSITE

The financing of the website has been changed from the previous solution based on a subscription from each connected system. Instead, the website improvements and operation is now based on sponsors who in turn can get their logo shown in a box on the website. There is still a connection fee to match the expenses for setting up the connection, but after that, it is free to stay connected and contribute to this "solar heat community".

5. CONCLUSIONS

The new features of solvarmedata.dk and the establishment of the corresponding website solarheatdata.eu will hopefully improve the usefulness for existing users, attract new ones and contribute to an increased awareness of solar heating in general.

REFERENCES

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