Chapter:	Implementation
Date:	April 2012
Size:	4 pages
Description:	Purpose of monitoring systems; information about the selection of data points, recording of data and accuracy of monitoring equipment. Description of which data the control system should monitor and the recommended accuracy of the logging as well as how frequent the logging should occur.
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Available languages:	English
Version id:	4.2-2
Download possible at:	www.solar-district-heating.eu

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Introduction

Monitoring of heating installations is a basic necessity for a charcterisation and observation of system behaviour and efficiency. The main purposes for doing monitoring and evaluation thus usually are:

- Get insight in system and component behaviour and interaction
- Do optimisation of system, components and control strategy
- Derive design improvements
- Ensure and demonstrate efficiency and feasibility

This is achieved by means of:

- Short term system and component analysis and characterisation
- Short and long term energy balances

What should be measured?

All data points necessary for setting up a complete energy balance of the energy system have to be measured. This includes:

- Quantity of heat for all involved components and/or main circuits
- Quantity of electricity for instruments, pumps, components, electricity producers and/or main circuits
- If applicable fuel supply, waste energy etc.

A measurement of relevant system temperatures and pressure levels enables for detailed analysis and control optimisation, e.g.:

- Supply / return temperatures of main components and circuits
- Pressure levels in main circuits
- Storage temperatures

Climatic data as ambient temperature, solar irradiation and where required wind speed gives additional information about the systems boundary conditions.

Recording of data

The minimum time resolution should be **10 minutes** when logging the following data:

- Logging of heat meter data
  - Heat
  - Thermal power
  - Flow rate
  - Supply / return temperatures
- Solar irradiation
- Temperatures in the storages
- Ground temperatures and heat flux sensors (resolution could be 30-60 minutes)
- Mean values for temperature (T) in pipes should be weighted by flow rate $\left(\dot{V}\right)$ or power:

$$T_{mean,pipe} = \frac{\sum_i \left(T_i \cdot \dot{V}_i\right)}{\sum_i \dot{V}_i} \qquad \text{(eq. 4.2.1)}$$

Data collection, processing and storage systems have to be able to process and store the data with an accuracy and resolution corresponding to the accuracy of the sensors, see next section.

Accuracy of monitoring equipment

The monitoring equipment and the kind of data that has to be stored in the control system (and *how* this is done) often has to be defined in the tendering document or in the contract. From IEA SHC Task 38 the accuracies given in figure 4.2.1 are recommended.

		relative accuracy [-]	with	value	unit	absolute accuracy [+/-]
Density	$\Delta\rho/\rho$	0.001	ρ	1000	kg/m³	1.00
Volume flow	$\Delta(dV/dt)/(dV/dt)$	0.02	(dV/dt)	1.56	m³/h	0.03
Heat capacity	$\Delta c_p/c_p$	0.01	cp	4.18	kJ/(kgK)	0.04
Temperature difference	$\Delta\Delta T/\Delta T$	0.02	ΔT	7	°C	0.14
Power	$\Delta(dQ/dt)/(dQ/dt)$	0.030	dQ/dt	15	kW	0.45

		Accuracy [+/-]
Signal conditioning devices		The proposal is to use a Data Aquisition System with at least the same accuracy as the sensor
Electric energy counter	ΔEel./Eel.	0.002
Pyranometer (solar irradiation)	ΔG/G	0.03

Fig. 4.2.1. Accuracy of monitoring equipment. [1]

References

[1] IEA SHC task 38 – Solar Air Conditioning and Refrigeration, Monitoring Procedure for Solar Cooling Systems, www.iea-shc.org/task38, 2011.

The SDH fact sheets addresses both technical and non-technical issues, and provide state-of-the-art industry guidelines to which utilities can refer when considering/realizing SDH plants. For further information on Solar District Heating and the SDHtake-off project please visit www.solar-district-heating.eu.

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