

BYG R-455
March 2021

Measuring report Stengården

Simon Furbo, Janne Dragsted





Measuring report Stengården

Simon Furbo
Janne Dragsted

juli 2021

Measuring report Stengården

Rapport BYG R-455
2021

Af
Simon Furbo
Janne Dragsted

Copyright: Hel eller delvis gengivelse af denne publikation er tilladt med kildeangivelse
Forsidefoto: Adam Rasmus Jensen
Udgivet af: DTU, Institut for Byggeri og Anlæg, Brovej, Bygning 118, 2800 Kgs. Lyngby
www.byg.dtu.dk
ISBN: 87-7877-557-4 (elektronisk udgave)

Content

1.	Introduction	4
2.	Outdoor temperature.....	5
3.	Energy use	6
4.	Indoor temperature	10
5.	HP electricity use vs. outdoor temperature.....	11
6.	COP heat pump	12
7.	PVT brine temperature.....	13
8.	Summary.....	14

1. Introduction

The report describes the monitoring system and the measurements for the PVT-E system installed in the row house in Stengården, Denmark. The system consists of a new roof design with PV and PVT panels connected to a battery and a heat pump.

The system consist of 16 PVT-E modules with a total gross area of 40 m² and 2 PV modules with a total gross area of 5 m² on the south facing roof and 20 PV modules with a total gross area of 50 m² on the north facing roof. The panels are connected to a 7.5 kWh Fronius battery and a modulating Danfoss Varius Pro+ heat pump of 3-12 kW.

Figure 1-1 shows a schematic sketch of the system with the applied measurement equipment. The space heating demand, the domestic hot water consumption, the electricity consumption, the heat and electricity production of the panels, the solar radiation, the outdoor temperature, the indoor climate and system temperatures were measured. In this way, the detailed operation of the system could be followed.

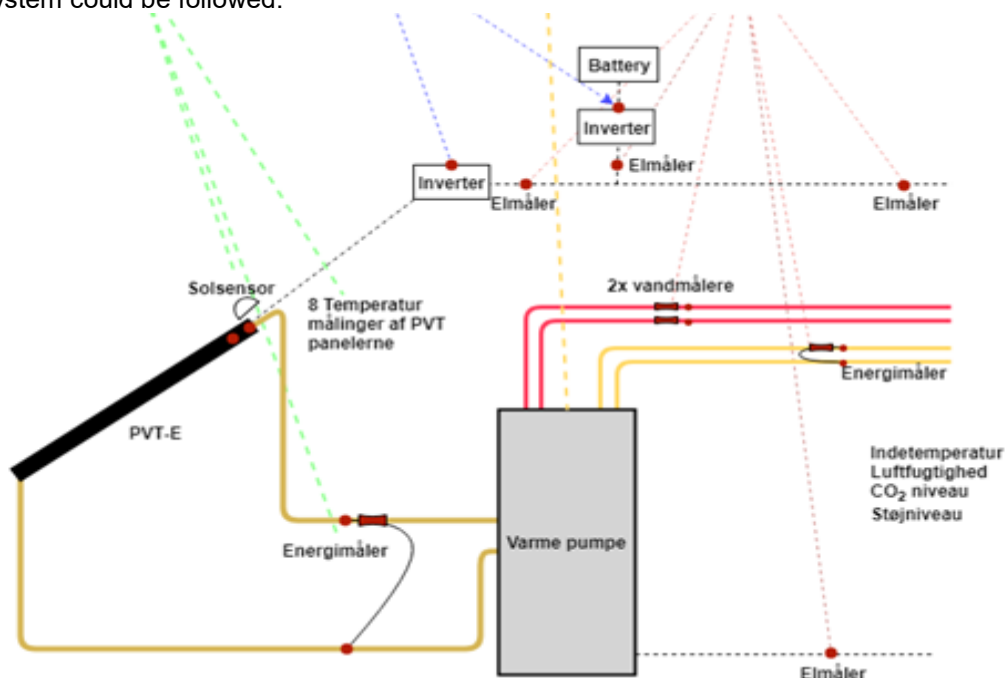


Figure 1-1 Schematic sketch of PVT system with monitoring equipment.

In the following the measurements and observations are presented along with the few adjustments made during the period from December 2019 to August 2019.

2. Outdoor temperature

The outdoor temperature is measured in order to determine the performance. It was detected early on that the temperature measurements from the Danfoss sensors was recording too high temperatures because of influence from the other installations in the shed. An additional sensor was installed with a radiation shield, see Figure 2-1. The pictures also shows an infra-red photo of the shed showing the heat interference from the installations onto the Danfoss sensors.

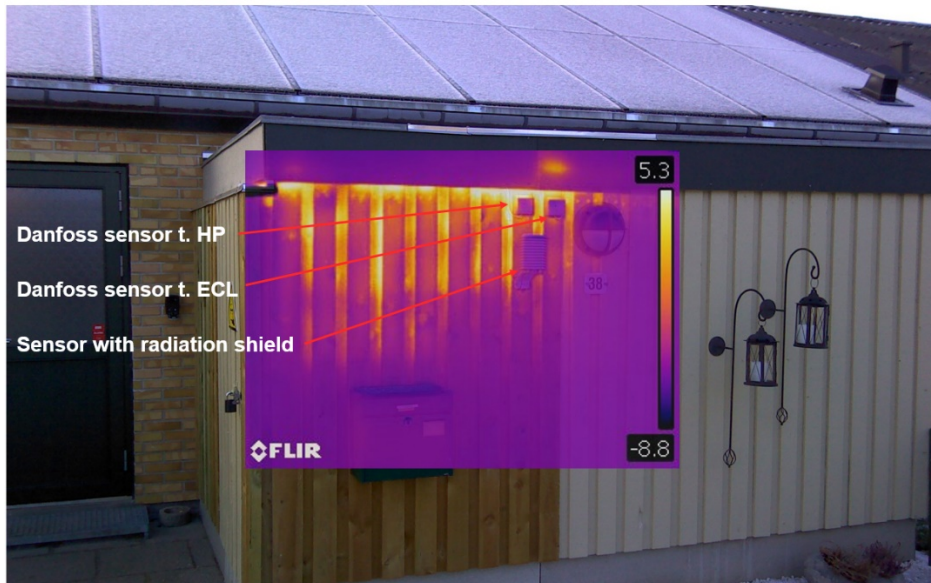


Figure 2-1 Placements of the Danfoss sensors and the new sensor with radiation shield.

The measurements with the sensor with the radiation shield is compared with measurements from DTU in Kgs. Lyngby in order to validate the measurements. The comparison can be seen on Figure 2-3, where a good correlation is obtained.



Figure 2-2 Comparison between outdoor temperature measurements in Stengården and DTU Kgs. Lyngby.

The outdoor temperature measured during the whole measuring period can be seen on Figure 2-4 with increasing temperatures in the summer period.

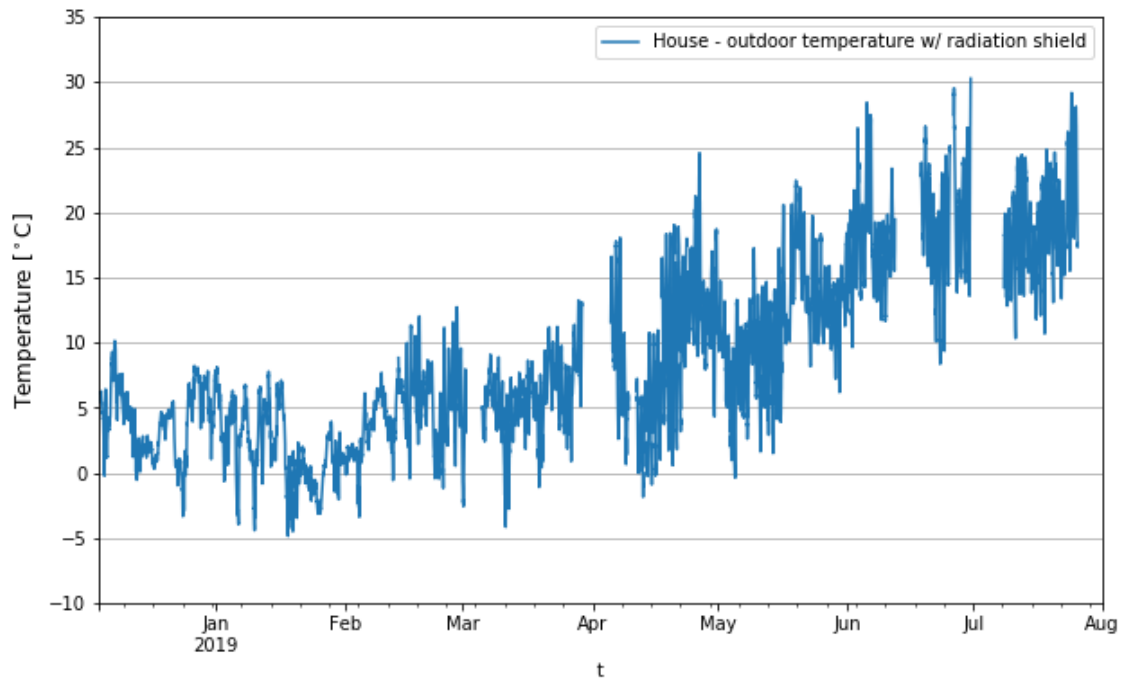


Figure 2-3 Outdoor temperature during the measuring period.

3. Energy use

The energy use presented here is the space heating and domestic hot water consumption in the house in Stengården.

3.1 Space heating

The inlet and outlet temperatures for space heating system, the indoor temperature, the outdoor temperature and the heat consumption can be seen on Figure 3-1. It is seen that the space heating demand is very low compared to the size of the heat pump. The highest space heat demand is lower than 2 kW, while the lowest power of the heat pump is 3 kW. The heat pump is therefore strongly oversized resulting in very short operation periods and relatively low efficiency of the heat pump. In this connection it should be noted, that no small heat pumps suitable for the low space heating demand were available on the market at the start of the project.

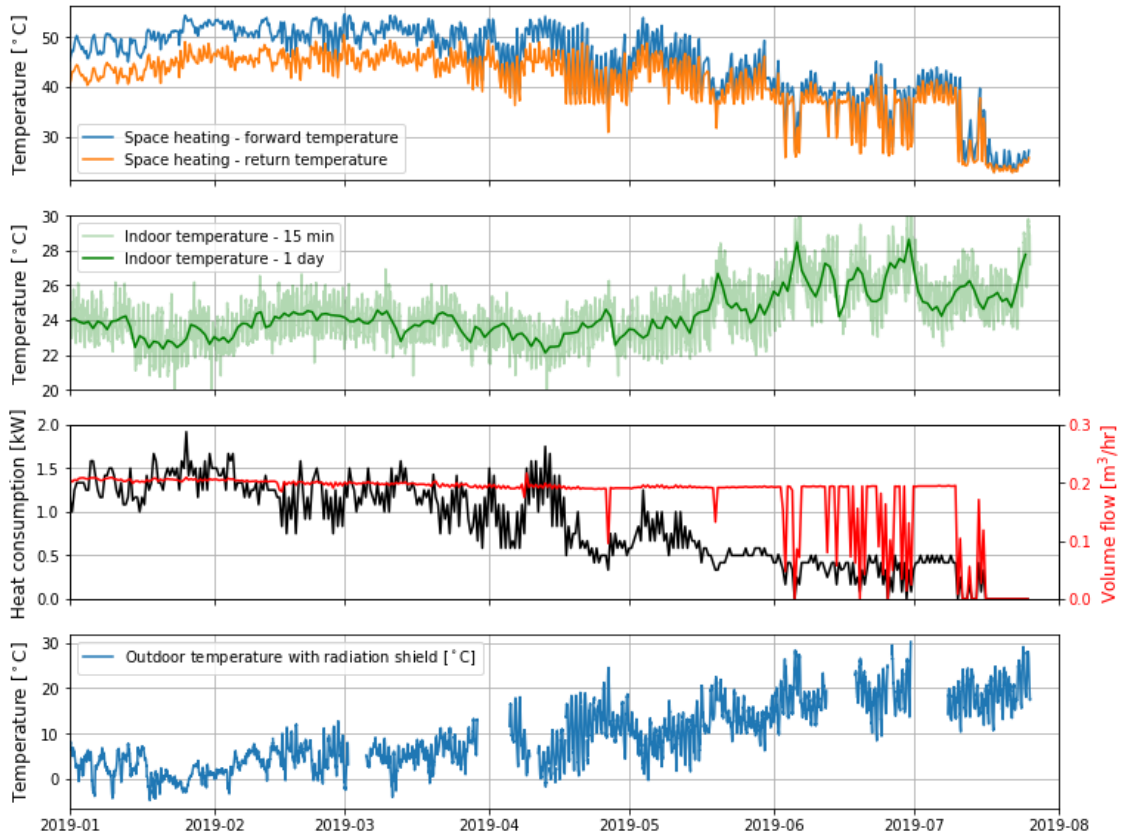


Figure 3-1 Temperatures and energy for space heating in the house in Stengården.

The daily heating demand in the house is dependent of the mean daily outdoor temperature, as it is seen on Figure 3-2.

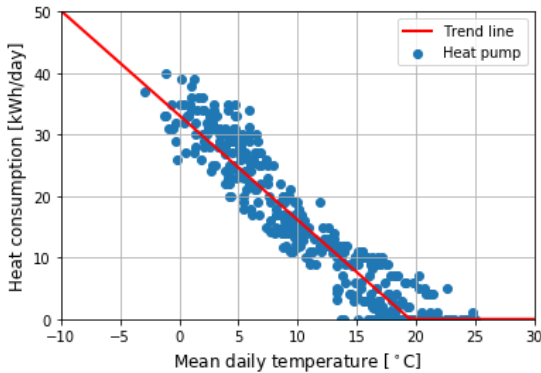


Figure 3-2 Daily heating consumption as a function of the mean daily outdoor temperature.

3.2 Domestic hot water

The directly measured temperatures for the hot and cold domestic water during hot water draw offs are shown on Figure 3-3. The cold water inlet temperature is fluctuating, since the measurement due to inertia of the temperature sensor is not accurate in the very start of hot water draw offs. Therefore, the measured cold water temperature is corrected, see the green curve on Figure 3-3. It is obvious that the cold water temperature vary through the year with a minimum of about 7°C in March and a maximum of about 19°C in August. The hot water