Power measurement of a basic Energy Monitoring System

1 Introduction

The system consists of 1 x **Sensor** connected via RJ 12 cable to 1 x **Transmitter**. The Transmitter is powered by two AA batteries and transmits the information from the Sensor to 1 x **Hub** via ZigBee. The Hub is connected to mains power and transmits the information to the Router using Wireless LAN. The information is then displayed to the user through an APP. The system boundary is drawn after the Hub, therefore the energy consumption of the router, app server and the handheld device were not taken into account in this assessment.

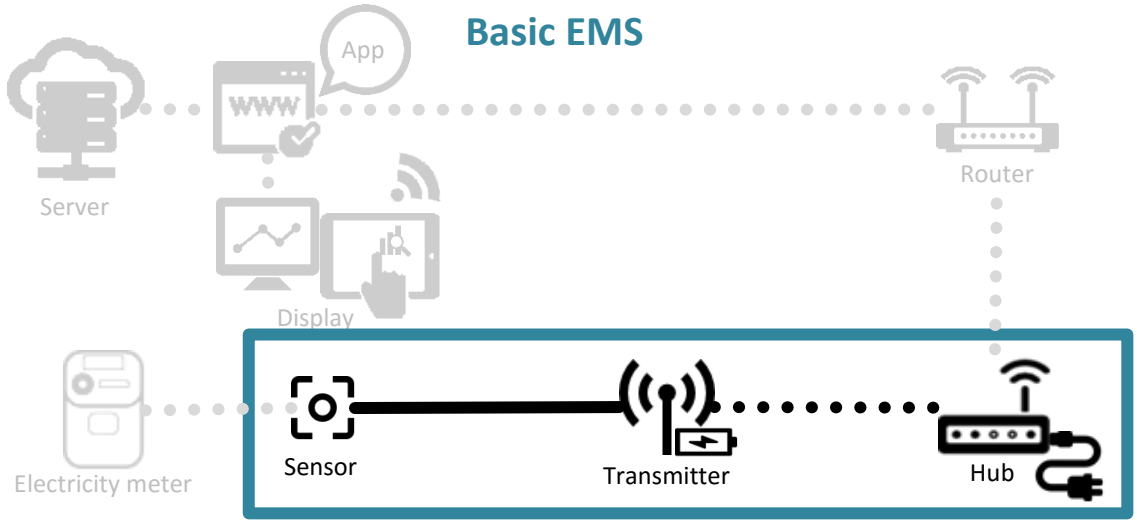


Figure 1 The basic Energy Monitoring System and the boundary set for this investigation

2 Method

The measurement method was based on EN50564:2011 but the measurement does not adhere to all rules set in this standard due to time constraints, mains power supply stability and measurement equipment capability.

The system was set up according to the supplied instructions. The Sensor was attached to the Electricity meter and connected to the Transmitter. The Transmitter was active & sending to the Hub. The Hub was connected to mains power via the Power Supply. It was active and exchanging information with the Router.

The distance from the Transmitter to the Hub module was approximately 5 meters and the distance from the Hub module to the Router was approximately 10 meters.

The measurement was carried out at room temperature using a Wattman HPM100-A (with a 1Hz readout rate) connected to a logging PC. The system was allowed to stabilise for over one hour before measurements were taken. The long-time energy consumption profile was recorded over a four hour period to identify periodic shifts in consumption. None were detected.

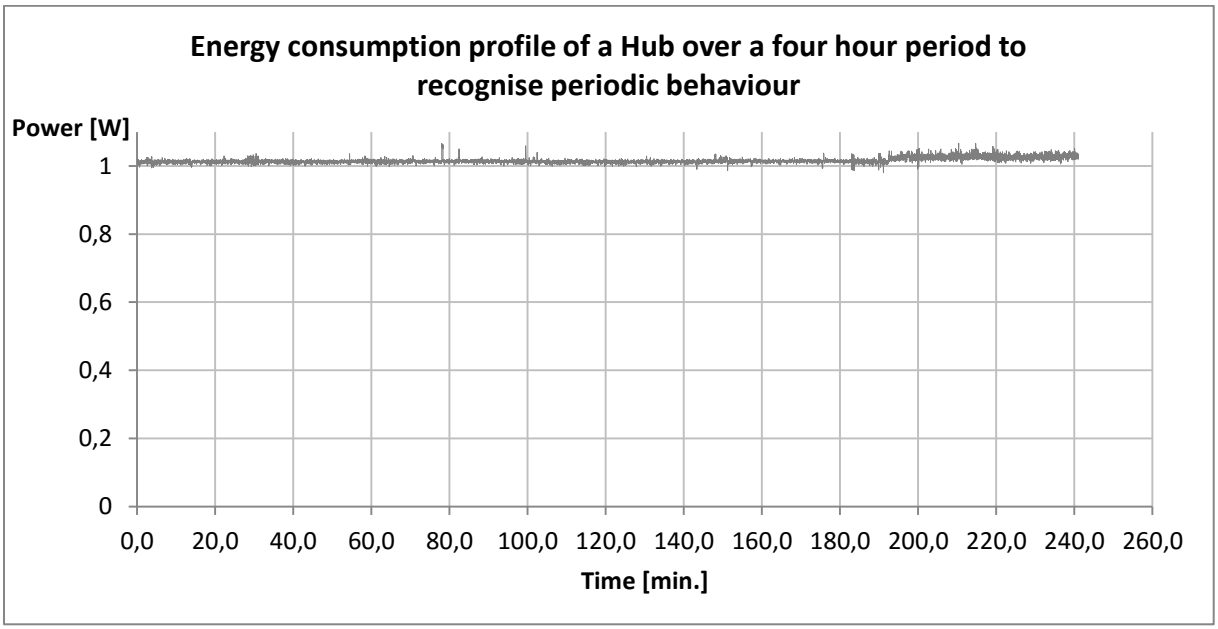
The Energy consumption was then measured over a one hour period and the measurement period was divided into three equal periods as described in EN50564:2011. The average consumption of the

second and last period can then be used to calculate the average consumption according to EN 50564:2011.

3 Results

3.1 Investigation into periodic behaviour

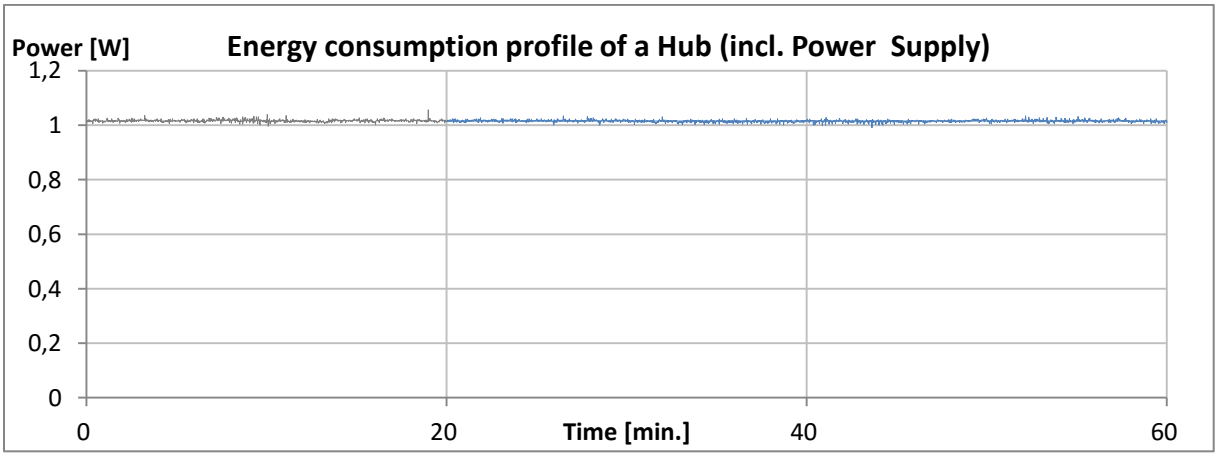
A measurement was carried out over a four hour period to identify periodic shifts in consumption. No periodic shifts were identified in this period as can be seen in the below Graph 1. Therefore a measurement period of one hour was defined for the identification of the power consumption.



Graph 1 Four hour energy consumption profile of the Hub, including Power Supply.

3.2 Stabilisation

The system was allowed to stabilize for one hour before a measurement over a period of one hour was taken. The results are shown in Graph 2 below.

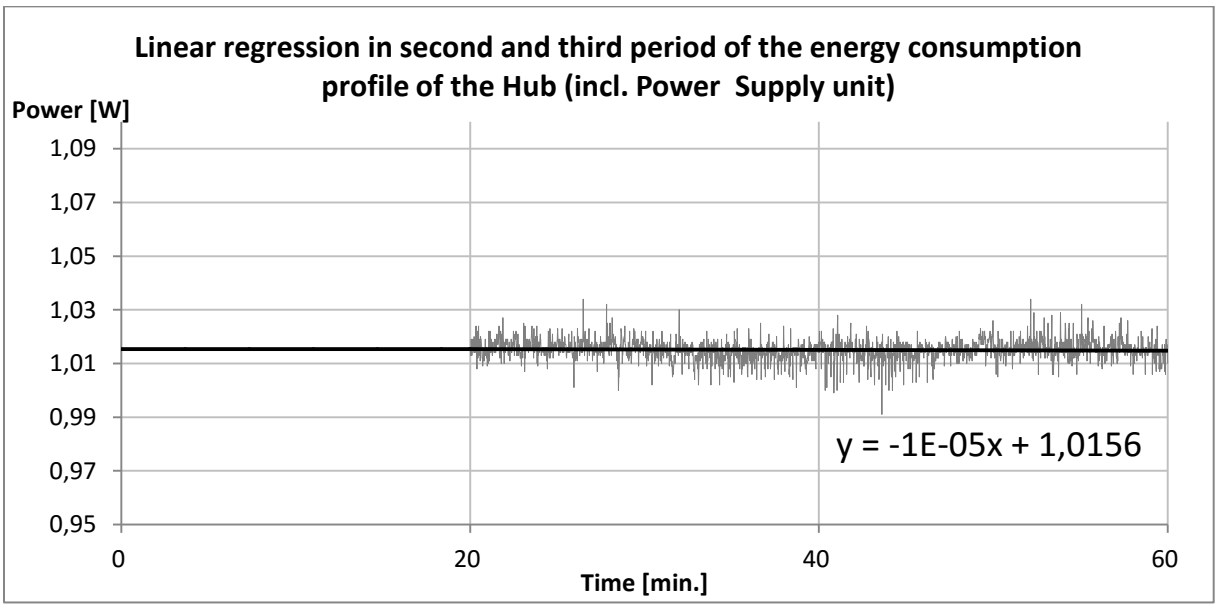


Graph 2 One hour energy consumption profile of the Hub, including Power Supply

Highlighted in blue is the second and last period, used to define stability and calculate the average consumption.

3.2.1 Linear regression

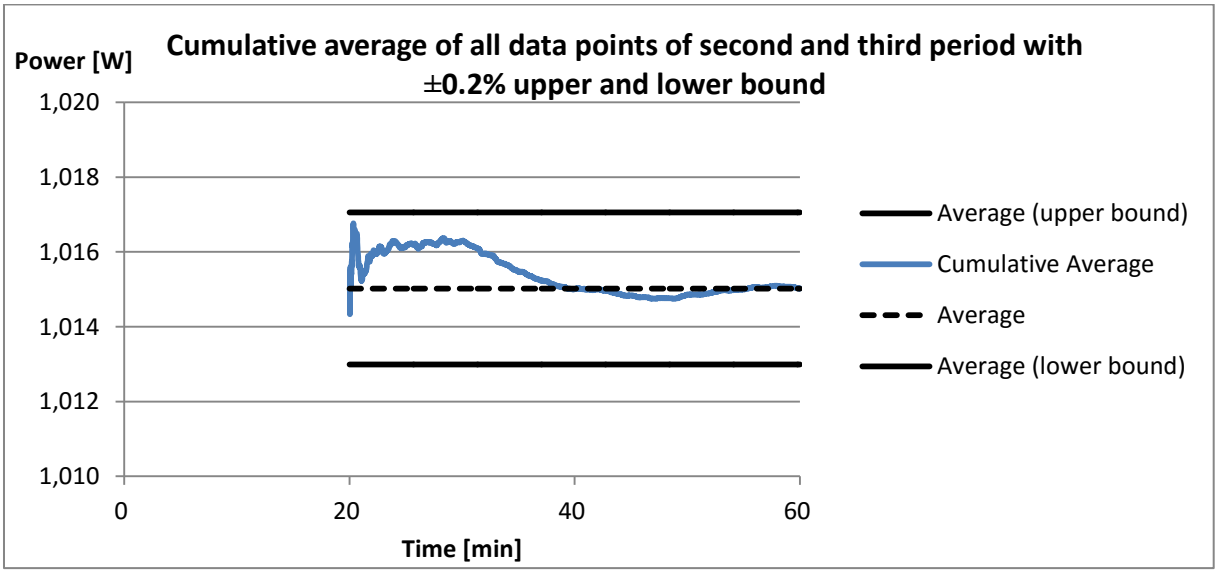
To qualify as a stable measurement within the context of EN 50564:2011, the linear regression *a* within the second and last period combined, must be less than 1% of the average over this same period. It was calculated to be $a = -1.42 \times 10^{-5} W/\min \equiv -0.85 mW/h$ equivalent to *0,001%* of the average of the same period.



Graph 3 Linear regression of data points in second and last third.

3.2.2 Variability of cumulative average

The second test for stability is for the cumulative average of each datapoint within the second and last period to lie within 0.2% of the overall average of this same period. This requirement is also fulfilled as can be seen in the below Graph 4.

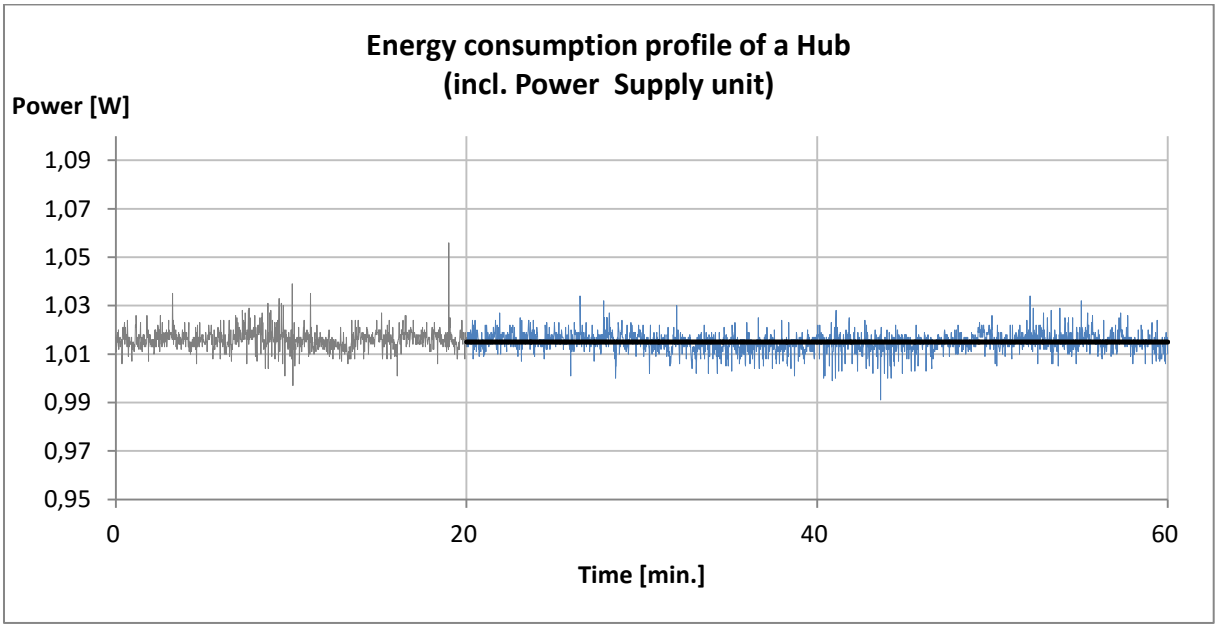


Graph 4 Cumulative average of all datapoints in second and last third, within boundary

3.3 Average power consumption of the components

3.3.1 Average power consumption of the Hub

The average own power consumption of the device can now be calculated as the average over the second and last period of the one hour measurement period as shown in Graph 5 below. **The average own power consumption of the Hub including the Power Supply is calculated to be 1,015 W.**



Graph 5 Average power consumption of the Hub over the measurement period

3.3.2 Average power consumption of the Sensor and Transmitter

The energy consumption of the Sensor and Transmitter could not be measured due to time and technical constraints. The expert interview indicated that the two AA batteries used to power these devices last approximately 1.5 years. Assuming that a powerful AA battery has a capacity of approximately 2,900 mAh (high estimate [1]) at a set Voltage of 1.5 V this would indicate an energy content of 4,350 mWh per battery. For the two devices this would reflect a power consumption of 8,700 mWh over a period of 1.5 years, equivalent to 13,140 hours. A high estimate for the power drawn by these two devices would therefore be 0.66 mW. This could be considered negligible compared to the power consumption of the Hub, however a multiplication over a period of one year results in a consumption of 5.8 Wh and will therefore be taken into account.

3.4 Own power consumption of the System (within the system boundary) & Discussion

The own power consumption of the investigated System over the period of 1 year (8,760 hours) is calculated to be 8,897 Wh of which 8,891 Wh are attributed to the Hub and approximately 6 Wh to the Sensor and Transmitter. The power consumption of the Server infrastructure in the background is likely also relevant and should be investigated. Any interim efforts to improve the efficiency of the system should focus on the Hub.

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1 http://www.tecchannel.de/pc_mobile/komponenten/2024596/batterien_im_test_lithium_vs_alkaline_15_volt_mignon/index5.html