SLightliMon

Street Lighting lite Monitor

Alarm Detector

Basic Principles

Software version:	0.3
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Introduction

The main goal of the SLightliMon Alarm Detector is to analyze power meter data related to street lighting profiles and automatically extract relevant information and detect alarms. A typical street lighting power profile is shown in Figure 1. The example shows the 24h (from 9 a.m. to 9 p.m.) power consumption of a three-phase system with a two-step power reduction during the night. SLightliMon can analyze the following measurements, which are typically retrieved from commercial power meters:

- active power and voltage for each phase
- power factor (cos(phi))
- total energy (energy counter)

From a single power profile (like that in Figure 1) SLightliMon can automatically detect:

- times of switch ON and switch OFF of a power line, and number of events
- voltage anomalies
- low power factor
- total energy consumption

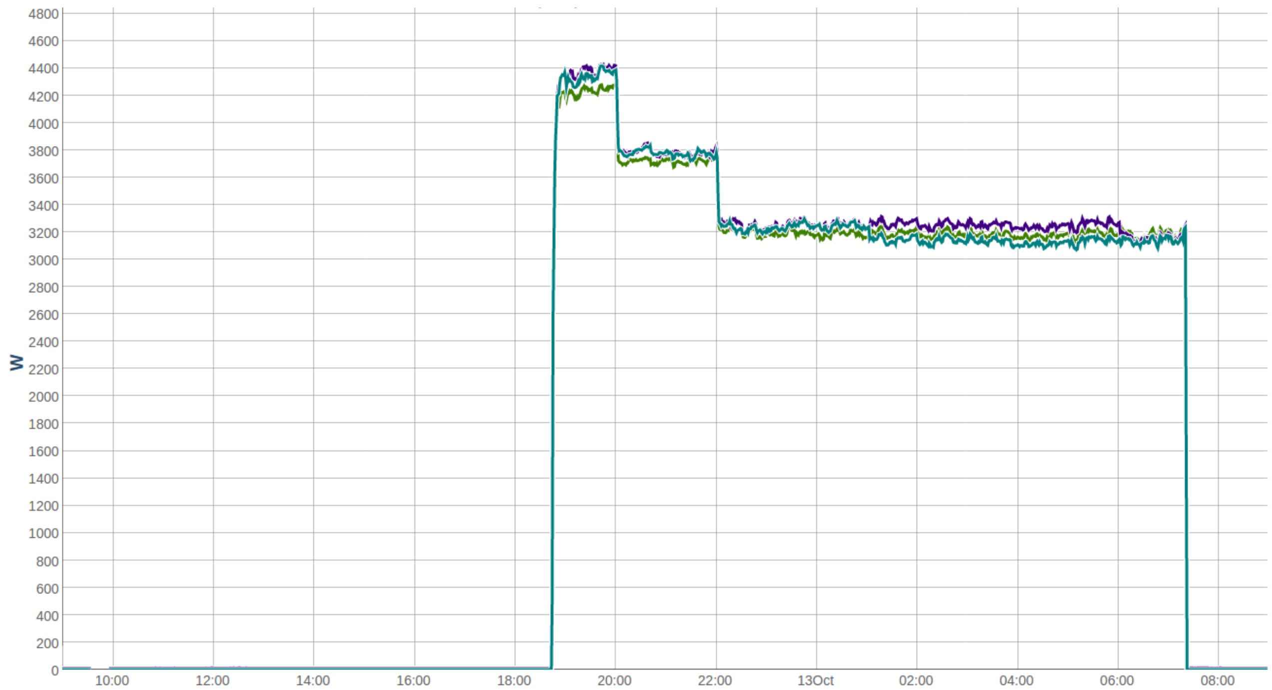


Figure 1

If reference data is provided (e.g., the profiles of the previous 5 days), SLightliMon can also automatically detect:

- power anomalies: periods with increased/decreased instant power
- total energy consumption anomalies

Figures 2 and 3 show examples of anomaly situations that can be automatically detected by SLightliMon.

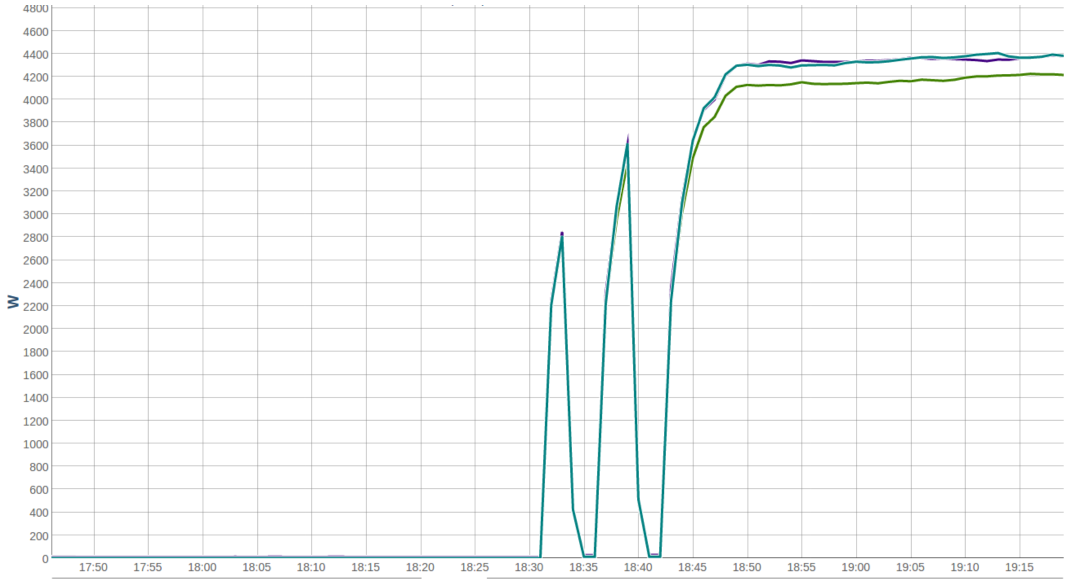


Figure 2: example of multiple ON events due to low hysteresis of a twilight switch.

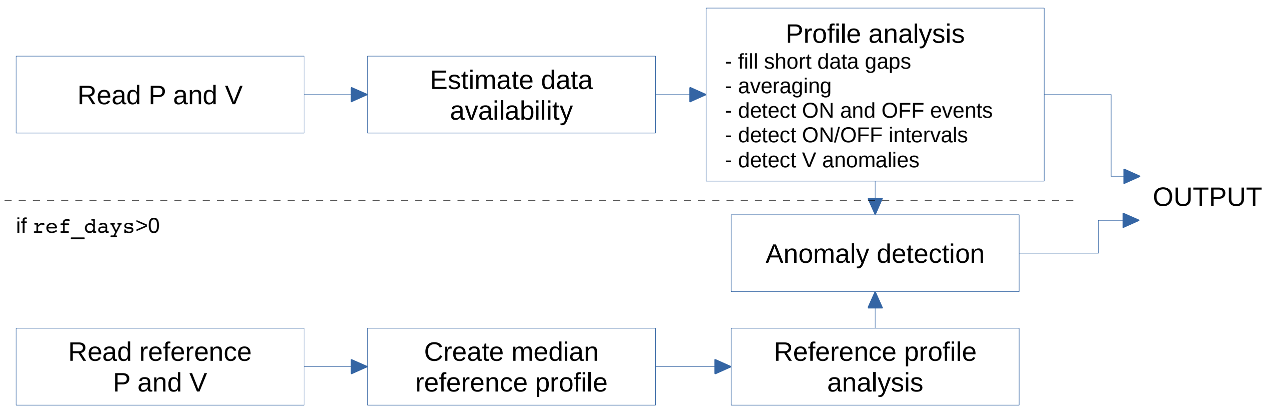
Figure 3: example of an unexpected change of the power profile due to a wrong setting of the system clock.

Assumptions on input data

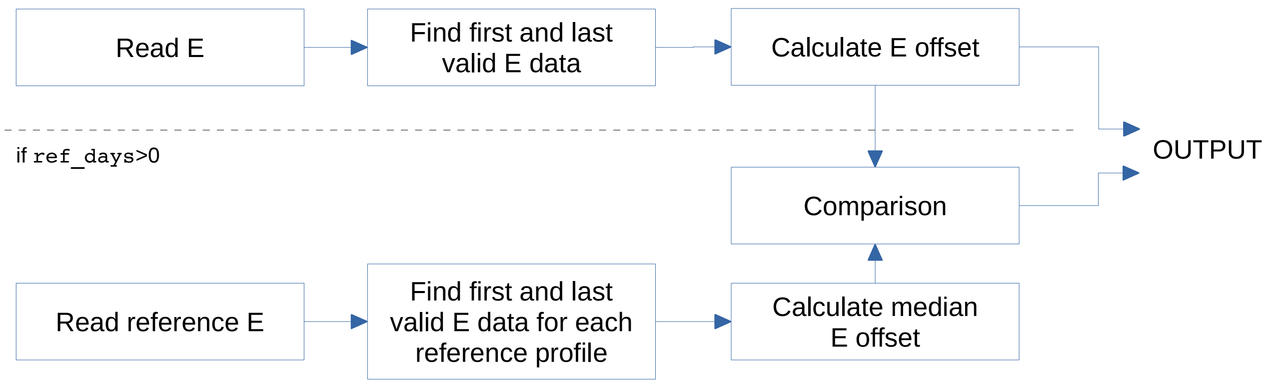
- The data points corresponding to the timestamps provided with the input parameters `t_start` and `t_end` are considered to be included in the data.
- Input data should be available for every minute between the start and the end timestamps. However, SLightliMon can handle missing data. Missing data intervals with a duration minor than the input parameter `delta_t` are recovered by linearly connecting the last and the first available values at the beginning and at the end of the data gap, respectively. Longer data gaps are not recovered but the algorithm infers whether during the gap an ON or OFF event is likely to be occurred.
- Both RRD and text input must contain data with 1 minute sampling.
- Power and voltage measurements are assumed to be taken at the same time for each phase. This means that each power data point has been measured while there was the voltage value of the corresponding voltage data point with the same timestamp. This also implies that for a certain phase if a power data point is missing also the corresponding voltage value must be missing, and vice-versa.
- Normally, all phase data, energy data and cos(phi) data are assumed to be taken always at the same time (e.g., through a single MODBUS query on all the registers of a power meter). This requirement could be relaxed by setting the `no_one_read_meas` input parameter. In this way, it is allowed that each phase data, energy and cos(phi) could have missing values at different timestamps. The only constraint that still holds is the one explained in the previous point.

Processing steps

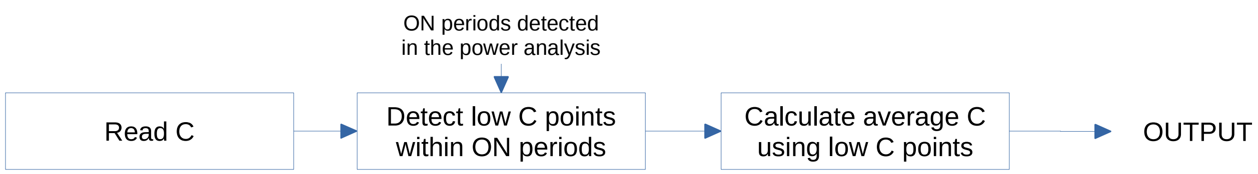
The analysis of the input data is carried out in three main steps: 1) analysis of power/voltage data, 2) analysis of energy data, and 3) analysis of power factor (cos(phi)) data. In the following the block schemes of the three main steps are shown. For more details on the implementation of the blocks have a look at the comments in the code.



Analysis of power/voltage data



Analysis of energy data



Analysis of power factor data