

Control PV Plant with a PLC

(Energy gateway for renewables)

Dušan Ferbas

Solar Monitor s.r.o.
Czech Republic

Product Components

Modular solution

Cost effective sensors



Monitoring of



Inverters



Safety Relays



String Boxes



Door Contact
(Theft Protection)



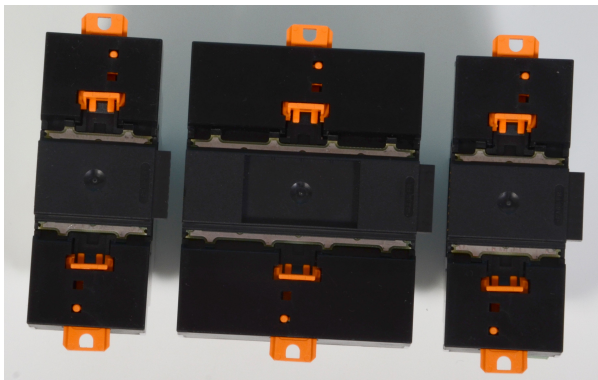
Electricity Meters
(AC, DC)



Overvoltage
(Lightning Protection)



Sensors (Irradiation,
Temperature, Wind)



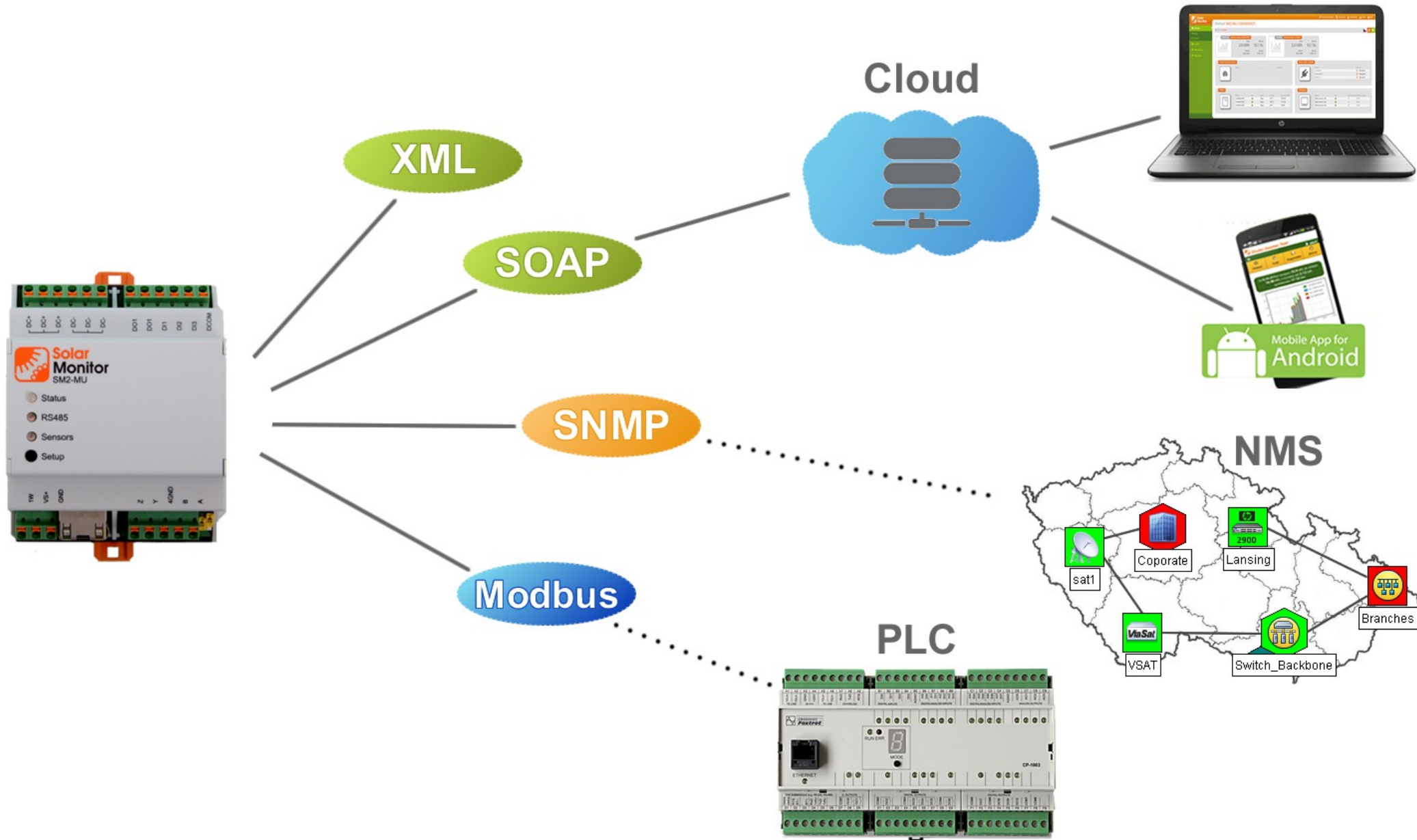
Supported Devices



Solar Monitor – Solution Areas



Software Interface Overview



Webserver of the SM2-MU: Responsive Design



Overview SolarMonitor - Studer Test

Overview

Peaks

LCD Panel

Charts

Alerts

Home > Overview



Inverters (Hybrid)



Name	State	Mode	Temperature	Grid power (0.2kW)	Power (0.2kW)	Updated
XTH 8000-48V (L1)	✓	Charger	- °C	104.98 W	141.96 W	0s
XTH 8000-48V (L2)	✓	Charger	- °C	151 W	42.99 W	0s
XTH 8000-48V (L3)	✓	Charger	- °C	-20 W	42.99 W	0s

MPP Trackers



Name	State	Mode	Temperature	Arr Power (0kW)	Power (0.1kW)	Updated
VT 80-48V	✓	Night	22 °C	0 W	52 W	0s
VS 70-48V	✓	Night	22 °C	0 W	0 W	0s
VS 120-48V	✓	Night	22 °C	0 W	0 W	0s

SNMP – Castlerock SNMPc: Geographical Maps

The screenshot displays the SNMPc Management Console interface. The main window is titled "SNMPc Management Console" and features a menu bar (File, Edit, View, Insert, Manage, Tools, Config, Window, Help) and a toolbar with various icons. The interface is divided into several sections:

- Root Subnet:** A tree view on the left showing a hierarchy of discovered objects, including Backbone, Coporate, Intl, R&D, Sales, and Switch_Backbone. Under Intl, several locations are listed: CRC_HQ, Dallas, Denver, Lansing, Miami, and NY.
- Branches:** A geographical map of the United States with icons representing network nodes at various locations: CRC_HQ, Denver, Lansing, Dallas, Miami, and NY. The map includes state names and a scale of 1:27,000,000.
- Network Topology:** A diagram on the right showing a network structure. It includes a "Company_WAN" node, an "HP_8200" node, a "WAP_1" node, a "Cisco_7200" node, and several server nodes: "App_Server", "Servers_1", "DNS", "Exchange", "VoIP_CM", and "Backup".
- Event Log:** A table at the bottom showing system events. The table has columns for status, date, time, source, and message.

Status	Date	Time	Source	Message
Normal	09/10/2009	14:15:28	User-PC	Sntp Service Up
Normal	09/10/2009	14:41:16	DNA	Device Responding to Poll
Normal	09/10/2009	15:03:58	San_Jose	Trend Report Agent Connected to Server
Normal	09/10/2009	15:09:51	Florida	Device Responding to Poll
Normal	09/10/2009	15:10:38	Dallas	Device Responding to Poll

At the bottom of the console, there are navigation buttons (Map, Mib, Trend, Event, Menu) and a status bar showing "localhost Administrator Supervisor".

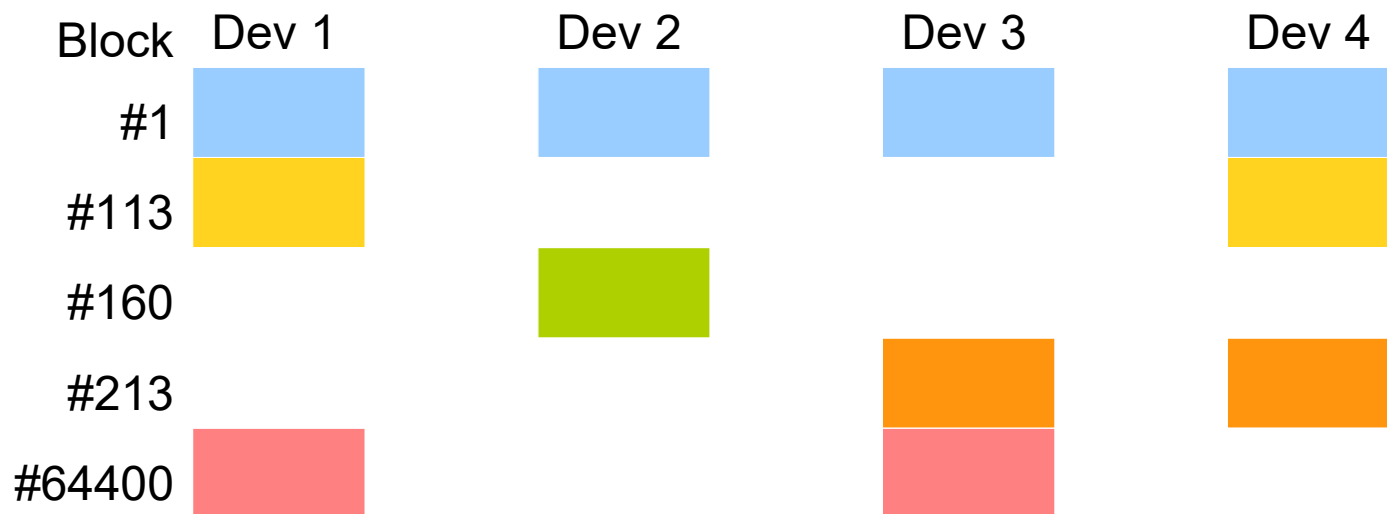
What we automate?

- Power control, fluent regulation
- Obtaining data from devices with proprietary protocols
- Smart house, Smart City, EV and Telecom system integration
- Parameters setting from a PLC



What makes our solution unique?

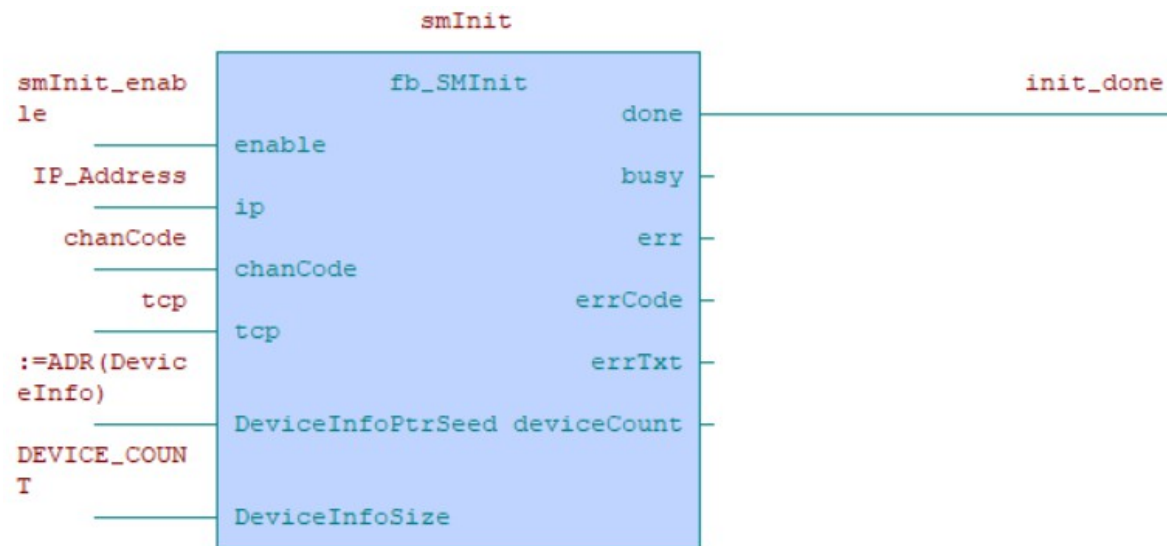
- Universal and custom blocks in the SM2-MU



- Mandatory / optional variables, subblock repetition
- Forward and backward both device and SW compatibility
- Communication with "not yet existing devices"

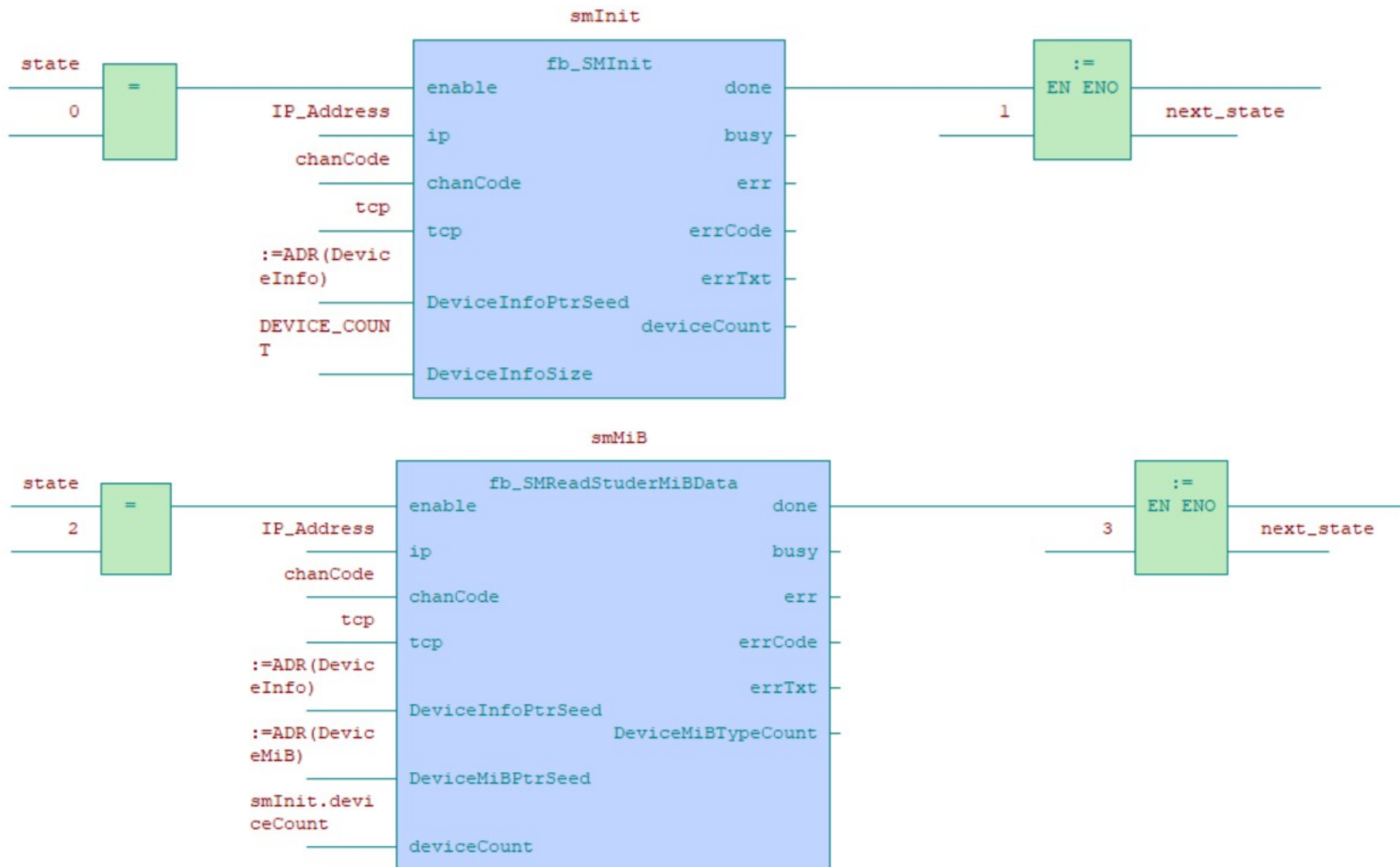
How do we achieve easy and fast implementation?

- Modbus variables organized in blocks (Sunspec)
- PLC library



- E.g.: Existing installation with 3 inverters from one manufacturer, 1 device breaks down, replaced with another one, no change in communication, neither in management

PLC Example in IEC 61131-3 FBD: Data Reading



PLC Example in IEC 61131-3 ST: Data Reading

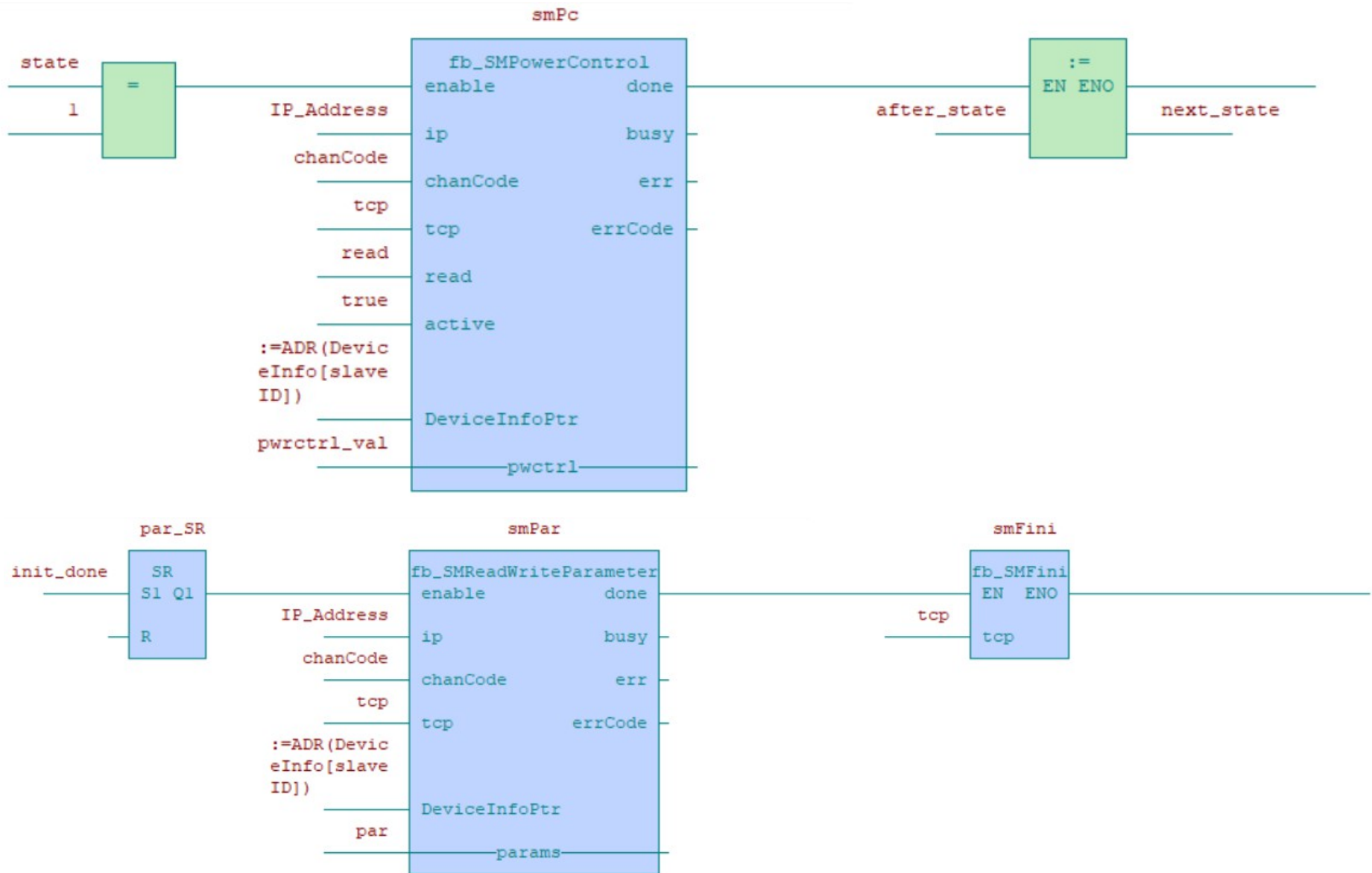
```
PROGRAM prgMain
  VAR_INPUT
  END_VAR
  VAR_OUTPUT
  END_VAR
  VAR
    enable : BOOL := 1;
    ip : STRING := '192.168.1.221:502';
    chanCode : UINT := ETH1_uni0;
    tcp : BOOL := TRUE;
    sm : fb_Solarmonitor10;

  END_VAR
  VAR_TEMP
  END_VAR

  sm(enable := enable, ip := ip, chanCode := chanCode, tcp := tcp);

END_PROGRAM
```

PLC Example in IEC 61131-3 FBD: Power Control



PLC Example in IEC 61131-3 ST: Power Control

```
PROGRAM prgMain
  VAR_INPUT
  END_VAR
  VAR_OUTPUT
  END_VAR
  VAR
    enable : BOOL := 1;
    unitID : USINT := 5;
    sm_pc : fb_PowerControl30;
    ip : STRING := '192.168.1.221:502';
    chanCode : UINT := ETH1_uni0;
    tcp : BOOL := TRUE;
    val : UINT := 60;
    active : BOOL := TRUE;

  END_VAR
  VAR_TEMP
  END_VAR

  sm_pc(enable := enable, ip := ip, unitID := unitID, chanCode :=
chanCode, tcp := tcp, pwctrl := val, active := active);

END_PROGRAM
```

Dashboard Example: normal, no consumption during day

← ↑ → Od 04.07.2018 Do 04.07.2018 **dnes** listopad 2018

Dashboard

Solar Production

Max: 2.94 [kW]
Energy: 23.69 [kWh]

Consumption

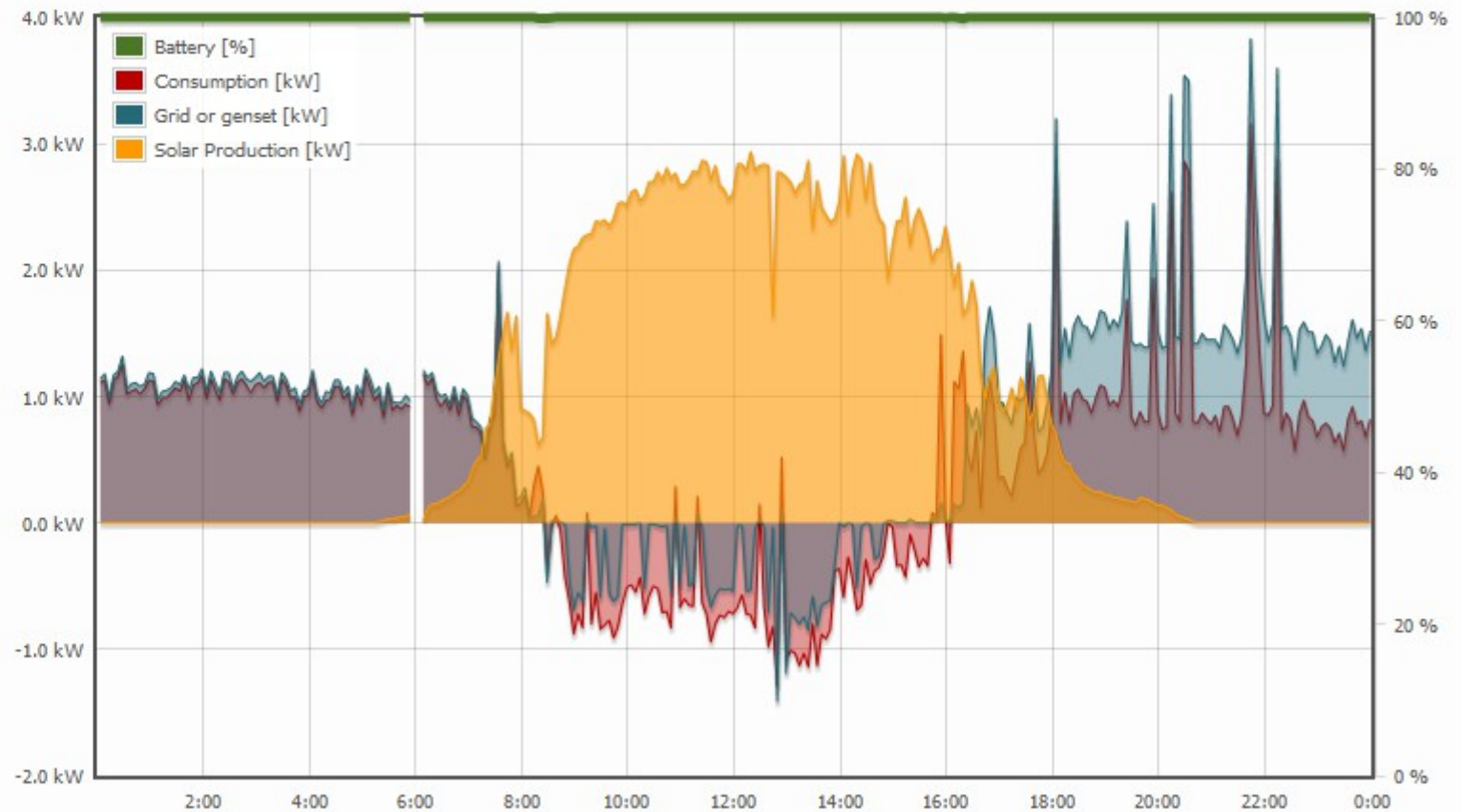
Max: 3.16 [kW]
Energy: 11.33 [kWh]

Grid or genset

Max: 3.83 [kW]
Energy: 18.13 [kWh]

Battery SOC

Max: 100.00 [%]
Min: 99.81 [%]



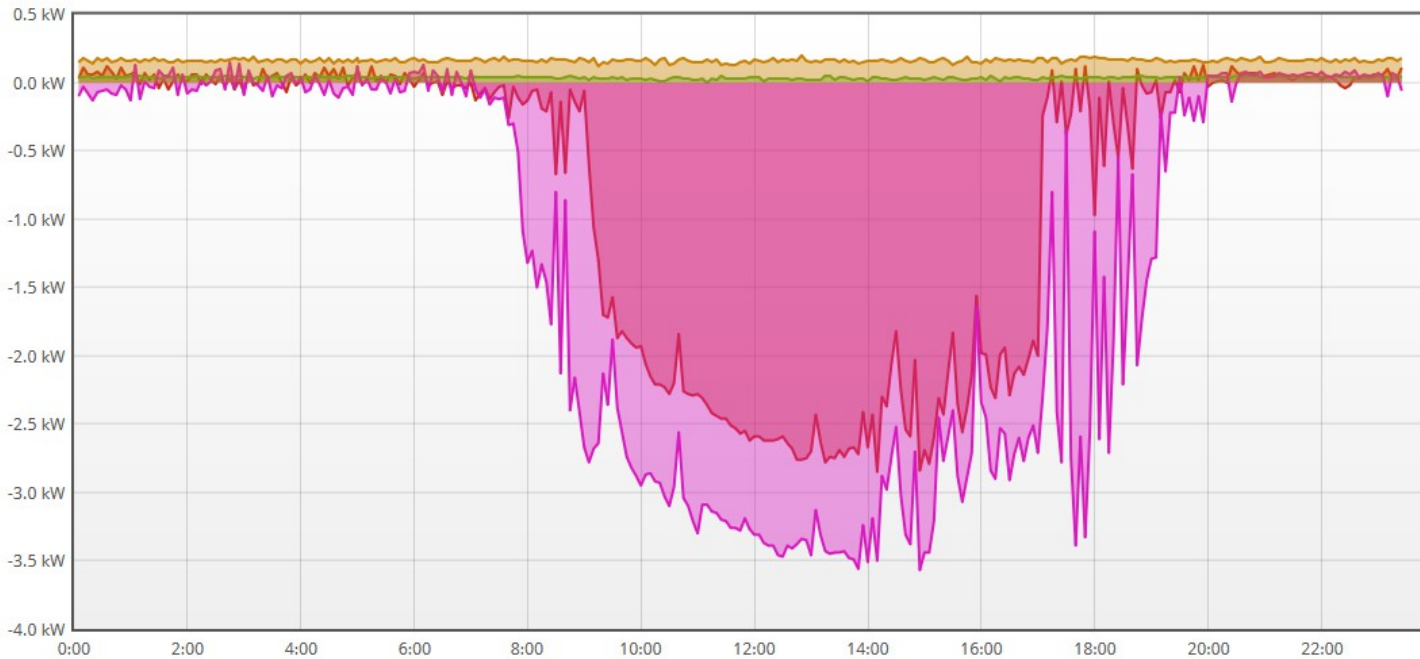
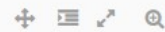
Custom Graph Example: data from different devices

Studer Test R_D

Home > Studer Test R_D

From 05/14/2019 to 05/14/2019 today May 2019 První osa Y: Výkon Druhá osa Y: -----

Veličiny zařízení



XTH 8000-48V (L1) (SN: 423C6401)

NE Pac grid [kW] (sn: 423C6401)

NE Pac load [kW] (sn: 423C6401)

Odebrat z dashboardu

XTH 8000-48V (L2) (SN: 423C6441)

ANO Pac grid [kW] (sn: 423C6441)

ANO Pac load [kW] (sn: 423C6441)

Odebrat z dashboardu

XTH 8000-48V (L3) (SN: 423C63C1)

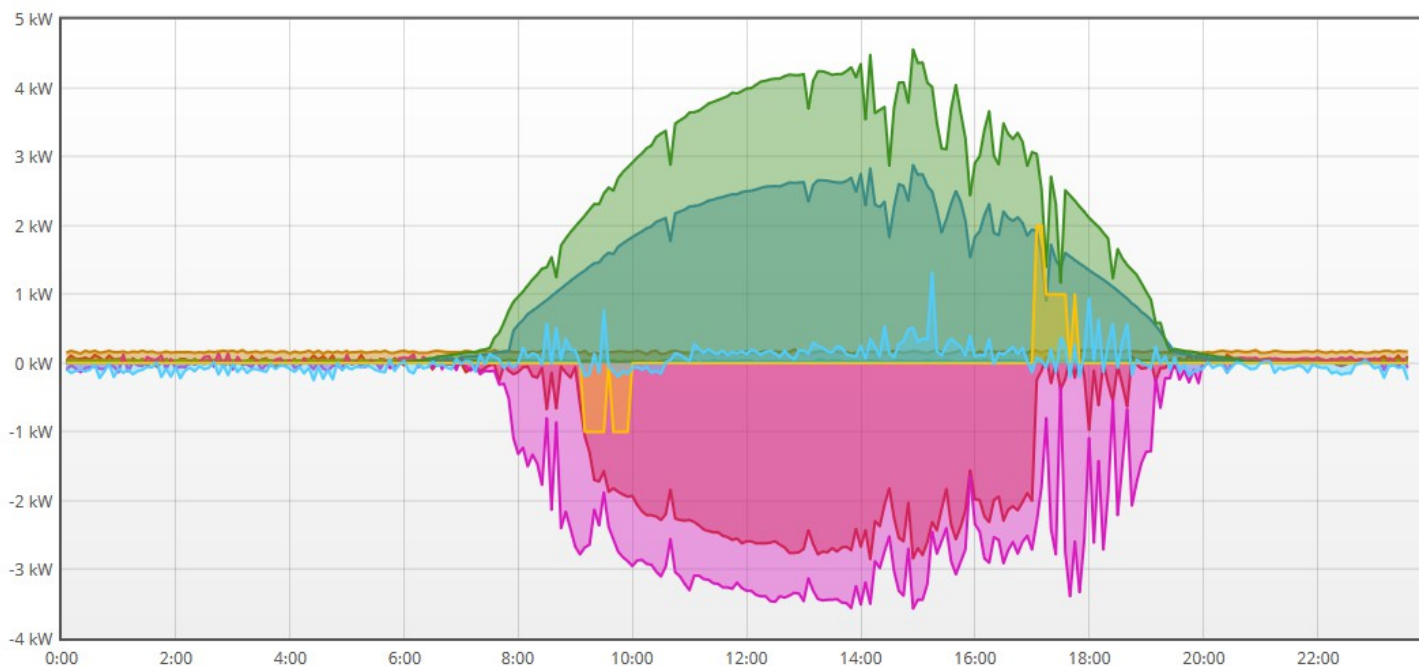
Custom Graph: inverters, trackers, BSP, meters

Studer Test R_D

Home > Studer Test R_D

From 05/14/2019 to 05/14/2019 today May 2019 První osa Y: Výkon Druhá osa Y: -----

Veličiny zařízení



Odebrat z dashboardu

VS 120-48.0V (SN: 390696E9)

YES Pdc O [kW] (sn: 390696E9)

NO Pdc I [kW] (sn: 390696E9)

Odebrat z dashboardu

BSP 500-48V (SN: 48FA0007)

YES Pdc [kW] (sn: 48FA0007)

Odebrat z dashboardu

Graph Example: normal, consumption during day

← ↑ → Od 30.07.2018 Do 30.07.2018 **dnes** listopad 2018

Dashboard

Solar Production

Max: 3.00 [kW]
Energy: 25.23 [kWh]

Consumption

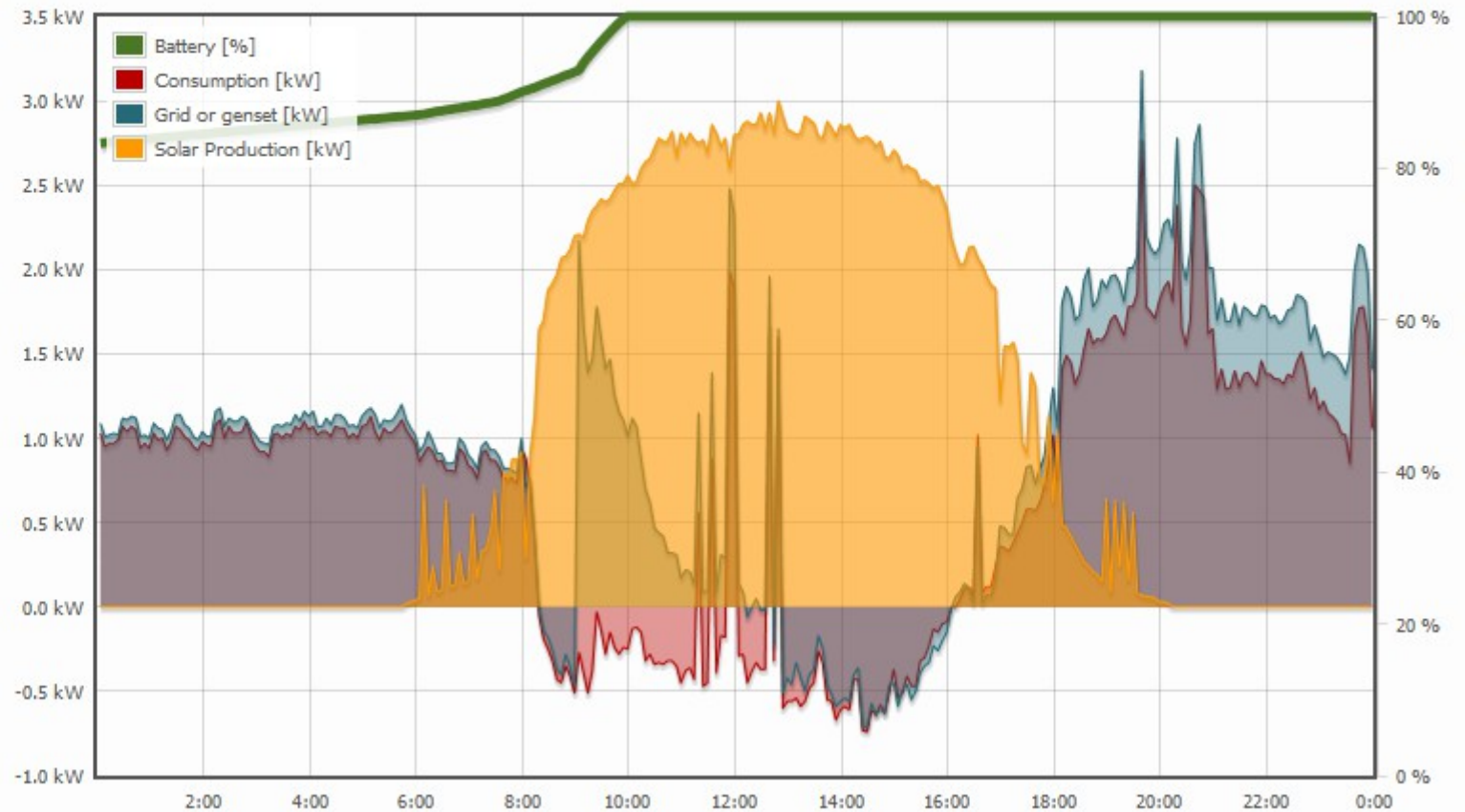
Max: 2.77 [kW]
Energy: 16.04 [kWh]

Grid or genset

Max: 3.18 [kW]
Energy: 22.24 [kWh]

Battery SOC

Max: 100.00 [%]
Min: 83.31 [%]



Graph Example: increasing consumption = ?

← ↑ → Od 27.08.2018 Do 27.08.2018 **dnes** listopad 2018

Dashboard

Solar Production

Max: 5.86 [kW]
Energy: 33.14 [kWh]

Consumption

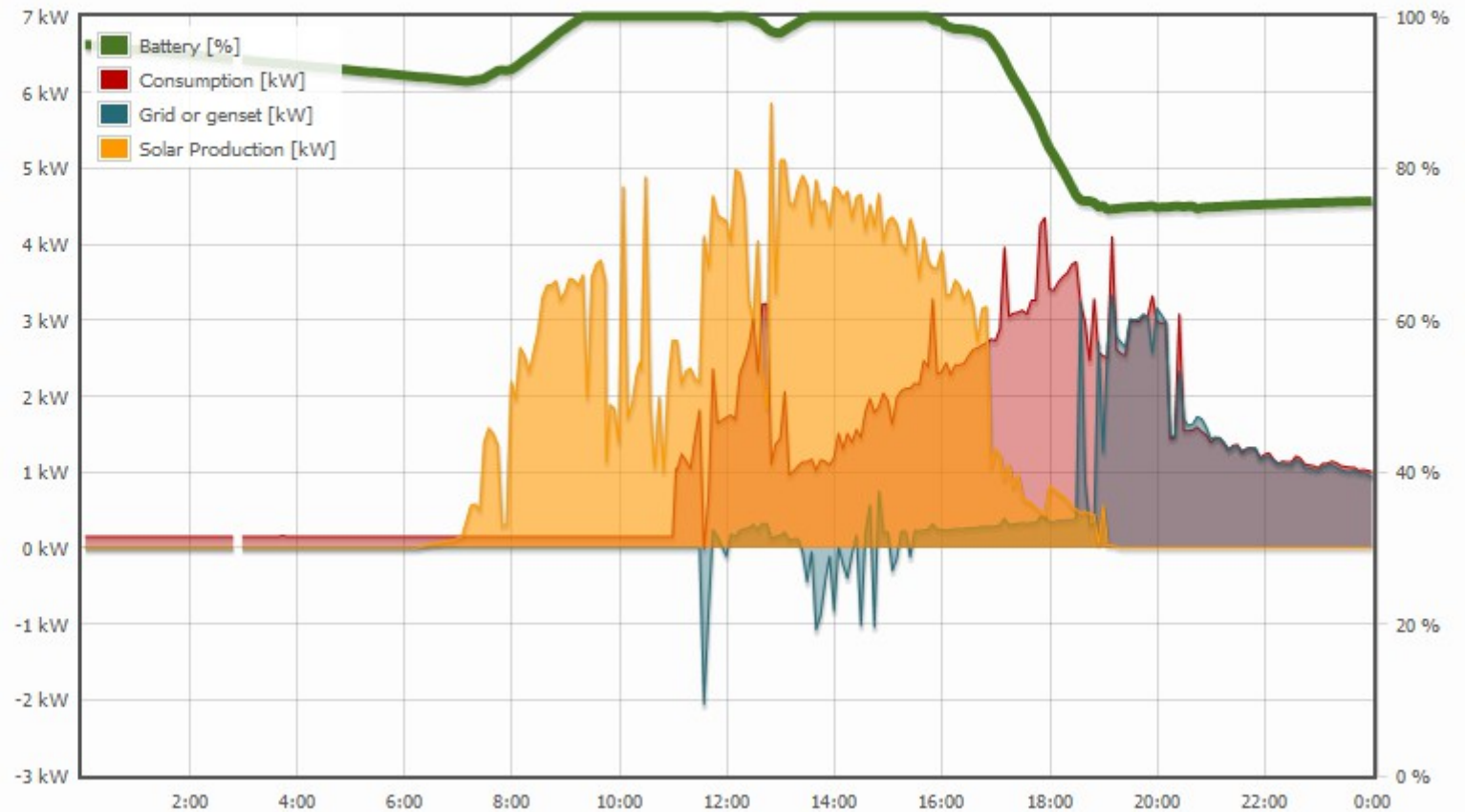
Max: 4.35 [kW]
Energy: 28.23 [kWh]

Grid or genset

Max: 3.33 [kW]
Energy: 9.62 [kWh]

Battery SOC

Max: 100.00 [%]
Min: 74.56 [%]



Graph Example: afternoon consumption discharge battery



Od 28.07.2018

Do 28.07.2018

dnes

listopad

2018

Dashboard

Solar Production

Max: 3.34 [kW]
Energy: 13.23 [kWh]

Consumption

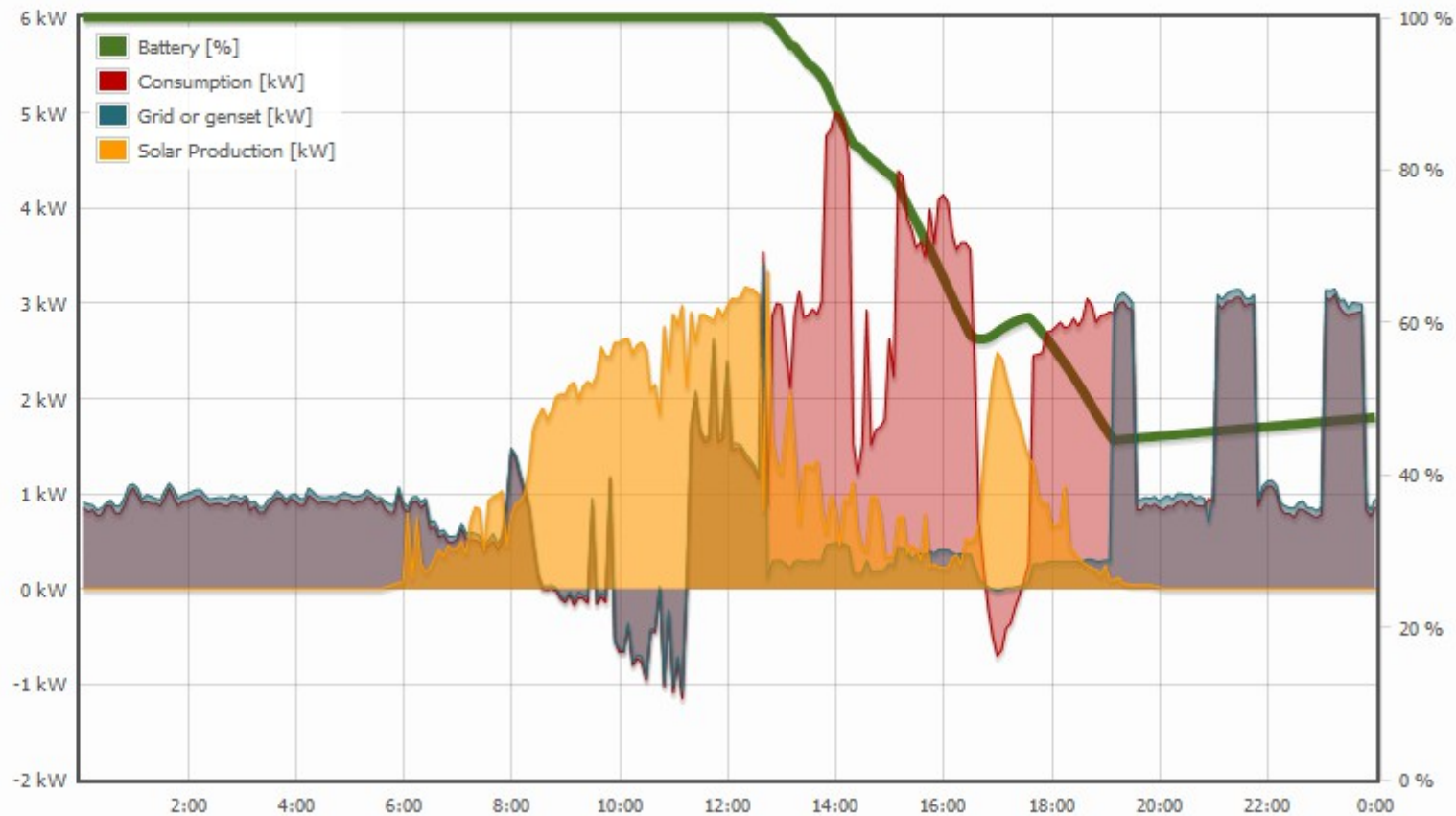
Max: 5.00 [kW]
Energy: 25.97 [kWh]

Grid or genset

Max: 3.42 [kW]
Energy: 11.88 [kWh]

Battery SOC

Max: 100.00 [%]
Min: 44.50 [%]



Graph Example: evening consumption, night peaks

← ↑ → Od 30.08.2018 Do 30.08.2018 **dnes** listopad 2018

Dashboard

Solar Production

Max: 4.40 [kW]
Energy: 25.54 [kWh]

Consumption

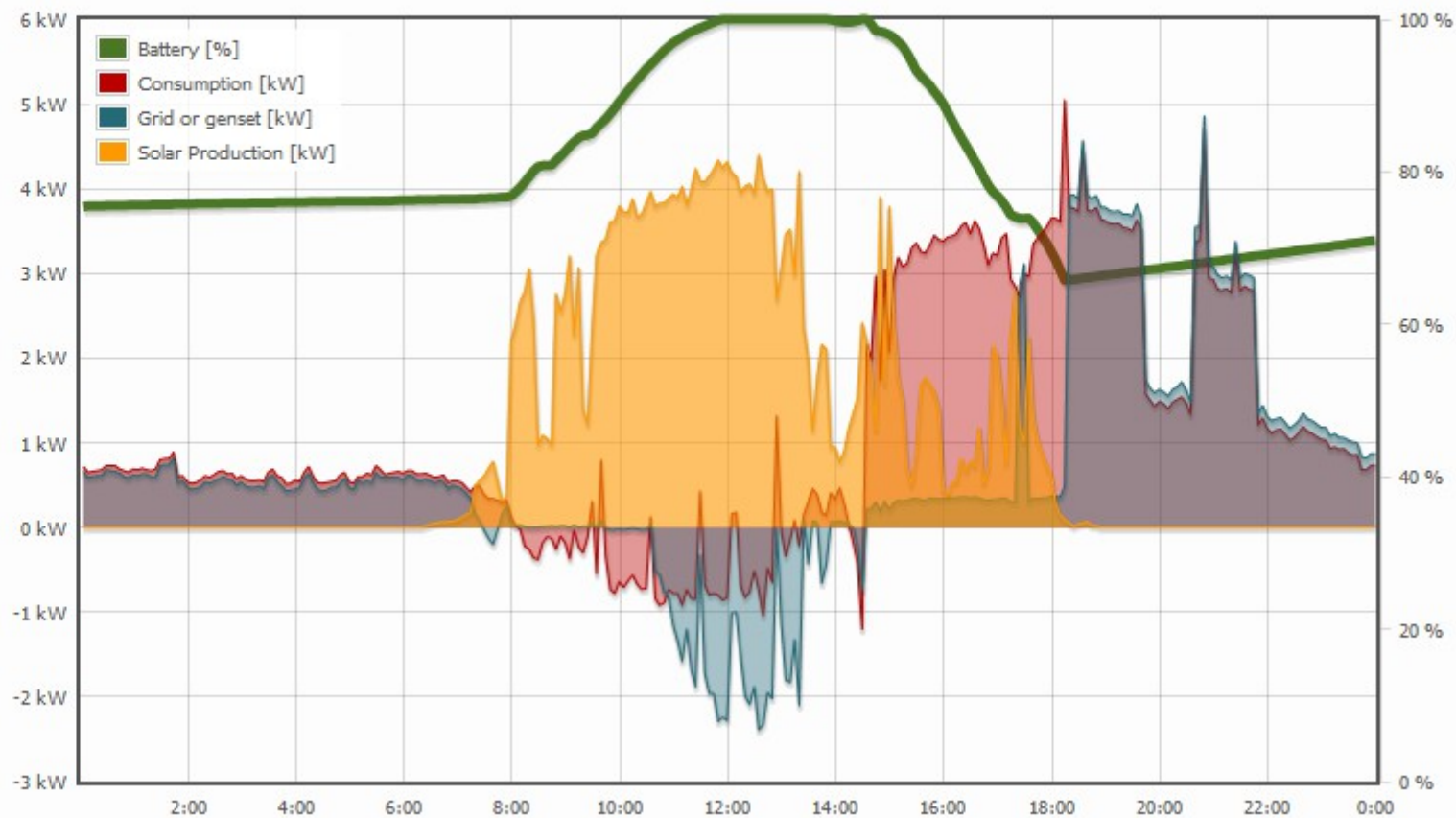
Max: 5.05 [kW]
Energy: 27.15 [kWh]

Grid or genset

Max: 4.86 [kW]
Energy: 14.68 [kWh]

Battery SOC

Max: 100.00 [%]
Min: 65.75 [%]



Graph Example: same situation + next day (charging)

← ↑ → Od 30.08.2018 Do 31.08.2018 **dnes** listopad 2018

Dashboard

Solar Production

Max: 4.40 [kW]
Energy: 45.60 [kWh]

Consumption

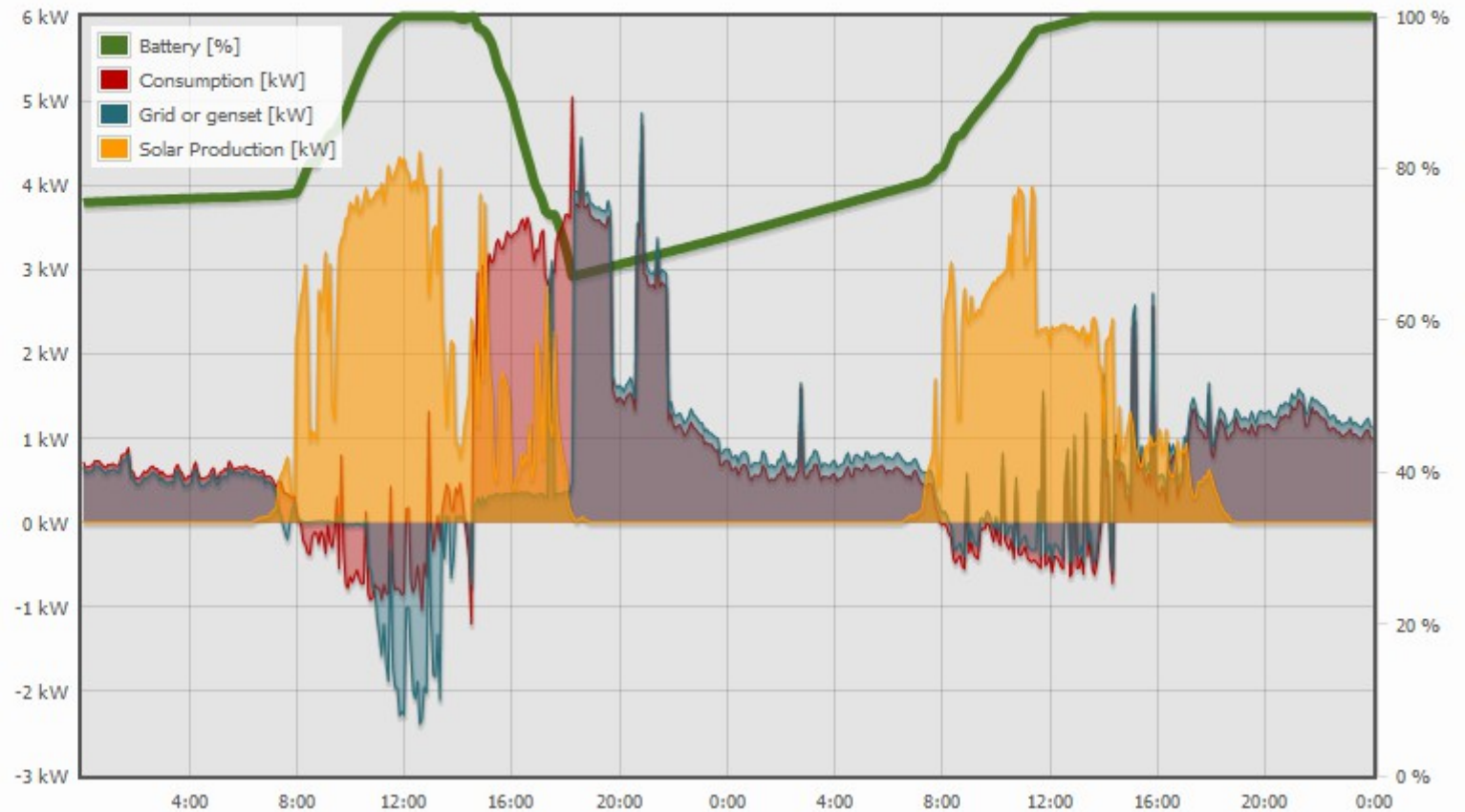
Max: 5.05 [kW]
Energy: 40.26 [kWh]

Grid or genset

Max: 4.86 [kW]
Energy: 31.26 [kWh]

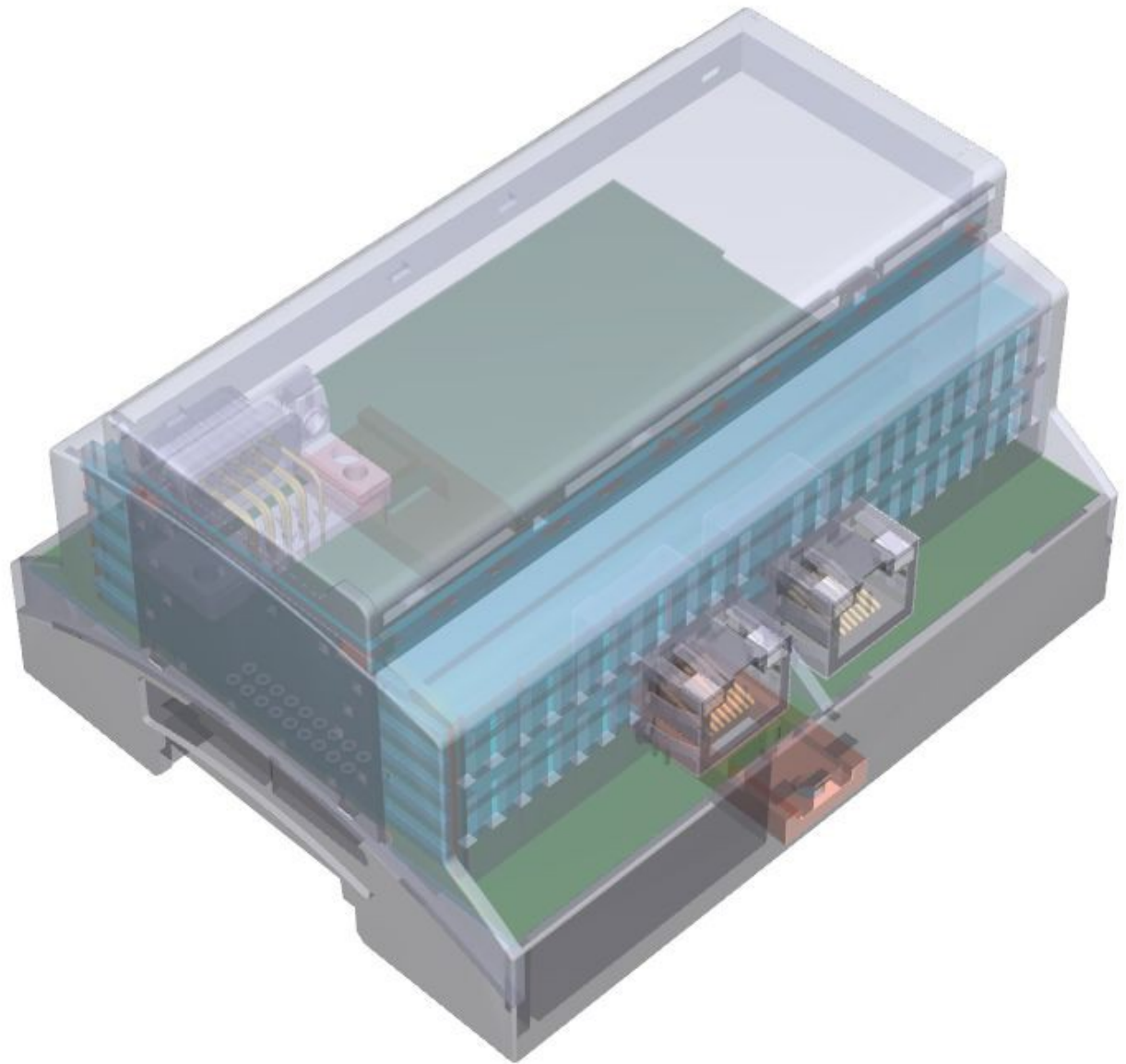
Battery SOC

Max: 100.00 [%]
Min: 65.75 [%]



Planned ... „miniCloud“ for DIN Rail

- For strict „in-house“ solutions
- Suitable for apartment house energy billing, banks
- 1x Gb ethernet
- 2x ARM Cortex A7, 1 GHz
- 1-2 GB RAM DDR3L 1.600 MT / s
- SATA SSD



Any questions are welcome!

Dušan Ferbas
Solar Monitor s.r.o.

dferbas@solarmonitor.cz