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Bundesamt für Energie BFE
Swiss Federal Office of Energy SFOE

IoT Monitoring and Control of Photovoltaic Inverters

Introduction

The "Sunshine" project, supported by the Swiss Federal Office of Energy (BFE), aims to develop a **new generation of photovoltaic (PV) inverters** that are more **energy-efficient** and **cost-effective.** The FHNW is tasked with minimizing energy conversion losses from direct current (DC) to alternating current (AC). To achieve this, integrating these inverters into a **cloud-based system** for real-time monitoring and control is essential. This integration requires the development of an IoT hardware device, specifically a **datalogger**, which will facilitate **communication between the inverters and the cloud system**

Project Goals

The goal of the project is to understand data exchange in commercial inverters and based on this understanding, develop the communication protocols to be used for the **SUNSHINE inverter**. In this project, the following three key aspects were addressed:

Commissioning & Configuration:
Five different inverters are to be professionally installed and commissioned.“

Main Code:
A program ensures communication, enables data reading and storage, and allows command transmission to the inverters.

Dictionaries:
Inverters and energy meters store data in different registers. It is therefore necessary to create a dictionary for every possible configuration.

Methods

Experimental Setup:
A PV simulator supplies a DC voltage to an inverter, which converts it into AC voltage and feeds it into the grid. The energy fed into the grid is measured using an energy meter. To simulate a load profile within a building, a load bank was used.

Python / MicroPython:
The main code and dictionaries were developed in Python. To ensure compatibility with the data logger, they need to be converted to MicroPython

Modbus TCP and RTU:
Data was retrieved from inverters and energy meters using the Modbus TCP and RTU protocols. For verification, the data was stored in a CSV file.

Read out Inverters

Manufacturer 1
- Modbus TCP ☑
- Modbus RTU ☑

Manufacturer 2
- Modbus TCP ☑
- Modbus RTU ☑

Manufacturer 3
- Modbus TCP ☑
- Modbus RTU ☑

Manufacturer 4
- Modbus TCP ☒
- Modbus RTU ☑

Manufacturer 5
- Modbus TCP ☑
- Modbus RTU ☑

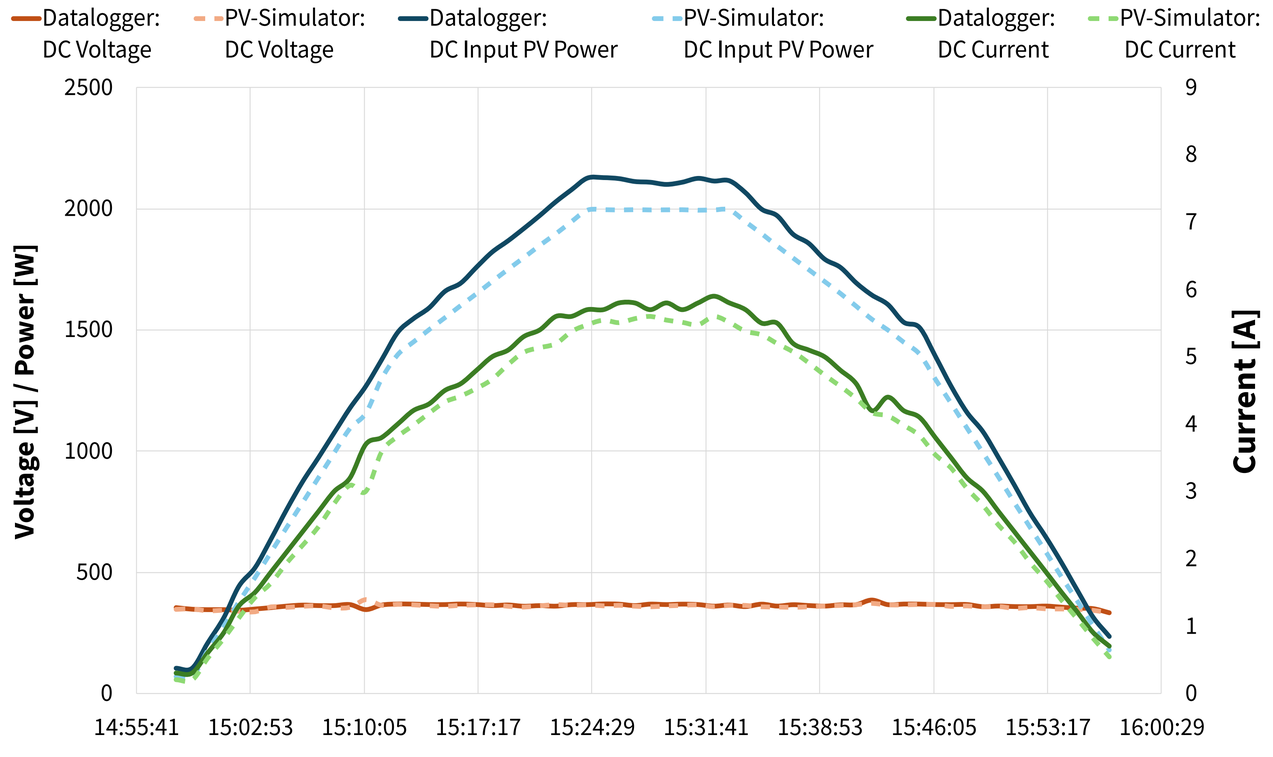
Results

The **diagram on the right** compares the **retrieved data** with the **voltage, current, and power** generated by the **PV simulator**. The comparison clearly shows that the measured data aligns with the values provided by the PV simulator.

By the end of the project, **seventeen dictionaries and a main Python script** were developed. These facilitate data retrieval from **all manufacturers**, along with their associated **energy meters**. In total, **five photovoltaic inverters** were successfully read out using different Modbus protocols.

Using the developed dictionaries, it is possible to retrieve data from the inverters via both **Modbus TCP and Modbus RTU**. The project ensured accurate data acquisition, providing the **foundation for the development of the data logger**.

Data comparison



Project number: EUT-P6-24HS-Kilchenmann
Project title: IoT monitoring and control of photovoltaic inverters
Project leader: Lukas Kilchenmann

Sources:

www.fhnw.ch/technik