Sponsor Project

Studer Innotec

Off Grid Solar Energy

Introduction

Business Rationale & Objectives

- Studer Innotec, founded in 1987, is an ISO certified company that develops and manufactures inverters, inverter/chargers and MPPT solar charge controllers entirely in Switzerland.

- Studer Innotec has for more than 30 years committed to manufacture power conversion products for the off-grid market. Today, there are hundreds of thousands of Studer products in operation all around the world.

Project Work & Assignments

Capstone Project

- Suggested Project Work structure is divided in three parts:
    - Part I: Data Preparation, Exploration and EDA
    - Part II: ML Modeling & Deployment
    - Part III: Final Project Presentation including:
        1. Poster
        2. Statement of Work,
        3. Conclusions & Recommendations
        4. Working Interface/Dashboard/Webapp

Preferred tools:

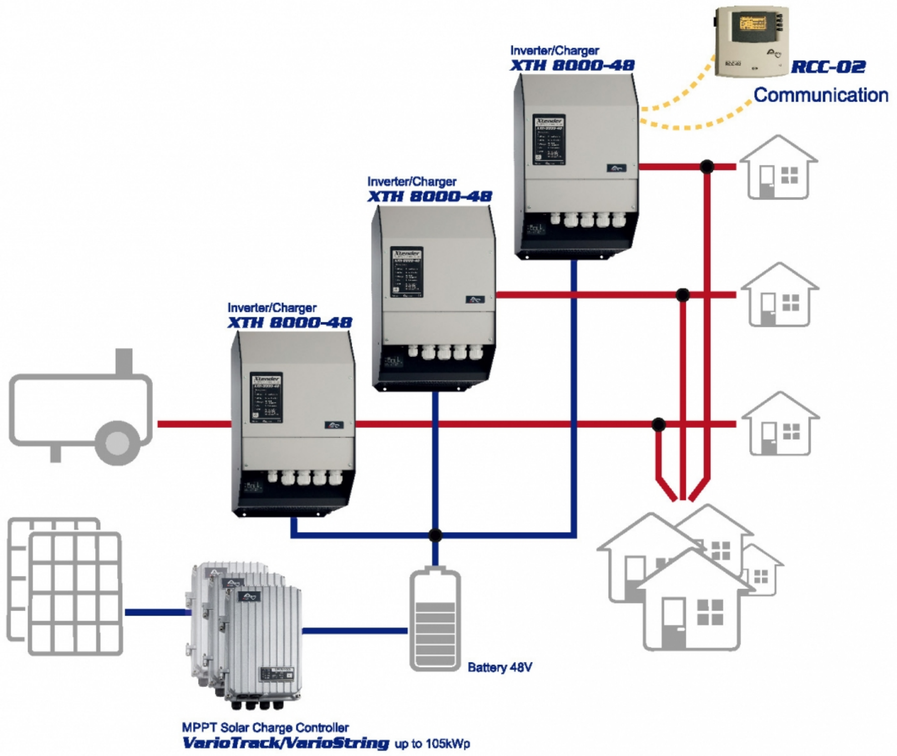
BigML (for EDA and ML Modeling/Evaluation/AutoML), Tableau, PowerBI (**Python** with BigML API https://bigml.com/api)

- BigML academic program available: https://bigml.com/education/ (free for faculty & students with .edu email, includes cloud storage and computing)
- BigML education/tutorials: https://bigml.com/education/videos

Solar Energy Installation – test site

Description

- Solar Panels (18-24)
- Diesel Genset 75CV*
- Battery bank – 48Vdc
- XT inverters (Xtenders x 3)
- VT charger (data available since winter)



** Assume Diesel cost = 1 EUR per hour (Genset consuming circa 1 litre / hour)*

1 diesel liter is equivalent to 2640 grammes of CO2

Datasets

Off Grid - Solar Energy Production & Consumption logs 2015-2020 time stamped

Daily Data Log files (.csv) from Aug 20th 2015 to Dec 26th, 2020
File naming: LGyymmdd.csv (LG+year+month+day)

Data Log Analysis tools (excel) available here:

- **Xtender Data Analysis Tool (V1.6.40)** – Year/Month/Week EN(862KB)
- Xtender Data Analysis Tool (V1.6.40) – Week EN(8MB)
- Xtender Data Analysis Tool (V1.6.40) – Month - EN(25MB)

Most Important Variables:

Solar power (ALL) (kW) : Total Solar Energy/Power in, from Solar Panels
XT-Pout a (kW) : Power out delivered for Consumption at Installation
XT-Pin a (kW) : Power in from diesel Genset

XT-Ubat (Vdc) : Batt Voltage [Vdc] from Xtender #1 reading
XT-Ibat (Adc) : Batt Current (>0 current in from Genset, <0 consumption from installation)
XT-Ubat- (MIN) (Vdc) : Minimum Batt Voltage [V] from Xtender #1

XT-Uin (Vac) : AC voltage incoming from Genset – L1 (phase 1: 0 or 220 Vac)
F6 : AC voltage incoming from Genset – L1 (phase 2 : 0 or 220 Vac)
F7 : AC voltage incoming from Genset – L1 (phase 3 : 0 or 220 Vac)
[0 or low Vac = Genset is OFF, circa 220 Vac = Genset is ON]

Relay Status:
XT-Aux 1 () = 0 Genset OFF
XT-Aux 1 () = 3 Genset is starting
XT-Aux 1 () = 1 Genset is ON
XT-Aux 1 () = 2 Genset is stopping

Objectives

Studer Innotec wants to optimize solar power delivery as well as reduce Genset costs (Diesel consumption).

Ideally, provide a working interface/dashboard (tableau or similar) with the following metrics by day/month/year

1. Total Power (kW) and Energy (kWh) Delivered to Installation
2. Total Power (kW) and Energy (kWh) Consumed
3. Power (kW) and Energy (kWh) from Solar Panels
4. Power (kW) and Energy (kWh) from Genset
5. Average time Genset was operating and cost (assume 1 hr operating = 1,5 EUR)
6. Next expected start of Genset (when)
7. Predict operating time for Genset for next week/month/year (nr of hours)
8. Predict 1, 2, 3 and 4 for next day/week/month/year
9. Predict CO2 savings considering electrical grid avg CO2 emissions and Genset

10. Battery voltage prediction hourly and daily (if feasible)
11. Battery charging (Ah) and time (positive current) and Batt discharging (Ah) and time (negative current), historical and prediction by day/week/month/year
12. Battery lifecycle analysis: predict batt cycle, nr of full charging/discharging cycles per week/month/year
13. Predict Battery lifetime (reaching the limit of charging cycles)

14. Explore and determine useful Anomaly detection features and policies

Objectives

Battery Analysis

- Assume Batteries have a lifetime of 12K charging cycles
- Determine avg cycles per week, month and year 2015-2020 and evaluate lifetime left
- Consider a cycle complete when Battery voltage reaches Float state 54.38 V after Absorption 57.6 V
- Consider deep discharge if Batt voltage is below 46
- Compute nr of deep discharges per month/year, estimate for future till end of lifetime
- Graph the evolution of Battery energy provided months/years, built a prediction for total energy delivery in lifetime

Objectives

Weather Data augmentation & analysis

- The test site location for this Solar Energy installation is the Mediterranean island of Mallorca
- Historical weather reports for the area (nearest weather station is Porreres – Illes Balears) available here: https://opendata.aemet.es/opendata/sh/1ee422ba
- Metadata and description: https://opendata.aemet.es/opendata/sh/b3aa9d28
- Main variables (daily metrics) tmed = Avg Temperature (Celsius), prec = rain (mm), tmin = min temp, tmax = max temp, velmedia = wind avg speed, sol = nr of solar hours, presmax = max pressure (UTC)
- Integrate weather info and find correlations with power generation and consumption (determine patterns)

Guidance

Structuring Project Work

Structuring the work

- Suggest dividing the work in teams, sharing progress cumulatively towards the goals
- After Data Preparation and Feature Engineering, subsequent teams should work with the same cleaned and augmented dataset for predictive modeling
- Ideally, the workflow followed should be able to be tracked back from the outcomes

Recommended tools:

For Data Prep and ML Modeling BigML is the preferred tool, a free PRO account is available to students and faculty at https://bigml.com/education/

BigML education tutorials: BigML education/tutorials: https://bigml.com/education/videos

Other tools: Tableau, PowerBI, Python, R, Jupyter, etc