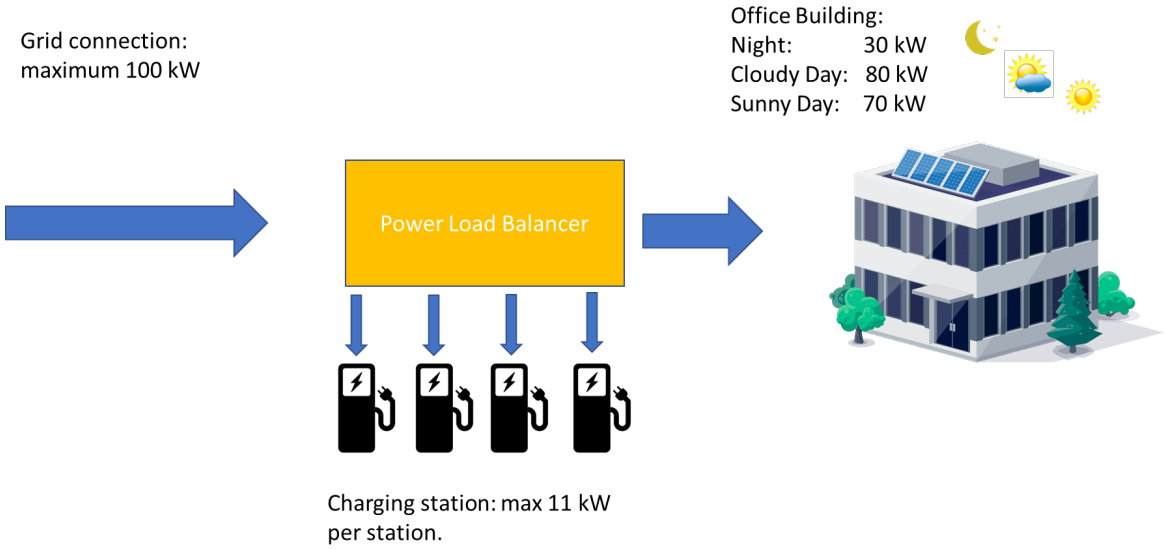
Power Load Balancing



Introduction

The goal of this Industry Project is development of a prototype for the “Power Load Balancing”. With the increase of electric vehicles presence, the problem of providing efficient charging of the vehicles related to availability, current price, and fair sharing arises. In this project we are going to simulate an office building with parking place and electric vehicle chargers.

Outline case

The office building has a 100 kW power connection. The office consumes 30 kW during night and 80 kW during day. The office has solar panels on the roof. Those solar panels produce 10 kW during sunny days. The office wants to connects 4 charge points and feed them with the power that is not used by the office building. Charging of a car takes normally 11 kW and a car is full after 4 hours. However, if there are 4 cars charging at the same moment during the day, the power consumption would be too high (as 80 kW for the office building + 4* 11 kW for cars > 100 kW maximum available). A car can also be charged with less kW (for example, 3 or 4 kW), however the charging takes much longer. For example, charging at 5.5 kW would take 8 hours.

You are asked to make a Power Load Balancer. The Power Load balancer should determine how much power capacity is left for the charging stations (after the consumption of the office building) and allocate it over the 4 charging points.

Proposed System

You should develop a system that keeps track of all charging stations for an office building, overall electricity consumption of the building and the prices of the electricity that are mostly dependent on the current network usage.

Your system should have 3 modes:

1. Static Load Balancing

   This is a fixed load sharing, the available capacity is shared between all charging stations equally, independent of whether at the charging station a car is being charged. So if there is 30 kW available, every station gets 7.5 kW.

2. Dynamic Load Balancing

   The available capacity for charging is equally allocated to the connected cars. So if there is 30 kW available, and 3 cars, every car get 10 kW.

3. First Come First Serve Load Balancing

   The first cars are charged with 11 kW, later cars have to wait. So if there is only 30 kW available, only 2 cars can be charged with 11 kW. The third car gets 8 kW, the last car gets nothing (until car #1 leaves)

4. Directors Parking

   The cars from the directors are always charged with 11 kW. All the rest of the power is equally allocated to the other cars. How would this work with 1, 2 or 3 directors?

Make sure you take care of the time; during day time there is less capacity available for charging than during night! The charging stations can not charge faster than 11 kW.

Keep the 100 kW constraint in mind! If your office building + cars would use > 100 kW, the fuse will blow and there is a black out! So avoid at all times your system consumes more than 100 kW!

Extensions/Advanced

There is an extension idea presented below. You can implement it as well as think about your own extension. Consult the extensions with your customer!

Low Cost Charing

The power price is being traded on the world market. It is dependent on many factors but most important is current usage. E.g. during the morning, day, evening, night, weekend, holidays, there is different usage of power. Another very important factor is weather (e.g. working of sun collectors and wind turbines). Simulate real-time power changes (or get the real values from the market, e .g. https://www.epexspot.com/en/market-data and use them to create different profiles/priorities per car or fleet. You can for example presume the car will be there 8 hours, or all night etc.

And what about making your solution scalable related to different number of the charging stations?

Note: Don't spend too much time on building HW for the machines that you make up. Even if it's nice to see machines, don't forget that the most important part of the project is software.

Robustness

- All combination of different modes, profiles, priorities, … should be possible
- What happens if one of the devices is switched off?
- What happens if suddenly the sunny day changes in cloudy day?

- There is no “single point of failure”. If one of the charging station has an error or crashes, the system is still functioning.
- Naturally, your implementation is error- and crash-free.

Management UI

- There is a UI with the state of all charging machines
- There is a UI where we can see the current status of charging of the cars
- UI offers a possibility to switch off the whole system
- UI offers a possibility to switch on and off all separate charging stations
- UI enables creating and setting different profiles/priorities/fleets/modes
- UI gives a warning if maximum charging capacity is reached and cars have to be queued.