Specification

Sandro Speth
Markus Zilch
Dominik Wagner

Wintersemester 18/19

1 Introduction

The traditional power grid is changing more and more over time. Due to increasing sensititization for the use of renewable and reliable sources of energy instead of nuclear power sources, there is an increasing accomodation of renewable energy. To fullfill our daily energy need only with such energy sources is quite difficult and needs lot of planning and simulation. In this work we build a smart energy system to simulate a smart grid.

A smart grid is an energy efficient system with information and communication technology, automation and awareness of energy consumtion. There are many different actors and technologies which are connected to each other and interoperate to optimate the grid.

A smart energy systems creates the bridge between a power grid and a resilient and reliable smart grid. Users can simulate reliable energy sources, as well as different kinds of energy consumers, e.g. homes or offices. Simulation of distributed energy sources and automation of processes build an energy management system. Through this microgrids we can possibly rely completly on renewable energy sources in the future. This can be checked with our smart energy system.

The report is structured as follows. In section 2 we present our system design. First, we give some basic foundations which are relevant for our smart energy system, such as the difference between kWh and kW. Afterwards we present our functional requirements for the smart energy systems as user stories. From these functional requirements we created our architecture which will be described in this section as well.

2 System Design

2.1 Difference between kW and kWh

W is a messuring scale for energy applied per timeinstance. There are different possibilities to describe W in common terms. A pretty graphic one is the movement of mass. $1W$ equals $1kg$ of mass moved by 1 meter in one second: $1\frac{kg*m^2}{s^3}$. Or in electrical terms: $1W$ equals 1 Ampere of electrical power with a voltage of 1 Volt. Both of those formulas are equal to a much simpler Term for Watt: $1W = 1J/s$. In simple terms, 1 Watt is the same as one Joule of energy applied over 1 second. For completeness, $1kW = 1000W$.

Wh are the common term for messuring energyconsumption/-production. $1Wh$ is $1W$ applied continuously over 1 hour. $1Wh = 1W * 1h = 1J/s * 3600s = 3600J$. For a scientific context the Wh therefore is simply not used, instead the common SI standard J is used.

In comparison, Wh is the total amount of energy used. W is how much energy is used in a specified timeslot (mostly 1 second).

Sources:
Robert A. Nelson: The International System of Units. Applied Technology Institute
`https://www.aticourses.com/international_system_units.htm`
Gérard Borvon: History of the electrical units. S-eau-S, 10. September 2012
`http://seaus.free.fr/spip.php?article964`
Das Internationale Einheitensystem (SI). Deutsche Übersetzung der BIPM-Broschüre „Le Système international d'unités/The International System of Units (8e édition, 2006)". In: PTB-Mitteilungen. Band 117, Nr. 2, 2007
`https://www.ptb.de/cms/fileadmin/internet/Themenrundgaenge/ImWeltweitenNetzDerMetrologie`
`si.pdf`
aufgrund der EU-Richtlinie 80/181/EWG in den Staaten der EU bzw. dem Bundesgesetz über das Messwesen in der Schweiz
`https://www.admin.ch/opc/de/classified-compilation/20101915/`

2.2 Difference between consumption and demand

2.3 Userstories

1. As a user, I need to create a wind turbine in the simulation so that I can calculate the potential energy output.

2. As a user, I need to create a photovoltaic panel in the simulation so that I can calculate the potential energy output.

3. As a user, I need to create a battery in the simulation so that I can **visualize** the impact of the energy storage on the grid.

4. As a user, I need to create a home on the demand side in the simulation so that I can calculate the energy demand of the home.

5. As a user, I need to create a commercial building on the demand side in the simulation so that I can calculate the energy demand of the commercial building.

6. As a user, I need to get continuously calculate dynamic prices per kWh form the simulation so that I can determine if I want to sell my produced energy or store it for later use or selling.

7. As a user, I need to use wetter data in the simulation so that the simulation gets more precise.

8. As a user, I need to be able to use already saved wetter data in the simulation so that the dependency on the availability of the wetter service is reduced.
9. As a user, I need to use the simulation to generate a forecast for energy generation and demand so that I can make informed decisions.
10. As a user, I want to add customizable suppler modules to the simulation so that ...
11. As a user, I want to add customizable consumer modules to the simulation so that ...
12. As a user, I need to run the simulation in an island mode which does not contain a connection to the main power grid so that I'm independent of the main power grid and its failures.
13. As a user, I need to get a visual notification if the supply is smaller than the demand so that I know that I have to add more energy supplier.
14. As a user, I need that the battery is used if the supply is smaller than the demand and it has enough charge so that ...
15. As a user, I need that the battery is recharged if the demand is greater than the supply so that ...
16. As a user, I need that the battery is recharged if the demand is greater than the supply so that ...
17. As a user, I need that the main power is used to manage peak demands if the microgrid has a connection to the main power so that ...
18. As a user, I need that the demand side simulation features standard loads like lighting so that...
19. As a user, I need that the demand side consumers feature different load scenarios like home users and commercial users (constant load, occasionally peak loads) so that ...
20. As a user, I need to use the system with my webbrowser so that I can use different platforms to view it.
21. As a user, I need to visualize different metrics so that ...
22. As a user, I need to view the current electric demand of the grid so that...
23. As a user, I need to view the electric consumption of the grid so that...
24. As a user, I want to adjust the demand by postponing the use of devices during peak hours so that...
25. As a user, I need that the simulation adapts the demand based the price per kWh so that...

Todo:

1. Replace ... with content
2. check spelling and grammar
3. price per min and price of the next day
4. user stories for visualization

2.4 Architecture

System architecture Diagram

A5

add weather component

A6

reliable and responsive system

A7

three-tier system architecture