Specification

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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).

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2.2 Difference between consumption and demand

2.3 Userstories

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

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

3. As a user, I need to create one or more batteries in the simulation so to save unused energy of in my simulation.

4. As a user, I need to get the charge state of my batteries to know the impact of the energy storage on the grid.

5. As a user, I need to create one or more homes on the demand side in the simulation so that I can simulate some energy consumer.

6. As a user, I need to create one or more commercial buildings on the demand side in the simulation so to simulate some high energy consumer.

7. As a user, I need to get dynamic energy prices calculated from the simulation to determine if I want to sell my produced energy or store it for later use.

8. As a user, I need to use weather data in the simulation to simulate the smart energy system more precise and realistic.
9. As a user, I need to use already saved wetter data in the simulation to not be dependent on the availability of the weather service.
10. As a user, I need to generate a forecast for energy generation and demand using the simulation in order to make informed decisions.
11. As a developer, I want to add more supplier modules than wind tubines and photovoltaic pannels to the simulation to improve the smart energy system in the future with further technology.
12. As a developer, I want to add more consumer modules to the simulation to be able to add more consumer than homes and commercial buildings.
13. As a user, I want to be able to create a smart energy system which is independent to an power grid to simulate a reliable smart grid.
14. As a user, I want to get a visual notification if the supply of energy is smaller than the demand of energy to know when more energy supplier are needed.
15. As a demand module, I need to get energy from the (charged) batteries if the provided supply to small for my demand so that I still have enough money.
16. TODO
17. As a user, I need that the battery is recharged if the demand is greater than the supply so that ...
18. As a user, I need that the battery is recharged if the demand is greater than the supply so that ...
19. 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 ...
20. As a user, I need that the demand side simulation features standard loads like lighting so that...
21. 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 ...
22. As a user, I need to use the system with my webbrowser so that I can use different platforms to view it.
23. As a user, I need to visualize different metrics so that ...
24. As a user, I need to view the current electric demand of the grid so that...
25. As a user, I need to view the electric consumption of the grid so that...
26. As a user, I want to adjust the demand by postponing the use of devices during peak hours so that...

27. 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