CONSTRUCTION OF AN MICROGRID COOPERATING WITH A RESIDENTIAL ESTATE AND INSTALLATION FOR REFUELING BUSES WITH HYDROGEN

I. Introduction

Progressing climate changes resulted in the tightening of the energy and climate policy of the European Union. The result were new challenges faced by energy companies trying to meet the new requirements. One of the easiest to observe changes is the gradual shift away from coal-based energy in favor of renewable energy sources.

However, renewable energy sources, apart from their advantages, have some kind of limitations. An example is the strong dependence of electricity production on weather conditions. In order to mitigate this impact, renewable sources are combined into so-called hybrid sources (combination of several renewable energy technologies) or innovative solutions such as microgrids or hydrogen.

1. Project background

A new housing estate is under construction. It will be composed of 70 single-family houses. The estate will be built on previously undeveloped land. There are other single-family houses nearby, as well as a local shop, medical clinic and school. In an already built-up area, there are

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sporadic problems with the quality of electricity or even its shortages. The construction of a new housing estate may worsen the existing situation. The management of an energy company providing energy in the area has stated that there are two possible solutions to this situation.

The first solution is to modernize the distribution network. Such an investment is difficult not only due to high costs, but also requires a large amount of excavation over a large area. Modernization of the distribution network requires the consent of the owners of the plots through which the distribution network passes. The process is lengthy and difficult to plan.

The second solution is to build a microgrid cooperating with the new housing estate. Such a microgrid will allow the supply of energy to consumers from the new housing estate in the event of problems with the quality of energy in the distribution network. The microgrid will also help improve the quality of energy in the surrounding area.

The new housing estate will be inhabited by young people for whom environmental and climate protection issues are important. In addition, there is a city bus depot in the vicinity of the estate. The owner of the depot would like to equip it with an instalation for refueling buses with hydrogen. The power of the installation will be 225 kW. It is essential that the hydrogen installation is supplied with renewable energy from the microgrid. As a result, the produced hydrogen will be considered a clean fuel.

2. Tasks to be done

Based on information from the case study description and the knowledge acquired during the summer school, it is necessary to:

Imagine that you are the manager of a described project. Taking into account the economic, management and technical aspects of the project:

- Identify possible climate and financial risks. Propose forms of mitigation of these risks.
- Prepare PEST analysis for the project.
- Propose sources of financing for the project
- Develop a schedule for the described project.

II. Project description

1. The aim of the project

As part of the project, a microgrid installation cooperating with a housing estate is to be implemented. As part of the project, it will be determined which generation sources (photovoltaic panels / wind turbines / gas engine / biogas engine) will be used. In addition, the microgrid will be equipped with an energy storage.

Due to the close vicinity of the bus depot, an installation for refueling buses with hydrogen is also to be built as part of the project. The microgrid and installation for refueling buses with hydrogen are to be built at the same time.

2. What is a microgrid?

A microgrid, or a self-balancing area of the power grid, is a physically separated area of electricity supply that includes local energy sources (mainly those generating electricity from renewable resources) and the energy consumers gathered around them (households, offices, shops, etc.).

In order to ensure the stability of power supply to energy consumers within the microgrid, they are additionally built in energy storage and / or stabilizing sources (e.g. generators producing electricity from natural gas). All elements of the microgrid are connected with the power grid. A dedicated microgrid management system supervises the balancing of electricity demand and supply in the microgrid. The microgrid can operate in the following operating modes:

- classic method (generation sources generate energy to the grid, consumers get energy from the grid)
- island mode (the microgrid operates independently of the grid. The generation sources of the microgrid generate energy consumed by the microgrid consumers or accumulated in the microgrid energy storage).

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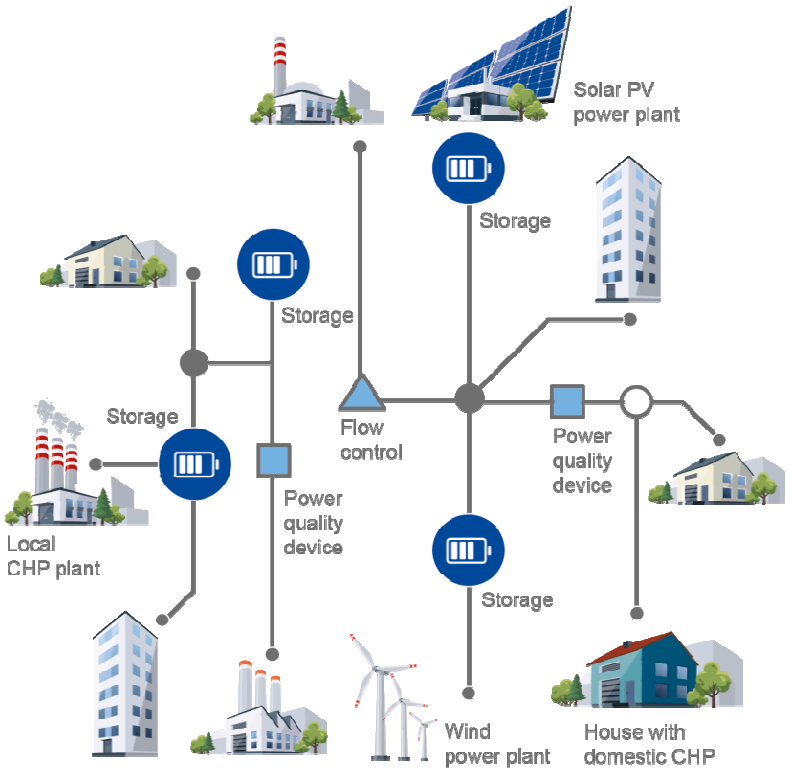
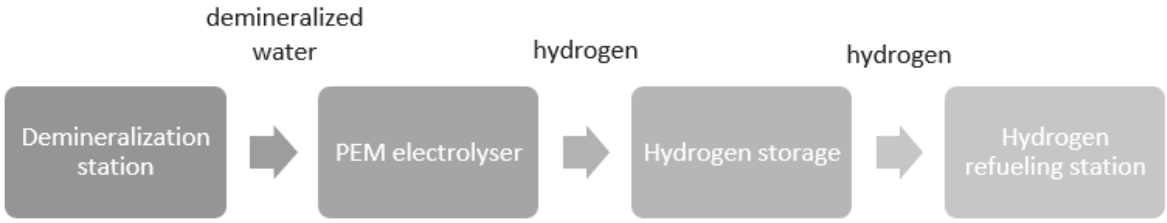


Picture 1. Exemplary microgrid diagram

3. Installation for refuelling buses with hydrogen

The main components of the installation for refuelling buses with hydrogen are commercially available. The basic element of the installation is an electrolyser in which the electrolysis process is used to produce hydrogen. The electrolysis process uses the phenomenon of water molecule breakdown under the influence of direct current electricity. The installation will operate on the basis of the PEM (polymer electrolyte membrane) electrolyser, which is a technology used on the market. The installation will be equipped with a stationary hydrogen storage facility. In addition, the installation must be equipped with a water demineralization station, which will allow water to be prepared for the electrolysis process.

The last element of the installation is a hydrogen refuelling station. It consists of a hydrogen compression and cooling system, distributors and a gas accounting system.



Picture 2. Installation for refuelling buses with hydrogen diagram

4. Main assumptions and tasks of the project

The microgrid will be owned by an energy company. It was specified that the installation would be built on a plot of 5,500 m2, to which the Energy company has the right to dispose of. The plot is currently not developed and there are several trees growing on it. Trees will have to be felled. To meet the energy needs of the estate and hydrogen installation, about 400 kW of power is needed. This power will be mainly produced from renewable energy sources. It is not specified what type of sources they will be (photovoltaics/wind turbines/biogas/biomass). It is known that the installation will be equipped with an energy storage with a capacity of 200 kW and a capacity of 300 kWh. The installation should be equipped with an engine with a power of about 40 kW. The engine can run on gas or biogas.

The operation of the installation will be controlled by the Microgrid Management System, which will be designed for the needs of the project. The main innovative element will be the possibility of operating an island pilot installation.

No buildings will be built on the site of the installation. The gas engine and energy storage will be installed in the container. It is necessary to prepare foundations for wind turbines.

In addition, the installation must be equipped with elements such as:

- Automation;
- Fire protection system;
- Fencing of the installation site;
- Monitoring of the installation site;
- Burglary alarm system;
- Transformer station.

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The pilot microgrid installation is to be designed, built and put into operation by a Contractor who has to be selected in the tender. Moreover, the Contractor must obtain all the necessary approvals and permits enabling the installation to be operated. The termination of cooperation with the Contractor will take place after the pilot installation is commissioned for operation.

The microgrid is to power households as standard. The energy storage should be charged systematically. It should be remembered that the hydrogen refuelling system for buses also has to undergo a similar design and construction process. The installation, apart from the main components, must also be equipped with monitoring, automation, fire protection installation, fencing. In the case of hydrogen installations, it is important to take care of roads that will allow buses to conveniently access the refuelling installation.

5. Challenges monitored

During the development of the assumptions, the following challenges were monitored:

- Microgrid will have to obtain the necessary building and environmental permits issued by the Office governing the area planned for construction.
- The investment outlays for the project are high. They are estimated at around 3,500,000 euro.
- Due to the complexity of the project, the tender for the selection of the Contractor will be complicated and will consist of stages such as market research; inviting potential Contractors to submit preliminary offers; checking initial bids; negotiations with selected potential Contractors; submission of final offers; selection of the Contractor; signing a contract.
- The project will consist of 4 main stages:
  - Determination of technical parameters of microgrids - including the power of energy generating sources
  - Preparation for the tender to select a Contractor
  - Performance of the tender and selection of the Contractor
  - Cooperation with the Contractor in the construction of the pilot installation and its commissioning

Stages must be planned in a way that minimizes delays.

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6. Task tips

a) Task 1 – risks

- The risks may concern both the construction stage and the operation of the constructed installation.
- During construction there may be problems with obtaining the required permits, delays in the production of devices.
- During operation, significant risks may be related to the climate and weather, e.g. storms and storms may damage the devices

b) Task 2 – Prepare PEST analysis for the project.

- During the task, do not propose the capacity of photovoltaic panels or wind turbines or biomass/biogas devices. However, it is necessary to consider what factors may influence the choice of the power of individual sources.
- For example, there may be requirements in local legislation that prohibit certain generation sources. This is often the case with wind turbines.

c) Task 3 – Propose sources of financing for the project

- The project consists of two topics: construction of innovative renewable energy sources (microgrid) and construction of installations for refuelling buses with hydrogen. Each task may be eligible for different funding.
- It should be considered whether the entire project should not be divided into two smaller ones. The first would be to build a microgrid. The second is at the construction site of an installation for refuelling buses with hydrogen. In such a case, each of the smaller projects can be co-financed separately.

d) Task 4 – Develop a schedule for the described project.

- The entire schedule should be within 17 months
- If you divide the project into two smaller ones, keep this in mind when building the schedule
- The term „Ordering Party" mean the company that buys the installation and will use it in the future (in the case of a case study, it is an energy company)

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- The term Contractor means a company selected by the Ordering Party through a tender. This company will carry out works resulting from the contract binding the Contractor with the Ordering Party. In the case of a case study, it is the design and construction of microgrid installations
- The entire schedule should consist of several major steps:
  - *Step 1*: Preparation of documents to be selected by the Contractor: development of technical assumptions for the project, preparation of a contract for the construction of the installation with the Contractor
  - *Step 2*: Conducting a tender for selecting a Contractor: preparing a list of potential Contractors and inviting them to the tender, negotiating with invited Contractors, signing a contract with a selected Contractor
  - *Step 3*: Cooperation with the contractor: designing the installation and its construction. It should be remembered that the Contractor is usually not the manufacturer of the equipment and they must be ordered and delivered. At this stage, many tasks are carried out in parallel.
  - *Step 4*: Tests and acceptance of the installation: The Contractor is obliged to perform the tests specified by the Ordering Party. After their correct implementation, the Contractor hands over the installation to the Ordering Party and its operation begins

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