The impact of using distributed generation in smart networks

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***Abstract* — As the share of renewable energy sources increases, the classic centralized scheme is transformed into decentralized electricity generation. Thanks to renewable energy is now economically profitable to produce electricity directly at the point of consumption. Despite the advantages offered by renewable distributed generation technologies, the incorrect integration of distributed generation into existing distribution networks may give rise to several economic and technical challenges. Optimal planning of distributed production is therefore of paramount importance to ensure that the power of the distribution network can meet the expected energy quality, voltage stability, reduced energy loss, reliability and profitability.**

***Keywords* — distributed generation, renewable energy sources, SMART Grid.**

I. INTRODUCTION

At present, the so-called centralized generation of electricity is most often used. Centralized production is a form of power generation, in which electricity is produced in large power plants, which are located at large distances from end users. The amount of electricity produced is based on statistics, which is based on electricity consumption in the past. After power generation, the power supply voltage transformed to a higher voltage level, in order to reduce transmission losses by lines. Voltage in the vicinity of consumers is transformed back to a lower voltage [1][2]. This can be seen in the Fig. 1 below.

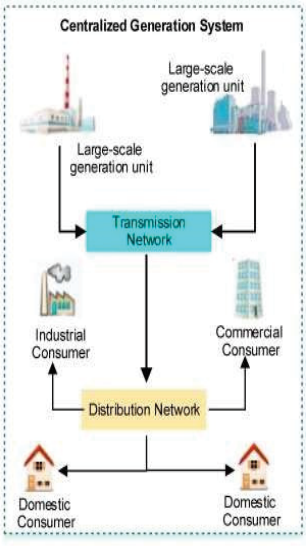

Fig. 1 Centralized generation system [3]

II. SMART GRID

In increasing the share of renewable energy sources is a classic centralized schema changes for decentralized production of electricity. Thanks to renewable energy sources it is currently economically profitable to produce electricity directly at the point of consumption. In the case of excess energy, it is also possible to store it for use when needed. New sources and new technologies are therefore increasingly appearing in the electricity grid. There is a need for new communication between such components. The electricity grid is transformed into a smart grid (SMART GRID). Smart Grid is shown in the Fig. 2.

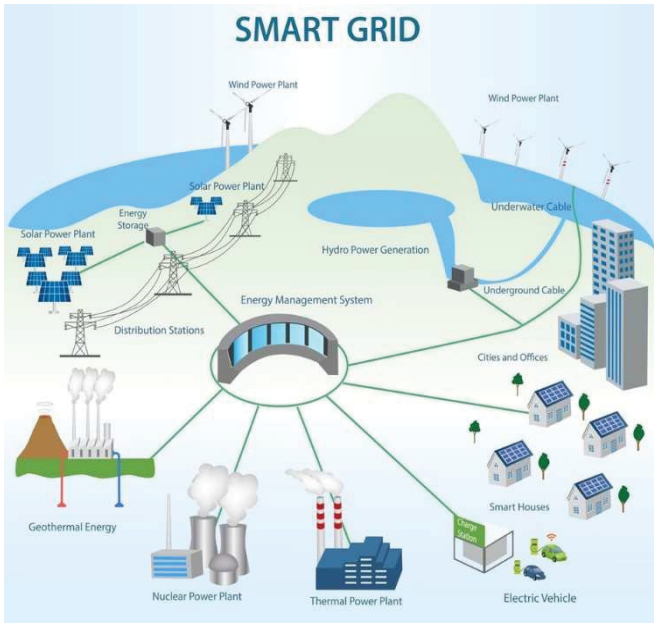

Fig. 2 SMART Grid [4]

The topic of smart grids is nowadays becoming increasingly topical, since electricity is needed to use most effectively. Energy must be transferred from production to the point of consumption with the least possible losses.

There are various methods how to reduce power losses in the networks. For example:

- usage of distributed generations,
- network reconfiguration.

In this article the first method will be described in more detail.

III. DISTRIBUTED GENERATION

Distributed generation refers to a variety of technologies that generate electricity at or near where it will be used. In applying distributed generation are commonly used renewable energy sources. Renewable energy sources are combined with heat and power plants. It is much easier to build small power plants than large power plants. It can be seen in the Fig. 1, that the electricity is produced with centralized method, but in the distributed generation it is produced with decentralized method, so the production is much more distributed in the networks [5][6]. This is shown in the Fig. 3.

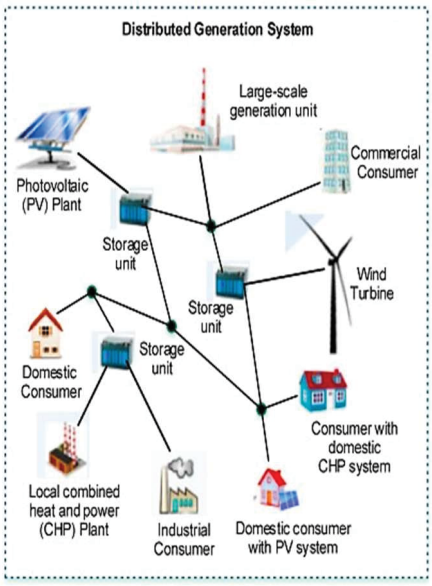

Fig. 3 Distributed generation system [3]

Typical distributed generation performance values are as follows:

- Hydro power plants
  - Small → 0.025 (MW) - 1 (MW)
  - Large → 1 (MW) - 100 (MW)
- Wind turbines → 200 (W) - 3 (MW)
- Solar power plants → 20 (W) - 100 (kW)
- Geothermal plants → 5 (MW) - 100 (MW)
- Biomass → 0.1 (MW) - 20 (MW),
- Battery → 0.5 (MW) - 5 (MW) [5][6].

The benefits of using distributed generations:

- reduction of power losses,
- improvement on electricity quality,
- improvement on system reliability,
- reduction of greenhouses gases emission,
- an emergency supply of power,
- reduction of peak power requirements,
- offsets to investments in generation, transmission, or distribution facilities that would otherwise be recovered through rates,
- provision of ancillary services, including reactive power [5][6][7].

Before application distributed generation, it is necessary to examine the network where to connect the new power plant to get the benefits described above. These cases may arise:

1. Determination of the optimal power (P, Q) of the power plant if the connection point is predetermined - for example, renovating an old power plant, or there is a place for photovoltaics because the best conditions are there. In this case, only the power of the plant can be changed.
2. Determination of the optimum connection point if the power output of the plant is predetermined - in this case the power is given - e.g. we want to connect batteries, biomass to the network, and only we can change where it is connected to the network.

To reduce the loss beyond the size of the installed power value, the method has some effect on what type of generator is used. The generator can:

1. Produce only active power – (P+),
2. Produce only reactive power – (Q+),
3. Produce active and reactive power – (P+), (Q+),
4. Produce active power but take reactive power – (P+), (Q-) [8].

IV. FUTURE RESEARCH

Further research focuses on setting up a computer program designed to calculate network losses based on input parameters. The loss-based program should determine the location of the distributed generations with optimization algorithm in order to reduce the losses and increase network stability.

ACKNOWLEDGMENT

This work was supported by the Scientific Grant Agency of the Ministry of Education of Slovak Republic and the Slovak Academy of Sciences by the projects VEGA No. 1/0372/18.

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