Study Committee C6

Active Distrubution Systems and Distributed Energy Resources

Paper ID 10855

A Research on Power Quality of Storage System in Photovoltaic Energy Generation Systems in Distribution Networks

Halil İbrahim AYDINÖZ

TEIAS

Motivation

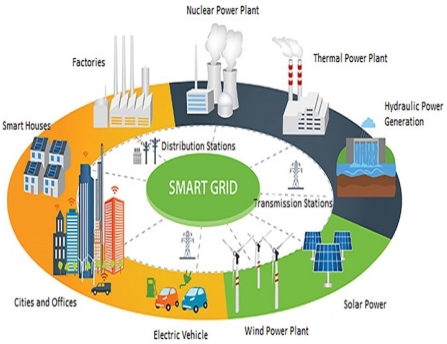
- Residential areas do not have the potential for far-reaching reasons for far-reaching comprehensive planning.
- Negative effects such as environmental pollution caused by supply and demand methods; makes it necessary to research and develop renewable, unlimited, environmentally friendly technologies and resources.
- The importance of energy storage systems is increasing day by day due to the fact that solar power plants are not close to the centers that demand energy, the production is not stable, they are affected by climatic conditions and the weather conditions cannot be predicted accurately enough.
- The aim of this study; First of all, it will be to see the effects of solar energy, one of the renewable energy sources, in a distribution network to be selected. It is the investigation of the effect of solar panels and energy storage systems that will be connected to the distribution networks later.
- Load flow was performed on the 30 busbar distribution network with the Newton-Raphson method in the PSS-E program, and then the voltage and power loss values of the distribution network were compared with the PV and ESS connected to the 3 selected busbars.

Smart Grid

In order to ensure mutual electronic communication between the producer and the consumer, smart meters and monitoring systems are added to the electricity networks, and it is an approach that should ensure user safety while monitoring and updating the electricity networks and providing reliable and high quality distribution.

Why do we need to transform the Classical grid into a "Smart Grid"? There are 3 reasons for us to make the classical grid smart;

- Increased energy needs:
- Reducing Losses:
- Production limit at existing facilities:



Energy Storage

Energy storage systems are active actors in the integration of renewable energy sources, which are of great importance today. It has an important place in maintaining a strong and reliable electrical system in the current situation. Energy storage systems allow the energy produced in renewable energy systems to be stored.
With this

- Power stability
- Integration into the network,
- Frequency
- Its use in various fields such as voltage management is rapidly becoming widespread.

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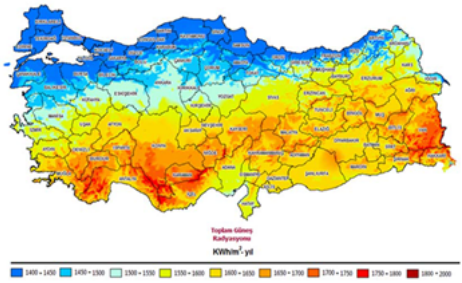
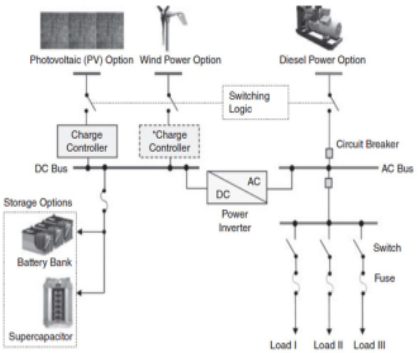


Total Solar Radiation Map for Turkey

In addition to the inability of solar panels to produce continuously during the day, the decrease in production capacity due to the change in the amount of solar radiation during seasonal changes affects the annual production amount. Therefore, ESS is an important complementary system for solar panels.



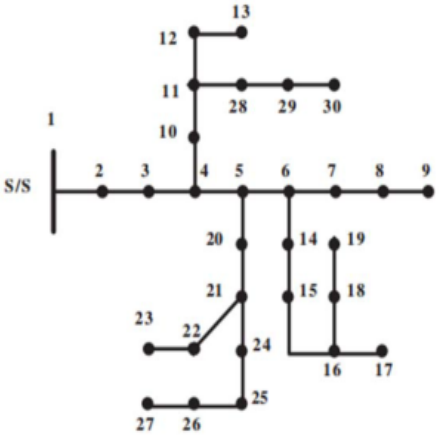
30 Busbar Distribution Network

It regulates the frequency response process as well as the network stability. Thus, it improves the fluctuations in power and increases the efficiency of renewable energy systems. As a result, it reduces greenhouse gas emissions. Many different storage systems are used in the realization of energy production. These;

- Mechanical Systems
- Thermal Systems
- Electrochemical Systems (Batteries)
- Hydrogen Storage Systems

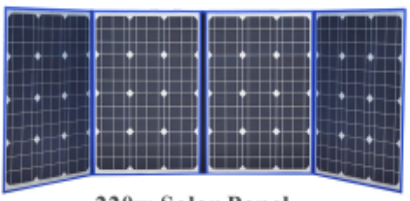
Materials and Methods

In this study, the effects of three generators connected to the 30 busbar distribution network given below with unlicensed generation on the distribution network were investigated, the changes in voltage levels and line losses were examined.



Use of Energy Storage Systems in Distribution

The panel used has a power of 220 W and consists of 52 cells. The panel voltage at the maximum power point is 26.8 V and the open circuit voltage is 33.8 V.



220w Solar Panel

First of all, the load flow program for the distribution network was run, and then solar panels with a power of 35,45 and 30 kW were connected to the 7th, 13th and 22nd busbars, respectively. Finally, energy storage systems with a power of 25, 30 and 20 kW are connected to the same busbars

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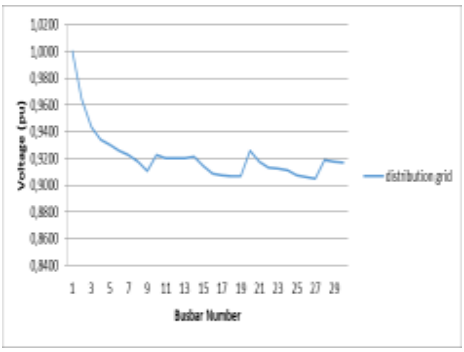
Simultion Results

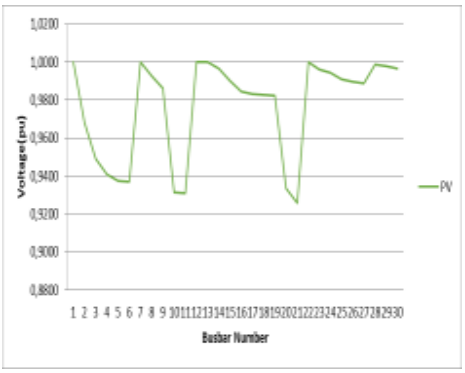
The voltage (pu) graphs of these results are given in Figure 3, Figure 4 and Figure 5, and a significant increase in voltage levels has been observed and the active power loss of 137,0 kW decreased to 107,2 kW and the reactive power loss of 72,9 kVAr to 59,1 kVAr. With the connection of the energy storage system to the grid, some voltage levels have been improved and power losses have decreased by approximately 4,8 kW and 3,9 kVAr.

Total Power Loss		
Distribution Grid	PV Connected Distribution Grid	PV and ESS Connected Distribution Grid
PL= 137,0kW QL= 72,9 kVAr	PL= 107,2kW QL= 59,1 kVAr	PL= 102,4 kW QL= 55,2 kVAr

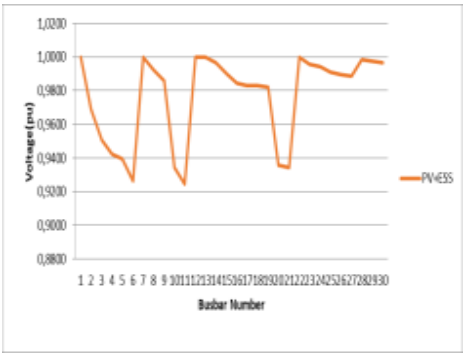
Load Flow Results



Voltage Levels(Distribution Grid)



Voltage Levels(PV Connected Distribution Grid)



Voltage Levels (PV and ESS Connected Distribution Grid)

Conclusion

- In recent years, with the legal regulations on bidirectional energy transmission and the abolition of the license requirement for the installation of renewable energy power plants below 1000 kW
- In this study, the effect of 3 generation power plants connected to the distribution network with unlicensed generation has been investigated, and the increase in voltage levels and the decrease in line losses are clearly seen.
- In the simulation studies with peak loads, the effect of the SPP and energy storage system on the distribution network was investigated and a significant increase in voltage levels and a decrease of approximately 20% in power losses were observed
- In addition to the installation of unlicensed SPPs in distribution networks, studies for ESS for solar panels, customizing the load profile, including demand management and electric vehicles are the subjects that can be studied in the future.
- Determining the optimum busbar to be installed for ESS and using it centrally has much more benefits than local systems.