

Advantages of Using Renewable Energy Sources in Smart Grids

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Abstract— An area whose development has increased rapidly has been the fields of information and communication technologies with the developing technology in recent years. It has always been the idea of integrating developing technologies traditionally into different fields. Electrical power systems is one of these areas. The integration of developing information and communication technologies into classical electrical power systems has revealed the concept of Smart Grids. The desire of the people of our age to reach the information they want with smart devices much faster than in the past has also been effective in this field. In today's technology world, the real-time information flow of smart grids between suppliers and consumers can be seen as a complementary element for both parties. The idea of using renewable energy sources as an alternative to fossil fuel sources is increasing in order to use the energy sources of smart grids and electrical power systems in the most efficient way. In this study, a review has been made about the advantages of using renewable energy sources and energy efficiency in smart grids. Therefore, this study is expected to be a supportive resource for researchers working on smart grids, which is an area of increasing interest.

Keywords— *Smart Grid, Renewable Energy Sources (RESs), Energy Efficiency*

I. INTRODUCTION

Energy is one of the indispensable elements for the continuation of the present situation today. The energy requirement is increasing day by day as it provides the basic fuel for heating, lighting, transportation and other vehicles. Since this increasing energy requirement leads to more energy consume, rapid depletion of resources, deterioration of the environment, and foreign dependence of countries in terms of energy. Depletion of existing resources and the need for new energy sources or reserves have become a frequently discussed issue. The world obtains most of its energy requirements from fossil fuels. However, the inability to use sufficient alternative sources over time has led to a rapid decrease in existing fossil fuel sources. Studies show that if this continues, fossil fuel resources have a short lifespan [1].

It is obvious that a livable world cannot be left to future generations unless the current production and consumption patterns are changed [2]. At this point, research of new energy sources have emerged.

II. RENEWABLE ENERGY SOURCES

The energies that can be found in nature, have no certain limit and are sustainable are called renewable energy. Renewable energy source; it is defined as the ability to renew itself at the same rate or faster than the depletion rate of the source as the energy taken from the energy source [3]. There are many renewable energy sources available today. These resources can be listed as solar energy, wind energy, geothermal energy, hydraulic energy, biomass energy, hydrogen energy, wave and tidal energy [4]. Today, nearly 85% of the world's energy demand is met from conventional energy sources such as oil, coal and natural gas [5]. However, many negative issues related to conventional energy sources have given a great impetus to the studies on clean and renewable alternative energy sources. Renewable energy sources play the most important role in reducing dependency on fossil fuels such as coal, oil and natural gas.



Fig. 1. Fig.1. Renewable Energy

A. Types of Renewable Energy Sources

- **Solar Energy:** It is the energy obtained from the sun, which is the source of energy for all planets in the solar system.
- **Wind energy:** It is the type of energy produced by converting the kinetic energy of the air into electricity by means of wind turbines.
- **Biomass Energy:** It is the name given to the energy obtained from the remains of living things that have not yet been fossilized.
- **Geothermal Energy:** It is the energy that is created by utilizing the heat accumulated in the depths of the earth's crust.
- **Hydraulic Energy:** It is the energy converted by using the energy of flowing water.
- **Wave Energy:** It is the mechanical energy created by the tides that occur in the seas and oceans.
- **Biofuel Energy:** It is a type of renewable energy obtained from fossil fuels [6].
- **Hydrogen Energy:** Hydrogen energy is the energy source formed by the processing and conversion of hydrogen gas, which is found in nature as compounds [7].

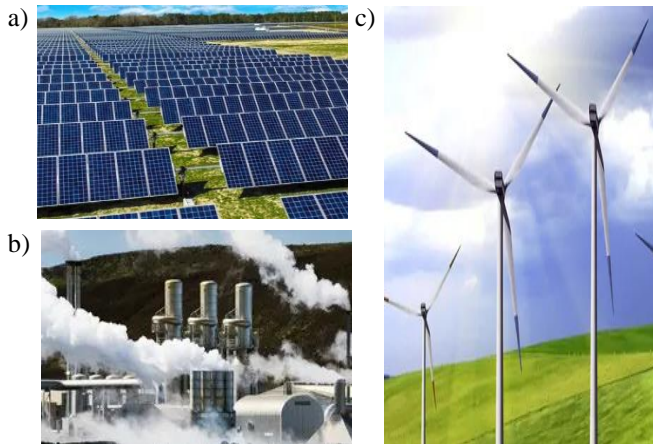


Fig. 2. Fig.2. a) Solar energy, b) Geothermal energy, c) Wind turbine

B. Advantages of Renewable Energy Sources

1. Renewable Energy Resources have many benefits for Health and Environment;

Renewable energy sources emit little or no polluting gases or greenhouse gases into the air. This means that renewable energy sources create a smaller carbon footprint [8]. For these reasons, other contributions of renewable energy sources to the environment are as follows [9].

- Having clean content
- Reducing air pollution
- Reducing water pollution
- Reducing the greenhouse effect
- Reduces core pollution

- Reducing soil erosion and protecting flora and fauna.

2. Being Renewable (Inexhaustible);

Resources obtained from the environment are used while generating electricity/power in facilities or power plants established using renewable energy technologies [10]. The fact that these energy sources are not exhaustible like fossil fuels is advantageous for the continuity of electricity production [11].

- Renewable energy sources being indigenous
- Increasing employment opportunities by developing the business area.

3. Saving by using Renewable Energy Resources;

The use of renewable energy sources saves money in the long run. Thanks to the use of technologies that generate electricity/power from renewable energy sources such as solar, wind or steam, no additional payments are made for operations such as refueling. At the same time, the maintenance and operating costs are lower in technologies using renewable energy sources [12]. For these reasons, the savings provided by renewable energy sources are as follows [11,13].

- Being economical
- Low external costs
- Supporting social and economic developments
- Contribution to energy efficiency
- Low fuel costs
- Low security costs
- Low operating costs
- Low cost of disposal of waste
- Low economic end-of-life dismantling costs.

4. Lower Maintenance Requirements;

Plants built using renewable energy technologies generally require less maintenance than generators. The main reason for this is that solar technology and the operation of wind turbines do not rely on flammable fuel sources. Less maintenance saves time and money [11,13].

C. Disadvantages of Renewable Energy Sources

1. Higher investment cost;

- Although the installation costs of renewable energy technologies have decreased, they are still at high levels. To combat this, incentives can often be used to reduce your renewable technology costs.

2. Intermittent service;

- Although renewable energies are available worldwide, most of these resources are not available 24/7 throughout the year. Some days are cloudier than others, the sun doesn't shine at night, and droughts can occur from time to time. What will disrupt these technologies may be changing weather events

and climate. Fossil fuels are not discrete and can be accessed and used at any time [13].

3. Storage capabilities matter;

- Due to the intermittent nature of some renewable energy sources, there is a great need for energy storage. Current storage technologies can be expensive, especially for large-scale renewable power plants [9,13].

4. There are geographical limitations;

- There are various climates, topographies, vegetation and many more different geographies in the world. This may lead to some disadvantages. For example, a large farm with open space might be a great place for a wind turbine or solar power system, while a townhouse located in a city shaded by tall buildings cannot reap the benefits of either technology [9,11].

D. Problems That Can Be Caused By The Use Of Renewable Energy Sources In Smart Grids

Energy is one of the indispensable elements for the continuation of the present situation today. The energy requirement is increasing day by day as it provides the basic fuel for heating, lighting, transportation and other vehicles. Since this increasing energy requirement leads to more energy consume, rapid depletion of resources, deterioration of the environment, and foreign dependence of countries in terms of energy. Depletion of existing resources and the need for new energy sources or reserves have become a frequently discussed issue. That's why today many governments are making great efforts to develop renewable energy sources.

But renewable energy sources are not without problems. Since renewable energy sources are not uninterrupted and difficult to predict, there are difficulties in integrating them into current electricity grids [14]. Therefore, it should be examined separately when integrating renewable energy sources into smart grids. Because the increase in semiconductor and power electronic devices to be used can cause serious problems in transmission and distribution systems in electrical networks [15]. As a result of this situation, harmonics can be produced, which can make the systems unstable.

Harmonics are defined as sinusoidal waveforms of different sizes that exist in a grid and have frequencies in multiples of the fundamental grid frequency [16]. Harmonics are becoming an increasing problem with the increase of non-linear load and semiconductor used in today's technology [17].

Although a single inverter causes low harmonic distortion, it has been observed that voltage harmonics increase significantly as a result of using a large amount of inverter [18]. Knowing the effects of harmonics, which have many technical and economic effects and analyzing them in enterprises, is extremely important both in terms of energy quality and continuity of the enterprise [19].

III. SMART GRID

Smart grids are networks formed by integrating information and communication systems into electricity distribution networks [20,21]. While integrating advanced computer and network technology into today's networks, the demands of users connected to these networks have not been ignored. Smart grids offer a sustainable, secure and energy efficient energy network. At the same time, it makes it possible for users to access information about the system by providing real-time two-way information transfer between suppliers and consumers at every stage from energy production to consumption [22,23].

The increase in the interest and demand for renewable energy sources and smart grids in electrical power systems at the same time has brought to mind that these two issues can combine at one point [24]. With the developing technology, smart grids have a large share in the configurations of future electrical power systems. Many studies have been conducted on using smart grids to make electrical power systems more efficient [25]. The main goal of smart grids is to use energy efficiently by reducing the rate of loss and leakage and to integrate the energy produced from renewable energy sources such as wind and solar into the system [26].

A. Energy Efficiency

The use of renewable energy sources in energy production has become a widespread alternative solution. However, the point reached in this field is not at the desired level due to the fact that energy production from renewable energy sources or the availability of alternative energy sources, the necessary systems and mechanisms, and the establishment of power plants take time and it's quite costly.

In this case, the question of how to find a solution other than producing more energy has become negotiable. Studies have been started to see if the present produced energy can be made more efficient without increasing the amount of energy produced. Energy efficiency does not mean producing less energy. This definition belongs to energy saving. In fact, energy efficiency can be summarized as using the available energy more wisely. Energy efficiency is the development/use of technology and software that need less energy to perform the same function.

Energy efficiency is to use the present produced energy in the most accurate way without a reduction in production and workforce. At the same time, it is not the amount of energy used, but the reduction of energy consumed per product.

IV. CONCLUSION

Smart grids provide reliable electricity supply with electricity generation, transmission and distribution systems. Conventional networks create many problems such as voltage and current harmonics, losses and interruptions, short circuits, low efficiency. These problems cannot provide the reliable,

clean and economical electricity that consumers need, so in recent years, smart grids have replaced conventional grids.

On the other hand, the world's energy demand has increased with the developing industrialization and increasing population. In order to meet the increasing energy demand, renewable energy sources have been used as an alternative in recent years, instead of fossil fuels used in energy production. Renewable energy sources now play a major role in power generation, and this article discusses the benefits and challenges of the effects of integrating renewable energy sources into smart grids.

Renewable energy sources have a smaller carbon footprint compared to fossil fuels. Therefore, it emits very little greenhouse gas or polluted gas into the environment. The clean content of renewable energy sources reduces air and water pollution, greenhouse effect and core pollution. In addition, electricity generation facilities that will produce energy using renewable resources are economically advantageous in terms of low cost after the first installation and require relatively less maintenance and repair activities. Thus, with the integration of renewable energy sources into smart grids, many benefits are provided for health and the environment, the power generation systems built around the sources provide advantages such as the creation of new business areas and increased efficiency, reduced losses, low cost for consumers, safe and sustainable electricity.

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