

Recent Advances of Hydropower Energy in Saudi Arabia

Khalid A. Althobiti¹, Ahmed M. Nahhas^{2,*}

¹Department of Distribution Network Planning, Saudi Electricity Company, Makkah, Saudi Arabia

²Department of Electrical Engineering, Umm Al Qura University, Makkah, Saudi Arabia

*Corresponding author: annahhas@uqu.edu.sa

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Abstract This paper presents the recent advances of the hydropower energy in Saudi Arabia. The hydropower energy is one of the renewable energy power resources. It is used in the generation of the electrical power in different areas of the world. The hydropower is a clean and environmentally friendly source of energy. Recently, the hydropower energy is used to generate electricity and heat around the world.

Keywords: *hydropower energy, hydroelectricity, heat, renewable, environment, electricity, Saudi Arabia*

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1. Introduction

The need of electricity is growing in every aspects and field in the life. The world has insufficient oil reserves that will be dropped in the near future. In 2015, hydropower generated about 16% of the world's total electricity and 70% of all renewable electricity [1]. It is one of the renewable energy resources and less dangerous to the environment compared to the thermal power plants that are powered by organic fuels (coal, oil ...) or nuclear [2].

In general, the generation of this type of energy is very cost-effective, with an output of 80%-90% and more. The largest capacity of a hydroelectric power plant currently stands at 18 GW in the Great China Dam. The only method currently used to store electrical energy, which is commensurate with the vast amounts of energy stored and recovered, is the method of pumping water to an overhead tank when there is excess production and then using that stored water to generate energy at peak demand [3]. However, the electricity production from hydroelectric sources (kWh) in Saudi Arabia was reported at 0 kWh in 2014 [4].

2. Literature's Review

The hydropower is an important trend in most countries to produce electricity from water. Electric energy is a necessity of life, without its existence in our daily life depends on much of the progress of nations, not only progress has stopped but we will return to life for many decades, where electricity was It is a fantasy, and it is known that the use of electric power in the world is now so great that it threatens the extinction of the energies used in the generation of electric power [5]. It is also known

that the electric power is the generated by non-renewable energies and can be accessed at any time [6,7]. The world has sought to create opportunities for non-renewable energies that contribute to the generating of electricity extensively, eliminating the risk of the demise of this electricity generating energy, and there are many renewable energies that are currently used in the production of the electricity and contribute to the generation of the electricity [8]. The hydropower represents about 97% of the electricity generated by renewable energies around the world [9]. The hydropower is the source of the electricity for millions of people in the southern part of the desert of Africa. The waterpower could become a source of the electricity for 2.4 million people in different poor countries by 2025 [10]. The energy is a great opportunity, but it poses complex challenges, varying according to the type, location and size of the project [11]. The good management of the hydropower projects also helps to improve the management of the water resources locally; Services for irrigation and flood control; which will result in reducing the impacts of climate change and adapt to it [12]. The hydroelectricity is defined as the hydroelectric power used to generate the electric power. The potential energy in water is utilized in the form of the mode energy and converted to another type of energy, kinetic energy, which is later converted into electrical energy [13]. It is characterized by the fact that it is renewable and inaccessible energy, as it is clean energy that is not polluting the environment, and this has prompted many countries to use it extensively in the process of the generating electricity [14].

3. History of Hydropower Energy

The technology of the hydropower has long history and it used for many centuries. It was first exploited in the

Empire of Rome, where it was used for the purpose of operating flour mills and grain production in many regions of Egypt. Later, it was exploited in China and various other countries of the Far East [15]. In Wales, the Dolaucothi Gold Mines, a wave of water from the reservoir was used to extract the mineral ores in a way known as silence and developed in Spain in mines such as Las Medullas. In the eighth and the thirteenth centuries, the world has witnessed a great development and the use of hydropower, reaching a large stage in this area is the production of the hydropower, where the use of the hydropower in very simple things, and it was used in the work of the machines used during the process of the irrigation. The designs of 50 hydropower devices were described by the Islamic mechanical engineer of the island (1136-1206) in his book "Knowledge of innate mechanical devices" [16]. In 1753, French engineer described the vertical and horizontal-axis hydraulic machines [17], and in the 1830s the use of hydropower reached the peak. During the eighteenth and nineteenth centuries, the development has increased until the extent of this area to the use of the hydropower to generate electricity in different ways [18]. Since the early twentieth century, the importance of the hydropower has expanded to become the number one source of renewable energy [19]. In 2018, in the United States, hydroelectricity accounted for about 7% and 41% of the total utility generation in the state and utilities from renewable energy sources, respectively [20].

Today, using generators and turbines, modern hydroelectric power plants produce electricity. When turbines move water, they produce mechanical energy, and hydropower is used to generate power and electricity [21]. Recently, Paraguay and Brazil own the 12,600 MW, the world's largest hydroelectric power plant, followed by Venezuela's Power Plant, the world's second largest, producing about

10,300 MW. Washington also has the largest hydroelectric power plant in the United States which produces 7,600 MW [20].

Many believe that the use of hydropower for this purpose is its latest use, but the fact that the latest use of hydropower to this day is the use of water in chopping things by momentum. Sometimes there are factories with cutting machines that rely on cutting things with the force of water, and this makes it easier for us to realize that there are many new uses that will come to appear in the near future [22].

4. Types of Hydroelectric Power

The hydropower is divided according to the method used to produce the electricity from water into two main types [1,2,17] as shown in Figure 1. The first type depends on the production of hydropower on power plants that rely on water falls from high places [18]. They benefit from the power of the falling water from the highlands and for this reason dams are set up in all major river streams to facilitate the process of controlling and storing water on demand from electricity, while the second type is the production of hydropower which is used to produce electricity from flowing water in rivers [16]. The energy produced from the use of river water flow is much less than the electricity produced from the use of high watersheds, and the first type, the use of high-rainfall has a great advantage distinguishes it from the other type in the possibility of controlling the hydropower produced by Boa Plan electrical power plant where the dams to store water in reservoirs high above the ground level, making it suitable for the production of electrical energy when needed. The first type is therefore widely used around the world, which depends on the use of high watersheds and dams [23].

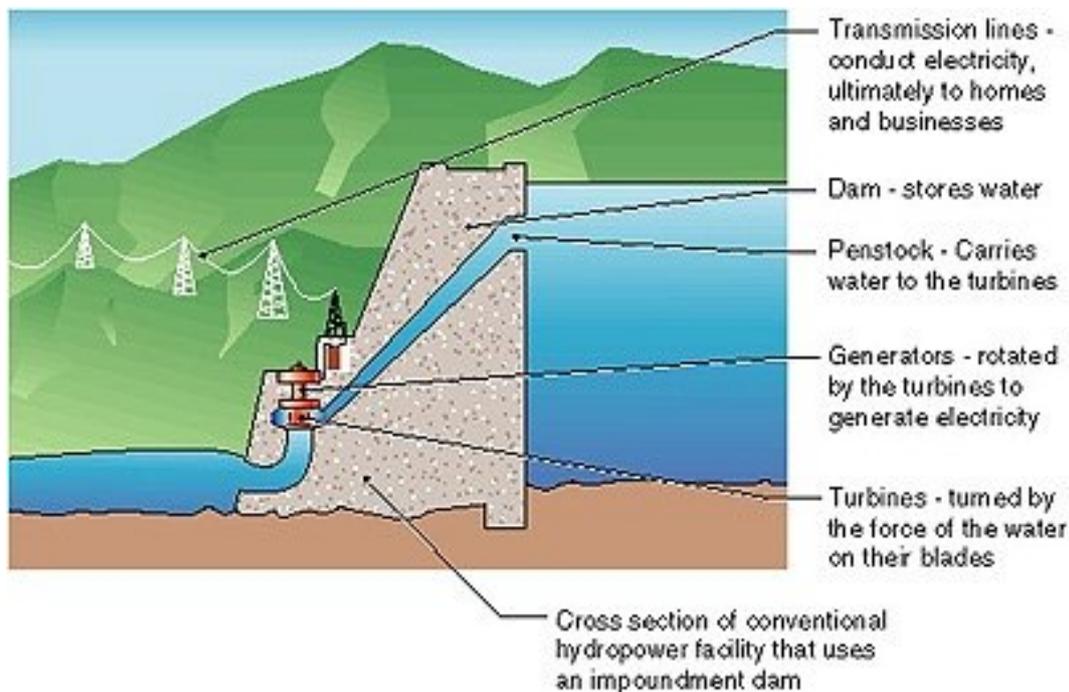


Figure 1. Types of hydroelectric power

5. Methods of Hydroelectric Power Generation

The generation of the electric power through the hydropower is very simple scientific, the idea is to search for the energy contained in water and it convert it to electricity [24] as shown in Figure 2. It is known that the easiest type of energy can be converted to direct electric energy is kinetic energy, and in the research found that water located in high places inside the dams contain a large amount of mode energy that is easily converted into kinetic energy when water falls Down, and then use that tab Kinetic energy to run a turbine, and then take the kinetic energy generated in the turbine and converted to electricity by an electric transformer, and so this process is called hydroelectric power, and the kinetic energy produced depends on the height of the water, also depends on the amount of water [25]. The gravitational force that increases the speed, and also the higher the higher the energy of the situation, which led to an increase in the amount of movement energy produced and then increase the speed as well, and increase the speed in both cases increase the movement of the turbine and then increase the electrical energy generated by the transformer [5]. The production of the hydroelectric power is much more than the situation in dams, where there are two factors: the

amount of water and the high altitude. The efficiency of the turbine, the electric transformer and the energy lost from the friction of water cannot be neglected [26]. China has the highest hydroelectric power plant with a capacity of 18,000 MW and is in the world's most famous dam, the Great Dam of China [27].

6. Worldwide Usages

The use of the hydropower and its dependence has become essential in many countries around the world, where the production of the hydropower has become very huge to reach 19% of the total electricity produced globally and to 90% of the total electricity produced by renewable energies [28]. The world's use of this type of energy has increased for its cleanliness and being environmentally friendly, as many countries in the world run by rivers and contain many dams that facilitate the production of this type of energy, and when talking about the countries used for this type of energy to generate electricity [29]. All countries have river dams, and there are other countries that produce this type of energy by sea and oceans, especially in areas characterized by strong winds that can move sea water and thus obtain kinetic energy that is easily converted to electrical energy [30].

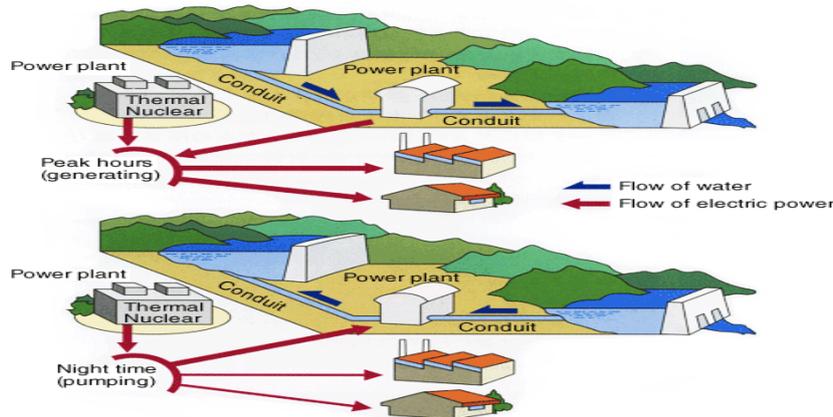


Figure 2. Methods of hydroelectric power generation

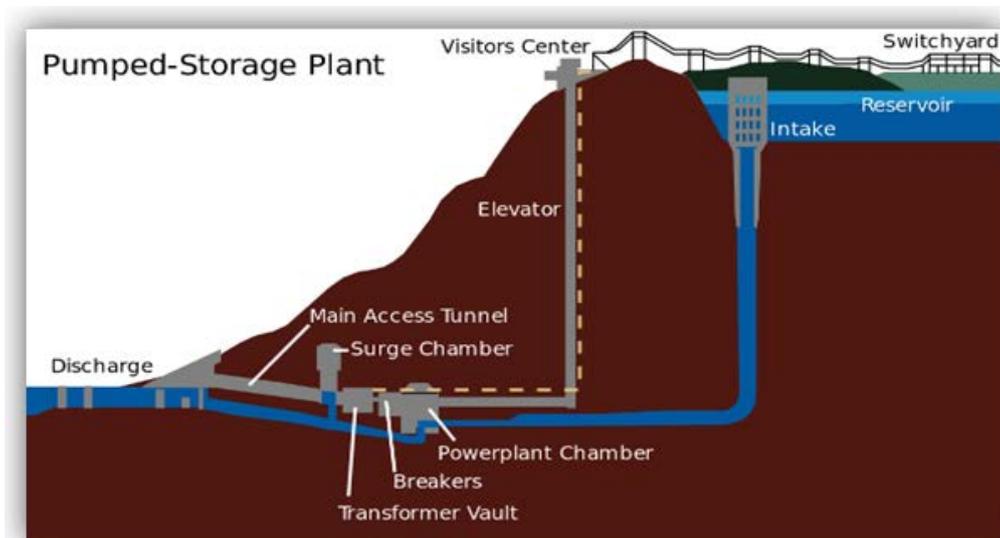


Figure 3. Methods of hydropower storage

7. Methods of Hydropower Storage

It is often believed that the electricity produced from the hydroelectric power plants is consumed as soon as it is produced [31]. This is a misconception that there is a large surplus of the electricity produced varies depending on the consumption of the country owning the power plant and therefore there is a problem faced by the country because of excess electricity is consumed, but found a solution to such a problem is the use of that electricity generated in the production of electric power later. In other words, this electrical energy is stored as another energy that is easily converted into electricity again [43]. It was found that the best way inside the power plant itself is to store that surplus electrical energy in the form of energy put back again by using it to raise water back to a high reservoir of water that has potential energy inside it in the form of energy put again. This process is based on the country's consumption, it can be daily if the consumption of the country is small and the surplus is large, and can be monthly or quarterly when the surplus is low, and this process is called the process of pumping and storage of hydropower [32] as shown in Figure 3.

8. Benefits of Hydropower

There are many varied benefits of hydroelectric power generation. These benefits start with the most important one: that the production of hydropower is not polluting the environment is a clean energy as hydropower does not produce any residues and not just emission of air pollution gases, but it is completely clean energy. In addition, they are constantly renewable and inaccessible [20]. This energy saves enormous costs to purchase fuel used to generate electricity. At the same time, it requires little cost to maintain, and the benefits that make us look at this type of energy [33]. It is a wealth that came from nothing, as countries are basically building dams to control and control water when a flood occurs, but these dams are simply used to produce hydropower [9]. Hydroelectric power plants are known for their optimal performance among all other types of energy [2]. Also, an abundance of hydroelectric production makes more investors at ease from their fear of electricity shortages in other countries [3]. Therefore, the abundance of hydropower attracts industry to the country.

9. Hydropower Damage

In spite of the many and varied benefits of hydroelectric power, it has at the same time negative effects on human life, as water reservoirs arise on large areas of land that are distinct from others in that they are land on a riverbed, and therefore have high soil fertility [34]. The waste of this vast area of this excellent land for agriculture is detrimental to the plant environment in human life, and each of us is aware of the inevitable danger facing fisheries because of these dams, especially those that use high watersheds, and sometimes increases the risk to fish when the dams work on Raise the water net temperature. Hydroelectric power plants are particularly negative for both animal and plant life, as well as directly affecting wildlife [7].

10. Hydropower in Saudi Arabia

Although the continent of Asia is one of the places with rapid economic growth [35], but the continent so far suffers from many problems and the most important problem of poverty in all, including poverty in energy, where almost half of the population of the continent does not have access to electricity and the number of people Electricity reaches 600 million people living on this continent [36]. Asia is a continent with huge rivers that facilitate the production of hydropower. So, the continent has been turning to renewable energy sources [35]. The total electric power produced from desalination plants in 2016 reached its highest level (about 43 million) MW per hour compared to 2010, where the total produced electricity was approximately 24 million MW per hour [37]. The total electric power produced from desalination plants for licensed companies, including the Saline Water Conversion Corporation, reached its highest level in 2016, reaching about 95 million megawatts per hour compared to 2010, where the total produced electricity was approximately 54 million megawatts per hour [36]. Statistics from the General Authority for Statistics showed that during the period from 2010 to 2016, the use of electric power from desalination plants showed a remarkable development in the increase of production, wherein 2010 was about 24 million and 305 thousand megawatts per hour and in 2016 it became about 42 million and 946 thousand megawatts per hour [38] as shown in Table 1 and Table 2. The desalination plant located in the city of Ras Al-Khair is one of the higher of hydropower producing cities, with an average production of 18 million 977 thousand megawatts per hour in 2016 [39]. This was followed by the city of a desalination plant in the city of Jubail, where the production of about 10 million and 366 thousand megawatts per hour, followed by the desalination plant located in the city of Al-Khair, which produced a production of about 5 million and 453 thousand megawatts per hour [40]. Saline water in Al-Khafji city is the least hydroelectric power plant in 2016, with 45 thousand and 410 MW per hour [41] as shown in Figure 4 and Figure 5.

Table 1. Total hydroelectric power produced from the General Establishment for Water Desalination saline (GWH)

year	Total hydroelectric power in Saudi Arabia
2012	23283247
2013	24170023
2014	29046177
2015	36274913
2016	42946651
2017	45236295

Table 2. Total electric power produced from desalination plants for licensed companies including Saline Water Conversion Corporation (SWCC) between 2012 to 2017 in Saudi Arabia

year	Total hydroelectric power in Saudi Arabia
2012	61915200
2013	63903887
2014	69872817
2015	79575447
2016	94877855
2017	113348641

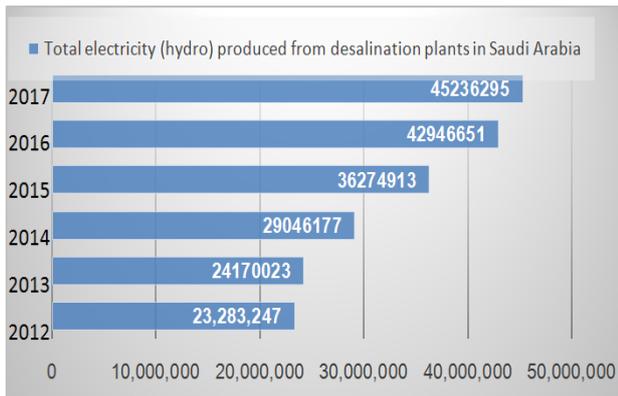


Figure 4. Hydroelectric power between 2012 to 2017 in Saudi Arabia [42]

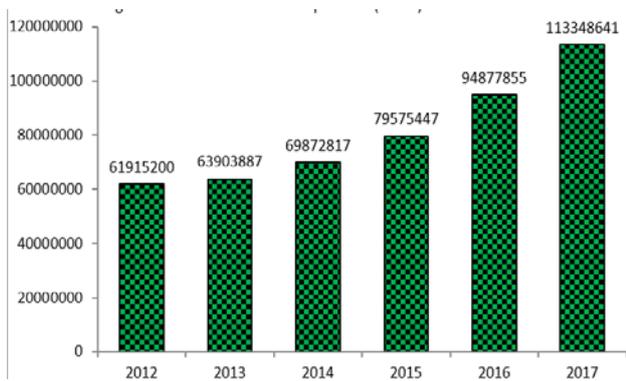


Figure 5. Total hydroelectric power produced from desalination plants for licensed companies including Saline Water Conversion Corporation (SWCC) between 2012 to 2017 in Saudi Arabia [42]

11. Conclusions

The trend of the world towards renewable energy has become a necessity that the world's countries must turn to it because of the non-renewable energy sources running continuously over time, and when the world turns to renewable energy, especially used in the production of electric energy, you only find hydropower not because it is the only type, but it is the largest type on the other types of renewable energies that produce electricity [8]. The hydropower is being used in Saudi Arabia to produce electricity. Several dams were built to benefit to from the production of this type of energy. On the other hand, but there are many negative effects of the hydropower in Saudi Arabia, especially on the wildlife and animal life as well as plant life.

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