Chapter 13

Energy Resources and Energy Conservation

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Energy and the Importance of Energy

Human and environment are inseparable parts of a continuous whole and the balance between human and environment has been going on for millions of years. However, especially since the 19th century, with the transition from the living conditions provided by nature to the living conditions created in line with human needs, many problems have been encountered in the relationship between human and environment. With the globalization of environmental problems, human beings have realized that they are rapidly consuming natural resources and have searched for different energy resources.

The word energy is derived from the Greek words en (in) and ergon (work). In its most general form, the ability of a substance or system of substances to work is defined as energy (EIA, 2020a; Spurgeon & Flood, 2014). In the scientific literature, energy is defined in different ways because it is an interdisciplinary concept. According to chemistry, energy is stored in the chemical bonds of atoms and molecules and occurs due to the arrangement of the molecules in the matter. Energy for physics; It causes objects to move or change and is the capacity of matter to do work. According to biology, energy is a cycle between living beings that take its source from the sun (Karaca & Göktan, 2007; Kurnaz, 2007; Spurgeon & Flood, 2014; Trefil & Hazen, 2004). Energy is seen as one of the most basic needs of all societies today and is accepted as one of the most important indicators of development by the world countries.

Today's rapid population growth, changing technology and development processes in industrial activities rapidly increase the energy needs of all countries. The concept of energy, which is closely related to the economic and political development level of countries, is seen as one of the basic inputs of all systems that a nation will establish for its economic and social development. Energy, which is seen as a basic need, has become one of the most important factors in determining the policies that countries should follow. But today, a significant part of the energy production in the world is obtained from non-renewable energy sources, most of which are fossil fuels. However, the fact that fossil fuels will be depleted in the near future, causing serious damage to the environment, and the encouragement of environmentally friendly and innovative technologies in accordance with the Kyoto Protocol, directs countries to renewable energy resources

(Boz, 2020; Fırat, Sepetçioğlu, & Kiraz, 2012). Therefore, clean, renewable, continuous and quality energy sources are needed to ensure a sustainable development and to prevent foreign dependency in energy.

Types of Energy

Energy appears in different forms in our daily life. According to the I. law of thermodynamics, the total amount of energy in a system remains constant. This law that states energy cannot be created or destroyed but may be changed from one form to another. Taking advantage of this law, energy is produced in different forms such as heat, light, nuclear, chemical and electrical energy in order to continue our daily activities. However, energy is generally examined under two headings, potential and kinetic. Potential energy is the energy an object has due to its position. Kinetic energy is defined as the energy that the object has due to its motion. The sum of the kinetic energy and potential energy of a system is called mechanical energy (Çengel, Boles, & Kanoğlu, 2019; TÜRÇEV, 2014). According to another classification, while potential energy is stored energy and positional energy, kinetic energy is defined as the energy resulting from the movement of waves, electrons, atoms, molecules, substances and objects. Potential and Kinetic energy types are summarized in Figure 1 (EIA, 2020b).

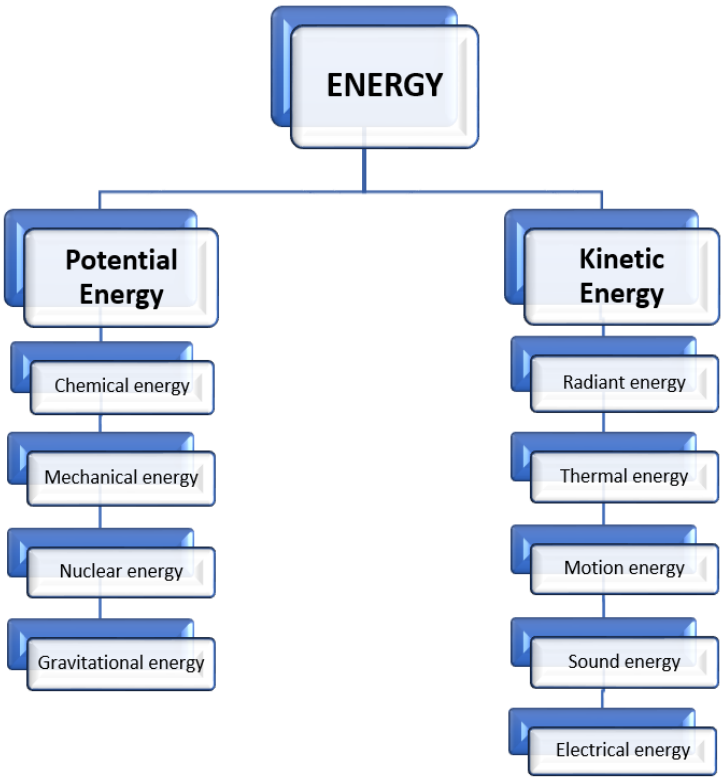


Figure 1. Types of Energy

One of the potential energy types is chemical energy. This energy is stored in the bonds of atoms and molecules. Mechanical energy is stored in objects by tension and Nuclear energy is stored in the nucleus of an atom the energy that holds the nucleus together. Gravitational energy is energy an object has because of its position or height. One of the kinetic energy types, Radiant energy, is explained as electromagnetic energy that travels in transverse waves. Thermal energy is the energy that comes from the movement of atoms in a substance. Motion energy is energy stored in the movement of objects and Sound is the movement of energy through substances in the form of compression waves. Electrical energy is provided by tiny charged particles called electrons, typically moving through a wire (EIA, 2020b).

Energy Literacy

Partnership for 21st Century Learning (P21), a strategic education project, explains the skills that individuals are expected to acquire in the 21st century. Energy literacy skills are among the main topics of 21st century skills in this project (Gelen, 2017). The concept of energy literacy is basically based on the Theory of Planned Behavior first put forward by Fishbein and Ajzen (1975) and developed by Ajzen (1985; 1991).

Energy literacy describes the awareness and competence individuals need to make conscious choices and pay attention to energy conservation. This concept also expresses a broad content knowledge about affective and behavioral dimensions (DeWaters, Qaqish, Graham, & Powers, 2013; Lay, Khoo, Treagust, & Chandrasegaran, 2013). Energy literacy is defined as making conscious choices about energy in daily life, both affectively and behaviorally. Energy literacy; to understand the role of energy in the universe and our lives, to find answers to questions about energy with this understanding, to solve problems related to energy (Boz, 2020; DeWaters & Powers, 2011; Öykün & Abbasoğlu, 2017). Energy literacy is also to pay attention to the efficient use of energy resources, to have knowledge about the production and consumption of energy, and to realize the environmental, social and global effects of energy use (Fah, Hoon, Munting, & Chong, 2012).

Classification of Energy Resources

Resources that obtain energy economically with different methods are named as energy resources. Energy resources are examined under two separate titles according to their convertibility and usability (Figure 2). Energy sources are classified as primary and secondary energy sources according to their convertibility, and as non-renewable and renewable energy sources in terms of their use (Koç & Şenel, 2013).

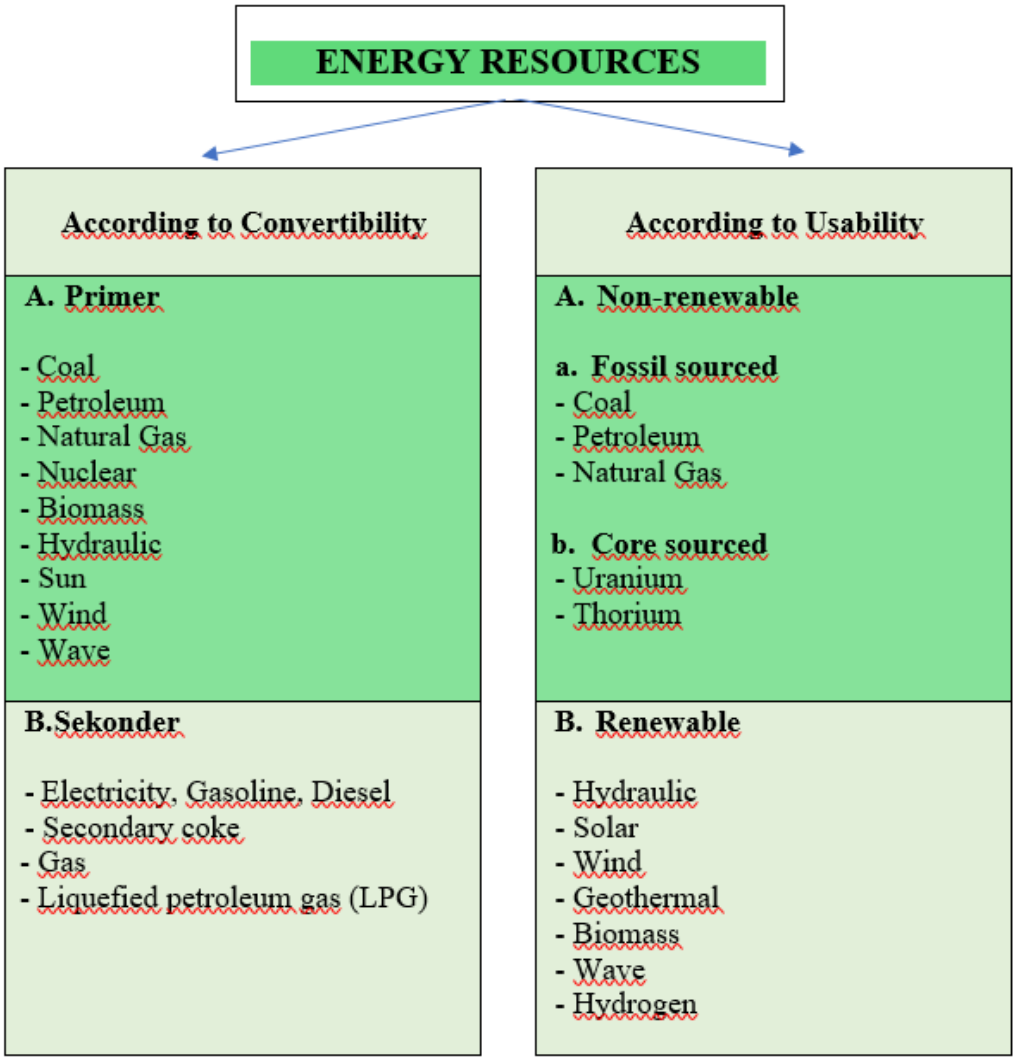


Figure 2. Classification of Energy Resources

Primary and Secondary Energy Sources

The form of energy that has not undergone any change or transformation is defined as primary energy (Koç & Şenel, 2013). Primary energy is the resources that occur due to various chemical reactions, occur within the functioning of nature itself, and can be used without any cycle other than separation and cleaning. Examples of these resources are coal, petroleum, sunlight, natural gas, nuclear energy, biomass energy, tidal energy, wind energy and stream energy. Secondary energy is the energy obtained by transforming the primary energy. For example, electricity, gasoline, diesel oil, coke, petroleum coke and liquefied petroleum gas are secondary energy sources, which are made available for use as a result of the conversion of primary resources such as coal, petroleum, natural gas, sun, water and wind (Aydın, 2014; Koç & Şenel, 2013).

Non-Renewable and Renewable Energy Sources

In another classification of energy resources, the existing reserves or stocks of the

resources in nature are taken into account. In this classification, resources are classified considering their exhaustibility or renewability at the end of use. According to this classification, energy resources that do not renew themselves when used are defined as non-renewable energy resources. Unlike non-renewable energy resources, energy resources that do not decrease despite being used and that can remain in a natural cycle process without being exhausted are called renewable energy resources (Koç & Şenel, 2013; Koç & Kaya, 2015).

Non-Renewable Energy Resources

There is no type of energy that cannot renew itself in nature. However, as a result of the ways in which some energy resources are formed, it takes a very long time to be renewed. These resources, which take a long time to renew and are rapidly exhausted, are called non-renewable energy resources (Soral, 2020). Non-renewable energy sources are divided into two as fossil-sourced and core-sourced. Coal, petroleum and natural gas are fossil-based non-renewable energy resources and uranium and thorium are core-sourced non-renewable energy sources (Koç & Şenel, 2013; Koç & Kaya, 2015).

a. *Coal*

Coal is a sedimentary rock consisting mostly of carbon (C), less hydrogen (H), oxygen (O), sulfur (S) and nitrogen (N) elements, composed of vegetable origin organic substances and inorganic components. It is formed as a result of the accumulation of plant and tree residues in the swamps and the chemical and physical changes over millions of years. Coal occurs as a result of physical (pressure, precipitation, etc.) and chemical events (heat, decay and transformation, etc.) called the carbonization process (TKİ, 2020).

Coal, one of the oldest known energy sources in the world, has increased its use with the invention of steam machines after the industrial revolution. Nowadays, with the increase in the use of natural gas and petroleum, the use of coal is decreasing day by day. On the other hand, coal is still widely used in Turkey for electricity generation and heating purposes (Özkan, 2020). A very small part of our country's coal resources are considered as reserves. The exploration and reserve development studies conducted in recent years have yielded results and the coal resources have increased significantly. The total coal resource in Turkey is approximately 20.84 billion tons (MTA, 2020; TKİ 2020).

Coal is an inexpensive energy source that is relatively easy to discover and extract compared to other energy sources. Another advantage of coal is its reserves spread over a wide area around the world. It is stated that the proven coal reserves in the world are much more than the sum of both petroleum and natural gas reserves. Despite these advantages, when coal is burned, it releases more carbon dioxide than all other fuels. In addition to causing intense air pollution and playing an important role in global warming,

coal is an energy source that has negative aspects such as expensive filter systems and an extensive transportation network (Torunoğlu Gedik, 2015). As a result, although coal is a fossil fuel that offers a financial advantage, it cannot be ignored that it has negative environmental effects. Although these problems are reduced with the help of better technologies, they cannot be eliminated completely (Kerimoğlu, 2020).

b. *Petroleum (Oil)*

Petroleum occurs naturally from animal and vegetable wastes in deep sediment deposits. It is a generally dark, viscous and foul-smelling hydrocarbon substance (McLeroy & Caudle, 2019). The word petroleum is a combination of the Latin words petra, meaning stone, and oleum, meaning oil. Refers to unprocessed crude oil extracted from underground (Öztürk, 2013). The term "crude" in the expression of crude oil indicates that it is a raw material and has not yet been distilled. Crude oil is distilled in refineries and transformed into many intermediate products and fuel oil products we use in daily life (Akpınar, 2007). Dead plants, algae, and plankton are subjected to intense heat and pressure among tons of rocks and sediment with virtually no oxygen. The organic matter here becomes a waxy substance called kerogen. With more heat, time, and pressure, kerogen is converted into hydrocarbons through a process called catagenesis. Different combinations of heat and pressure create different hydrocarbon forms. Fossil fuels such as coal, natural gas and petroleum emerge with the drying of the seas and the remaining dry basins (National Geographic, 2018). Crude oil is found in liquid form under the earth's crust in underground pools, reservoirs, small areas in sedimentary rocks and tar sands. In addition, most of the petroleum deposits are trapped in natural rock pores at depths between 150 and 7600 meters above the ground surface. After the petroleum is extracted from underground, it is sent to the refinery for separation into different petroleum products such as gasoline, diesel fuel, jet fuel, petrochemical raw materials, waxes, petroleum and asphalt (EIA, 2021; McLeroy & Caudle, 2019).

Petroleum, one of the most valuable fuels in the world, contributes to the increase of social welfare by facilitating the transportation of people and goods. In addition, petroleum products such as gasoline, diesel, LPG contain more energy than other fossil fuels, and are more easily stored and transported (Onur, 2006). Therefore, petroleum and petroleum products have a very important place in human life as an energy source (The World Bank, 2009). However, since petroleum is a fossil fuel, it causes environmental pollution in exploration, extraction, transportation and use processes. Threats the ecological balance by accelerating the global warming process (Mosbech, 2002). As another disadvantage, petroleum reserves are limited in the world. The concentration of these reserves in a certain region brings security problems for the countries of that region (Kerimoğlu, 2020).

c. Natural Gas

Natural gas is a mixture of hydrocarbons mainly composed of saturated light paraffins such as methane and ethane. It is a flammable, colorless and odorless gas mixture that also contains other hydrocarbons such as propane, butane, pentane and hexane. It is formed as a result of bactericide, kerogenization and thermal decomposition in organic materials in the lower layers of the earth. Generally, natural gas contains significant amounts of hydrogen sulfide or other organic sulfur compounds. It is known as "sour gas" for this reason. However, after desulfurization, a small amount of fragrance is added to the natural gas to ensure that any leakage that may occur in transport or use is detected (Carruthers, Solomon, Atwater, Riva, & Waddams, 2019; Devold, 2013). The formation of natural gas requires a similar process to petroleum and natural gas is a derivative of oil. But the geological conditions that create natural gas are more difficult than petroleum. While liquid petroleum can be found at a certain depth, there is no depth limitation for gas reserves. Natural gas is usually found dissolved in petroleum at high pressures in a reservoir. It emerges as a gas layer on top of petroleum (Carruthers, Solomon, Atwater, Riva, & Waddams, 2019).

Natural gas is seen as one of the most important energy sources used almost all over the world today with industrial development, urbanization and increase in population. Natural gas is the most energy efficient fossil fuel. It is a cleaner energy source due to its lower carbon content. Natural gas offers significant advantages to users in terms of efficiency and cost (Bayraç, 2009). As a result of its use, carbon dioxide (CO_2) and sulfur dioxide (SO_2) gases, which are composed of basic polluting gases, are not released (Hayhurts & Lavrance, 1992). In addition, natural gas does not have a serious effect if it is inhaled for a short time. Because it is lighter than air, it tends to rise in the atmosphere. With this feature, it rises to the air in case of leakage and does not pollute the underground water resources (Akpınar & Başıbüyük, 2011). However, although it is cleaner than other fossil fuels, when natural gas is burned, it emits greenhouse gases that cause global warming. Another disadvantage of natural gas is its limited reserves. As a result of the increase in demand for natural gas, it is predicted that natural gas reserves will be depleted in a shorter time than expected (Kerimoğlu, 2020; Montgomery, 2014).

d. Nuclear Energy

Nuclear energy is a type of energy produced from atomic nuclei. By bombarding heavy radioactive elements with neutron, atomic nuclei are fragmented (fission) or light atomic nuclei are combined (fusion). As a result of these events, a significant amount of energy is released. This energy is called nuclear energy or core energy (Altın, 2004; Doğanay & Coşkun, 2017). Nuclear energy is called as an alternative source in some documents. However, nuclear energy is a non-renewable energy source whose raw materials are

radioactive elements such as uranium, plutonium, thorium and which are limited in the world (Gezer, 2013). Uranium and thorium are the main raw materials of nuclear energy. These radioactive elements are not found freely in nature and form different compounds (Mahmutoğlu, 2013). During the reaction, a neutron strikes the nucleus of Uranium and a typical fission reaction takes place in the nucleus. The fission products emerging as a result of this first stage collide with other atoms and most of the motion energy is converted into heat energy. This heat is used to generate electricity (TAEK, 2010).

Today, nuclear power plants are seen as a cheaper, reliable and sustainable energy source compared to other energy sources and they are preferred by many countries. Nuclear power plants can generate electricity by operating continuously without being affected by weather conditions. One of the most important features of nuclear power plants is that they do not emit greenhouse gases. Therefore, electricity generation from nuclear energy helps to eliminate the accelerating effects of global warming caused by fossil fuels (T.C. Enerji ve Tabii Kaynaklar Bakanlığı, 2021a). In addition, Uranium reserves are found in many different parts of the world. Therefore, nuclear energy offers significant advantages in terms of fuel supply, cost, amount of use and storage facilities (Montgomery, 2014). Nuclear power plants reduce a country's dependence on foreign sources in terms of energy. Because when only renewable energy sources are used, energy production is disrupted in some cases, while nuclear energy is a sustainable resource (Pipe, 2013). The biggest disadvantage of nuclear energy is the threats to life in case of accident and the problems that nuclear wastes may cause. In case of contact of these wastes with the external environment, irreversible problems arise. In order to eliminate these problems, nuclear wastes are buried in special warehouses built 500 meters to 1,200 meters below the ground. Nuclear waste is degrading extremely slowly. If these wastes come into contact with groundwater, they can cause the poison to come to the earth (Kerimoğlu, 2020; Palabıyık, Yavaş, & Aydın, 2010). On the other hand, the technical life of a nuclear power plant is approximately 30-40 years and at the end of this period it is dismantled. Reactor dismantling is a very expensive process. The process time can approximately correspond to the time required to build the reactor (Kerimoğlu, 2020; Yarman, 2011).

Renewable Energy Sources

As a result of global environmental problems, the concepts of sustainable and renewable energy have come to the fore as an alternative to fossil and nuclear fuels. These resources are seen as a promising solution to environmental problems due to their sustainable and environmentalist nature. However, it is not enough for energy sources to be renewable only. Resources must also be sustainable for ecological balance (Aykal, Gümüş, & Akça Özbudak, 2009). Renewable energy sources are energy sources that are in a continuous cycle, can exist in the same way the next day in nature's own evolution, can renew themselves faster than the depletion rate of the resource and can be used again and

again (Gezer, 2013). Renewable energy sources are classified as hydraulic energy, solar energy, wind energy, geothermal energy, biomass energy, wave energy, hydrogen energy (Koç & Şenel, 2013; Koç & Kaya, 2015). Renewable energy types and their sources are summarized in the table below (TEİAŞ, 2021).

Table 1. Renewable Energy Types and Their Sources

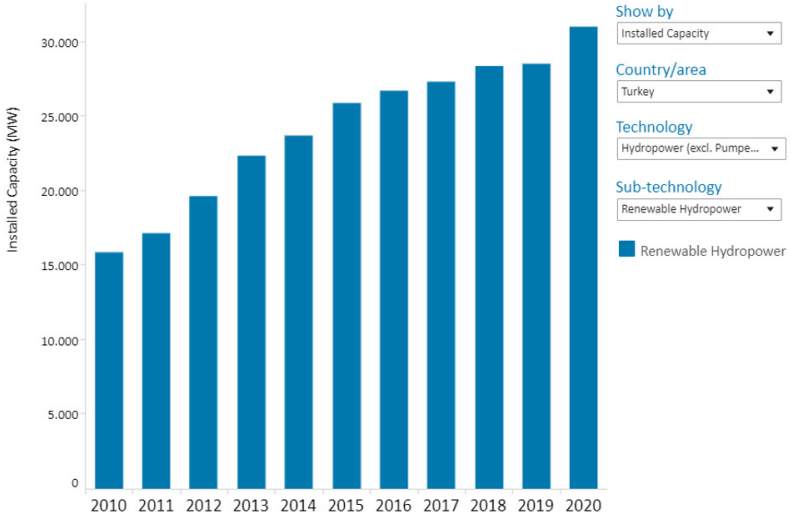
Renewable Energy Source	Source
Hydraulic Energy	River
Solar Energy	Sun
Wind Energy	Wind
Geothermal Energy	Groundwater
Biomass Energy	Waste
Wave Energy	Ocean and Sea
Hydrogen Energy	Water and Hydroxides

a. Hydraulic energy

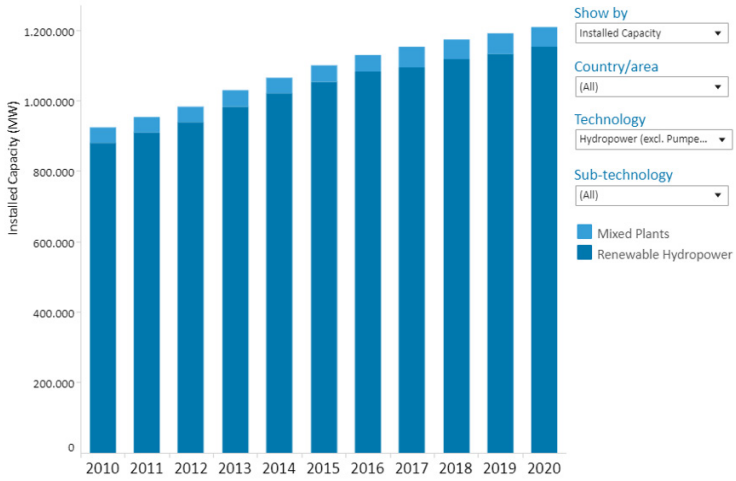
Hydraulic energy is energy produced from water. While this energy is produced, the potential energy between the two points where the water source is located is converted into kinetic energy. Then energy is this converted into mechanical energy and finally into electrical energy (Öztürk, 2013). In this respect, hydraulic power plants must be installed not where they are needed, but where water resources are located (Erdoğan, 2016). The water accumulated in dam-type power plants gains potential energy. Kinetic energy is generated by dropping this water from a height. This energy turns the water turbines and turns the generator that provides electricity (Kocaeren, 2016).

Figure 3. Hydraulic Energy

Hydraulic power plants are frequently preferred because of their environmentally friendly, clean, efficient, long-lasting and low cost. In addition, these power plants do not have fuel expense and high risk potential. Turkey's hydraulic potential corresponds to approximately 1% of the world's total hydraulic potential (T.C. Enerji ve Tabii Kaynaklar Bakanlığı, 2020b). The installed capacity of hydroelectric energy in the World and Turkey until 2020 is shown in Graph 1 and Graph 2 (IRENA, 2021a).



Graph 1. Installed Capacity of Hydroelectric Energy in Turkey



Graph 2. Installed Capacity of Hydroelectric Energy in the World

The basic element in the release of hydroelectric energy is water. For this reason, it does not cause any gas emission that causes global warming and environmental pollution during the electricity generation phase. These power plants are very long-lasting and highly efficient. In addition to electricity generation, these power plants undertake important functions in meeting the water needs of the region, reducing flood and overflow risks and irrigation of agricultural lands. The development of these power plants that generate electricity with domestic resources reduces the problem of external dependency in the field of energy and contributes to the economic security of the country (Başkaya, 2010; Yıldız, 2011). Along with these advantages, there are some criticisms that hydroelectric power plants also cause environmental and social devastating consequences by blocking rivers through large dams. Dams can cause drying of soils and deterioration of natural structure by creating large reserves. In addition, some lands, villages or historical areas may be submerged under the dam waters during the dam construction (Union of Concerned

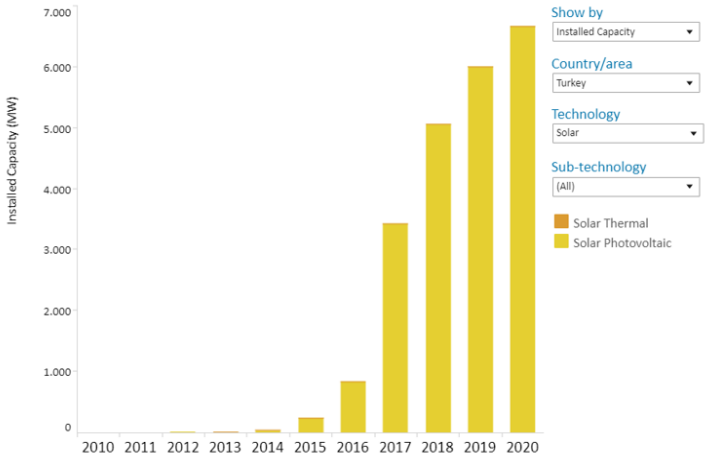
Scientists, 2013). Construction works may also have some negative consequences for the wildlife living in the region. Species living in the region may be extinct. However, the decaying of plants in submerged areas can lead to the emergence of large amounts of carbon dioxide and methane gas (Atak & Öztok, 2013; Kerimoğlu, 2020).

b. Solar Energy

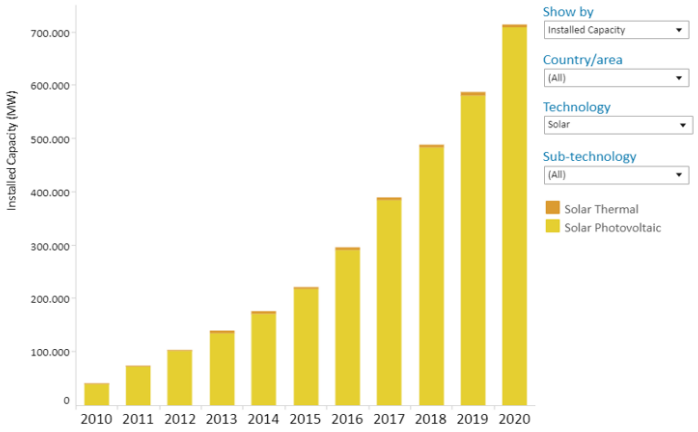
The sun is the main source of energy. For this reason, it is an important requirement for both electricity generation and other energy sources. Heat and light emerge as a result of massive nuclear reactions in the core of the sun. In the solar core, a powerful energy

Figure 4. Solar Energy

Solar energy is a clean and continuous energy source. It has no fuel problem, it is easy to operate, it works smoothly for many years (Çakırlar, 2015). Today, many different technologies are used to benefit from the sun's rays. Some of these technologies use energy directly, such as heat or light energy, while others use solar energy to generate electricity (Aydın, 2014). The installed capacity of solar energy in the World and Turkey until 2020 is shown in Graph 3 and Graph 4 (IRENA, 2021b).



Graph 3. Installed Capacity of Solar Energy in Turkey



Graph 4. Installed Capacity of Solar Energy in the World

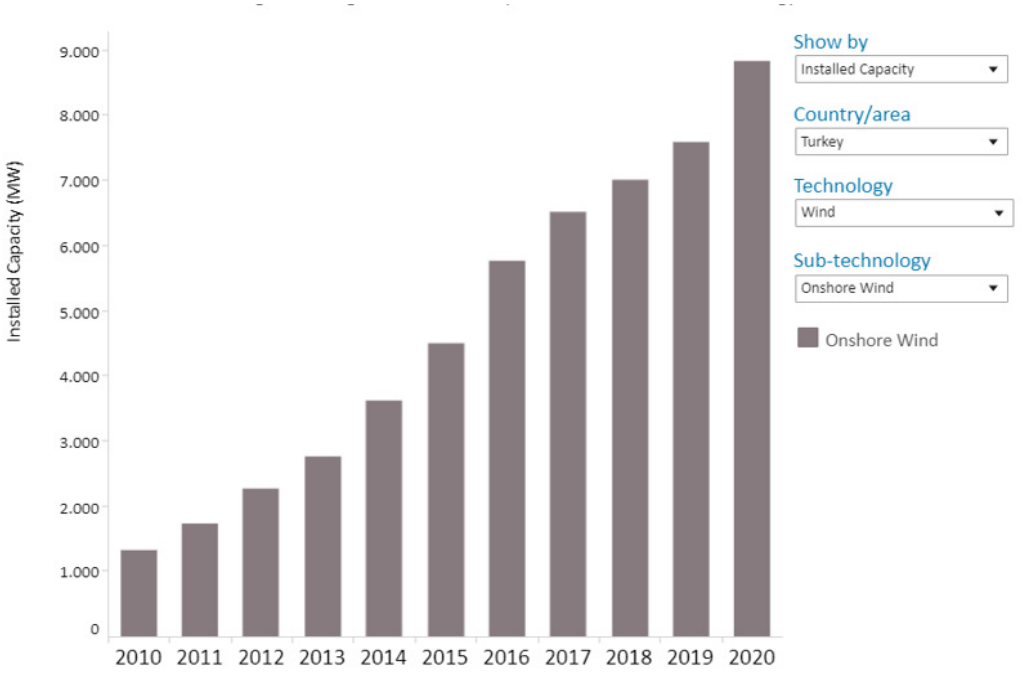
The most important advantage of solar energy is that it is seen as limitless. Solar energy is a renewable, environmentally friendly and clean energy source (Köroğlu, Teke, Bayındır, & Tümay, 2010). The cost of electricity generation with solar energy is decreasing day by day and its usage area is gradually expanding. On the other hand, solar heating / cooling, industrial applications and electricity production can be easily performed without requiring fuel costs (Akova, 2008). The most important disadvantage of solar energy is the high initial investment cost. Large surfaces are needed to collect solar energy. It is not possible to produce enough electricity from solar energy on cloudy days and at night. This problem makes it inevitable to store the energy obtained during the day. Storage is possible thanks to accumulators, but the high cost of accumulators also increases the energy cost (Akova, 2008; Kerimoğlu, 2020).

c. Wind Energy

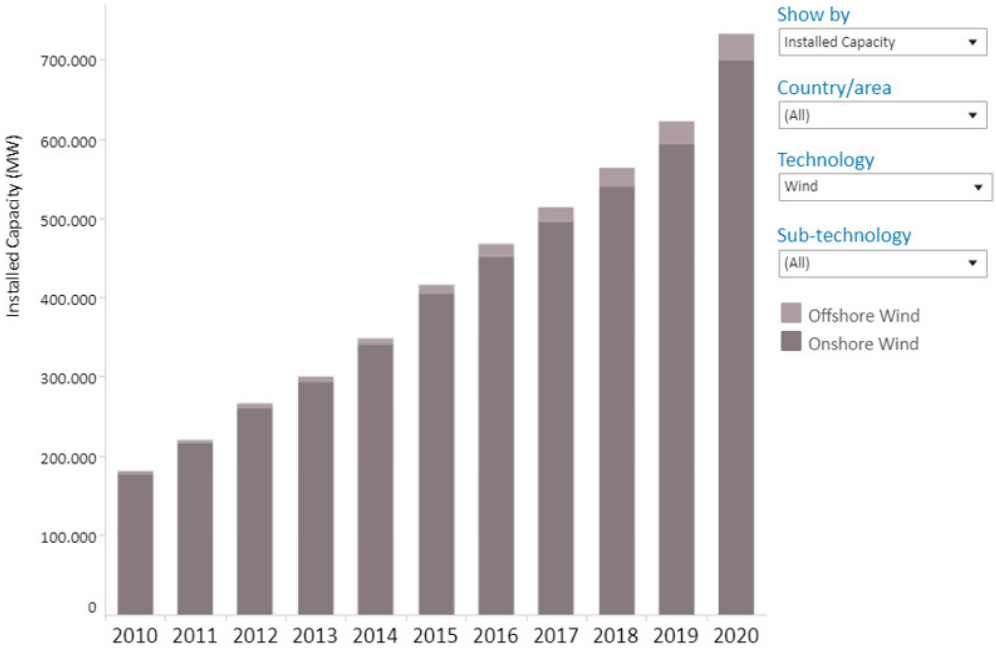
The heat energy reaching the Earth from the sun is used by gravity and electromagnetic forces, and approximately 2% of this energy is converted into wind energy (Öztürk, 2013). The wind emerges from the mutual interaction of low and high pressure centers, which are formed as a result of not heating every region of the earth equally (Doğanay & Coşkun, 2017). Wind, which is a natural phenomenon, is converted into wind energy by means of wind turbines.

Figure 5. Wind Energy

As a result of the increase in technology and industrial activities worldwide, the demand for wind energy is increasing day by day. The installed capacity of wind energy in the World and Turkey until 2020 is shown in Graph 5 and Graph 6 (IRENA, 2021c).



Graph 5. Installed Capacity of Wind Energy in Turkey



Graph 6. Installed Capacity of Wind Energy in the World

The most important advantage of wind energy is that it is an environmentally friendly and clean energy source. In addition, wind power provides continuous generation and reduces foreign dependency. The installation and operating costs of wind turbines are low and they allow agriculture in the land where they are established (İlkılıç, 2009).

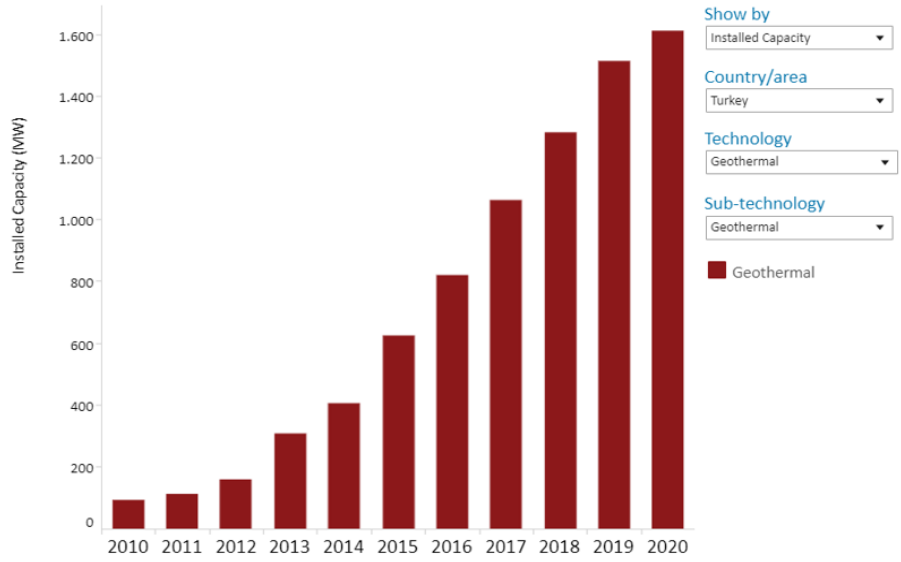
There are some disadvantages of wind energy. The biggest problem is that the wind does not blow continuously. Therefore, it is very difficult to produce the desired amount of energy at the desired time. At the same time, wind turbines cause a certain amount of noise, pose a danger to birds during migration, and create interference in communication (Kerimoğlu, 2020; Koçaslan, 2010).

d. Geothermal Energy

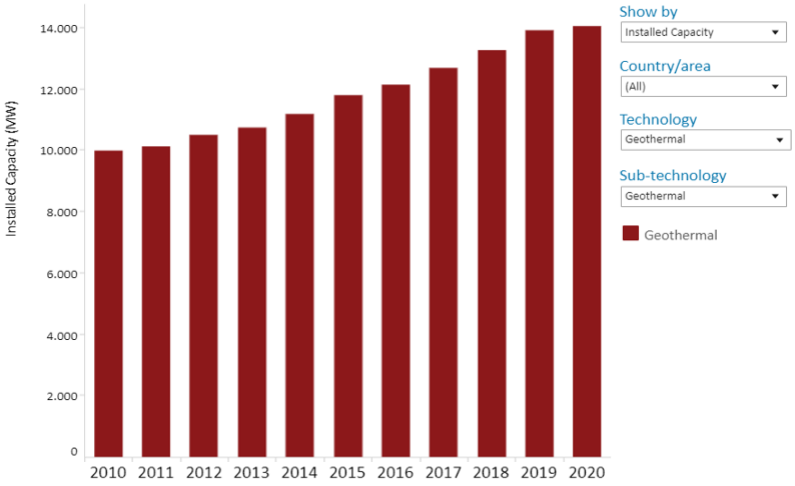
Geothermal energy is the energy generated by the heat in the depths of the earth. There are two main sources of heat that releases geothermal energy. The first of these sources is the temperature that is carried and spread with the magma rising towards the earth's surface. The other is the earth's own temperature, which increases as one goes deeper

Figure 6. Geothermal Energy (IRENA, 2021d)

The importance of geothermal energy is increasing due to its cheap and environmentally friendly nature. Turkey is rich in geothermal energy resources due to its location (T.C. Enerji ve Tabii Kaynaklar Bakanlığı, 2021c). The installed capacity of geothermal energy in the World and Turkey until 2020 is shown in Graph 7 and Graph 8 (IRENA, 2021d).



Graph 7. Installed Capacity of Geothermal Energy in Turkey



Graph 8. Installed Capacity of Geothermal Energy in the World

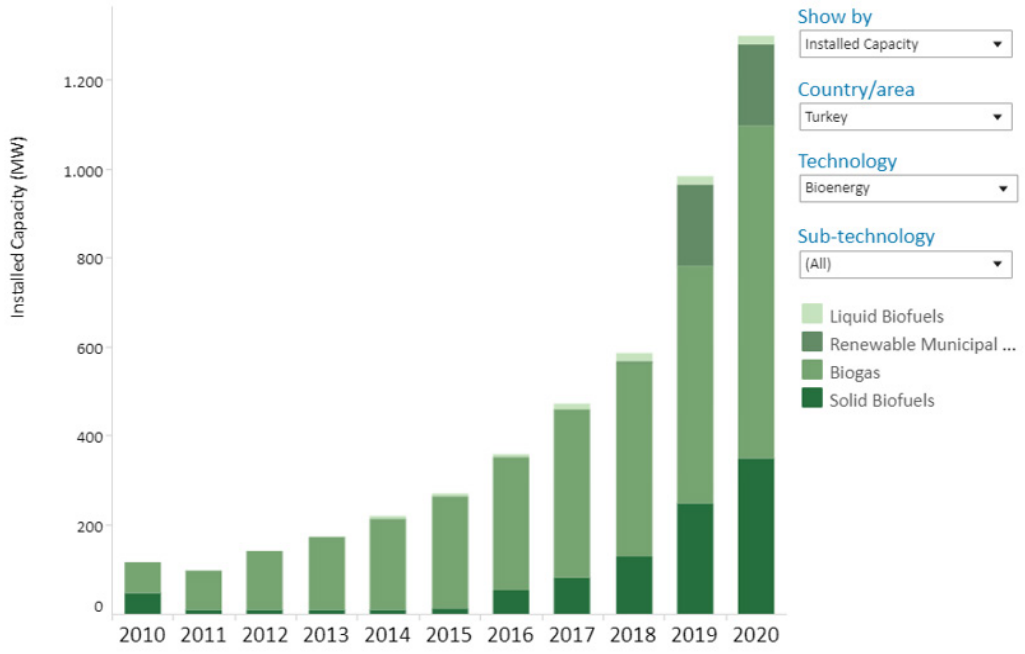
Geothermal energy is a highly efficient, stable, sustainable and environmentally friendly energy source. The cost of electricity generated from geothermal energy is lower than other sources. In addition, this energy is not affected by weather events such as solar and wind energy. Geothermal power plants do not occupy large areas, nor do they require any storage or transportation process. Risk factors such as explosion, fire and poisoning are extremely low during use (Aksoy, 2007; Kerimoğlu, 2020). The most important disadvantage of geothermal systems is that the total power obtained from power plants decreases as the source temperature does not increase. In addition, hot groundwater can also contain arsenic, mercury, boron, lithium and some types of bacteria. It can also be toxic and lethal if it is drunk (Montgomery, 2014).

e. Biomass Energy

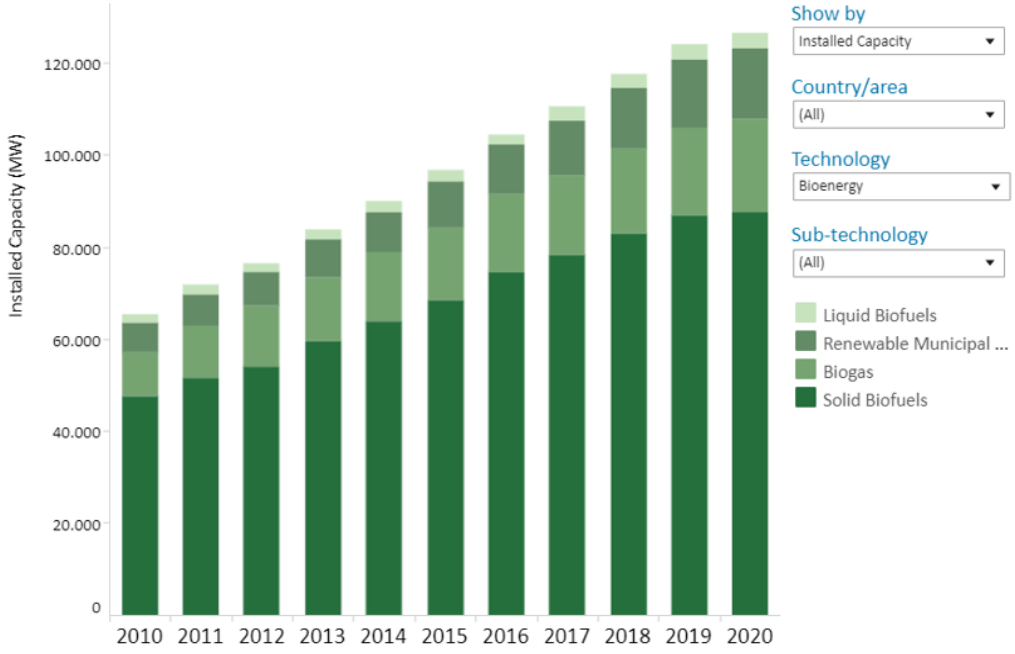
Biomass energy is energy produced from materials originating from biomass. Bioenergy use falls into two basic categories. The first of these is traditional use and refers to the burning of biomass in forms such as wood, animal waste, coal. Modern bioenergy includes liquid biofuels derived from plants, wood heating systems and other technologies (IRENA, 2021e).

Figure 7. Biomass Energy

Nowadays, with the development of technology, the usage areas of biomass energy have expanded and the production cost has decreased (Doğanay & Coşkun, 2017). The installed capacity of biomass energy in the World and Turkey until 2020 is shown in Graph 9 and Graph 10 (IRENA, 2021e).



Graph 9. Installed Capacity of Biomass Energy in Turkey



Graph 10. Installed Capacity of Biomass Energy in the World

Biomass is seen as a clean and inexhaustible energy source. Since animal and forest wastes are disposed of in the production of this energy, environmental pollution is also decreasing. Therefore, biomass energy creates positive results in terms of reducing

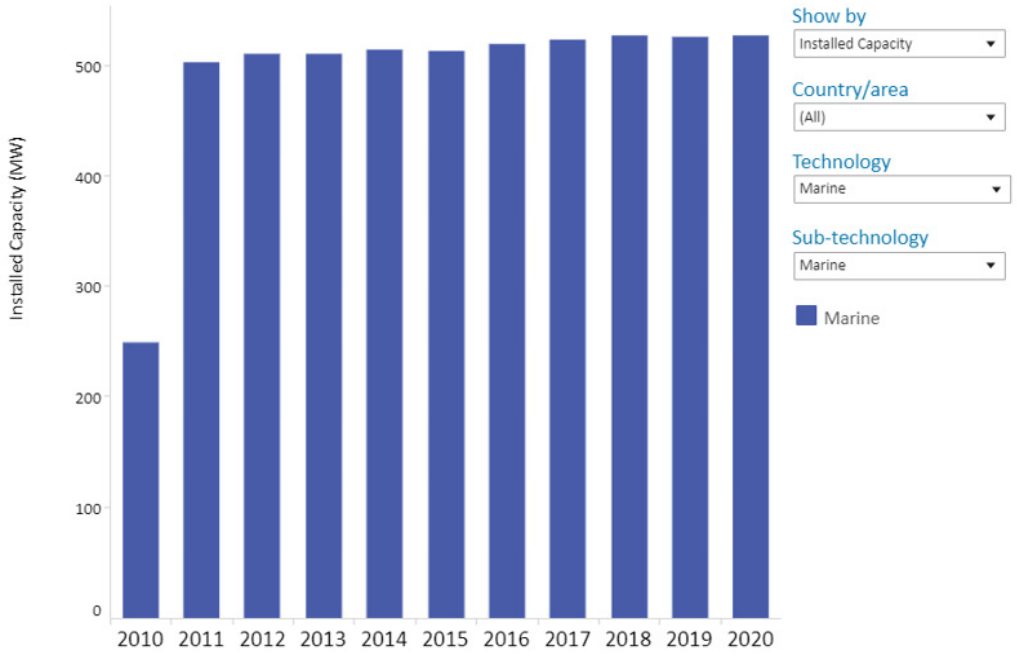
environmental pollution, reducing carbon dioxide emission, reducing expenses related to health problems, improving water-air-soil quality and increasing biodiversity (Jenkins, Baxter, Miles Jr., & Miles, 1998). Biomass production facilities can work for very long hours. And as long as the fuel is available, it can produce at high capacity continuously. In addition, production facilities contribute positively to the employment and income level in the region where they are established. As it creates an additional demand for agricultural work, it creates new job areas in rural areas and reduces the desire to migrate from the village to the city. Thus, biomass energy production facilities support regional development. The most important disadvantage of biomass energy is that it has lower calorific value and fuel quality compared to fossil fuels. Another disadvantage is the need for very large cultivation areas for growing plants that form the basic raw material of biomass energy resources. However, in case of focusing on growing these plants, the production amount of other grains decreases. This situation is reflected in the price of food products. At the same time, large-scale biofuel production can lead to soil erosion, extinction of endemic plant species and loss of natural forest areas (Christy, 2008; Duygu, 2009; Kerimoğlu, 2020).

f. Wave Energy

Wave energy is the energy obtained from the pressure created by the wave motion in the seas. Earthquakes, wind, tides and collapses in the sea bottoms cause the formation of sea waves. Dams are built at the mouth of the bays suitable for wave energy production and the incoming water is kept here. Then, electricity is produced with turbines by using the difference in height of the water (Bayraç, Çildir, & Çelikay, 2018; Kerimoğlu, 2020).

Figure 8. Wave Energy

Although wave energy is not a major energy source, it is seen as the most reliable among renewable energy sources. Considering that 2/3 of the world is water, it is thought that when the necessary importance is given, a significant part of the energy need can be met from wave energy (Bayraç, Çildir, & Çelikay, 2018). The installed capacity of wave energy in the World until 2020 is shown in Graph 11 (IRENA, 2021f).



Graph 11. Installed Capacity of Wave Energy in the World

The global sea current resource potential of wave energy is quite high. This energy has high energy densities, highly predictable power outputs. It is also independent from extreme atmospheric fluctuations and has no negative visual effects (TÜRÇEV, 2014).

g. Hydrogen Energy

Hydrogen is the main energy source of the universe. Hydrogen is defined as the type of energy that has the highest energy potential in terms of unit mass. It can be used in all areas that require heat and explosion energy. In addition, in energy systems where this energy source is used as fuel, the product emitted into the atmosphere is only water or water vapor (Özkan, 2020).

Figure 9. Hydrogen Energy

Hydrogen gas is considered as the most important clean energy source due to its high unit energy and environmental friendliness. It can be used as a fuel instead of petroleum in vehicles and as a fuel instead of natural gas in homes and factories. And it allows

electrical energy to be obtained (Dabanlı & Uyumaz, 2010). In addition, hydrogen does not remain as a puddle on the ground during a leak and is dispersed in the atmosphere due to its low density. For this reason, the security of the environment can be ensured. While obtaining hydrogen energy, fossil fuels are used due to their cheapness and this is seen as the most important disadvantage of hydrogen energy. In addition, there are some problems that require solutions in the production, storage, transportation and burning of this energy (Kocaeren, 2016; Ün, 2003).

Current Situation of Turkey in Terms of Energy Resources

Energy is an indispensable input for almost all processes that are necessary for us to continue our lives. It is one of the most fundamental elements of economic and social development of all countries. As a result of the increasing population growth, a great increase in energy demand is observed all over the world. According to the data of the International Energy Agency (IEA, 2020), global share of total energy supply of the world, which was 6,098 Mtoe in 1973, reached 14,282 Mtoe in 2018 with a big increase. Again, according to IEA (2018), it is thought that the energy demand will increase by 60% in 2030 and 100% in 2050 compared to today (IEA, 2018; 2020). The energy need in our country is increasing day by day.

Today, Turkey meets a significant part of its energy needs from fossil fuels. With the increasing population, urbanization and industrialization, there is a big increase in energy demand. Although our country is not rich in terms of non-renewable energy resources that it provides most of its energy needs, it is more fortunate in terms of renewable energy resources due to its geographical location and geopolitical structure. Our country is in a very favorable position especially in terms of hydraulic, geothermal, biomass, wind and solar energy potentials. However, Turkey cannot meet the energy it needs from renewable energy sources and imports energy (Kılıç, 2011; Koç & Şenel, 2013). Hydroelectric energy is currently used in Turkey. In addition, it is thought that resources such as wind energy and solar energy will contribute significantly to meeting the energy needs of the country. The fact that these resources contain low costs and the view that they can make the country more independent in terms of external dependency increases the expectations for these resources (Özev, 2017).

In our country, thermal and hydraulic resources are mostly used to meet the electricity needs. The share of installed power capacity of renewable energy sources in Turkey has increased significantly in the last 10 years. At the end of September 2019, the installed power of our country has reached 90,720 MW. In 2018, electricity energy consumption in Turkey increased by 2.2% compared to the previous year and reached 304.2 billion kWh. On the other hand, electricity generation increased by 2.2% compared to the previous year and reached 304.8 billion kWh. Electricity consumption is expected to

reach 375.8 TWh in 2023 with an annual average increase of 4.8%. According to the data published by ETBK, the distribution of our installed power according to resources as of the end of September 2019; 31.4 percent hydraulic energy, 28.6 percent natural gas, 22.4 percent coal, 8.1 percent wind, 6.2 percent solar, 1.6 percent geothermal and 1.7 percent is in the form of other sources (T.C. Enerji ve Tabii Kaynaklar Bakanlığı, 2021d). Again, according to the information published by TEİAŞ (2021), the data showing what percentage of our country's daily energy needs are met from renewable resources is given in the following figure (Figure 10).

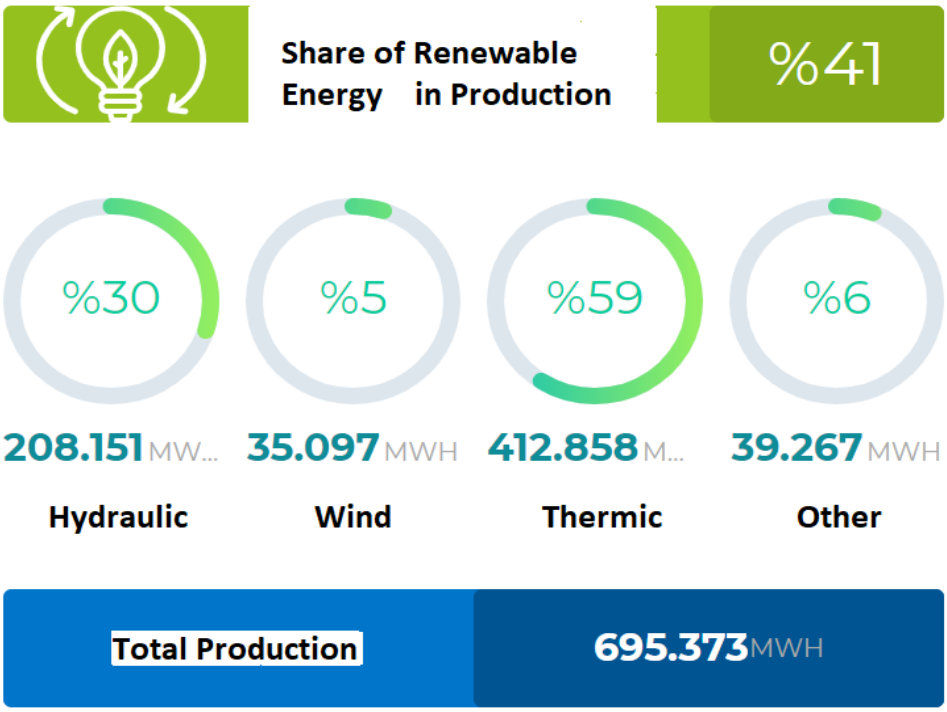


Figure 10. Share of Renewable Energy in Meeting Daily Energy Needs

According to the data in the figure, 30% of Turkey's daily energy needs are met from hydraulic energy, 5% from wind energy, 59% from thermal power plants and 6% from other energy sources. 41% of the daily electricity produced in our country is met by renewable energy sources. This ratio is expected to increase in the coming years (TEİAŞ, 2021).

Energy Conservation

One of the most important factors in energy efficiency is energy conservation. While energy consumption is mostly explained by socio-demographic characteristics, energy conservation is predominantly influenced by personal factors (Abrahamse & Steg, 2009). The most general definition of energy saving is the consumption of less energy and all behaviors that prevent existing energy losses (EIA, 2020c). Energy saving is explained by factors such as a sense of responsibility, environmental awareness, and the urge to get approval from the society. At this point, the personal components of the behavior

become important (Karlin, Davis, Sanguinetti, Gamble, Kirkby, & Stokols, 2012).

Sometimes energy conservation is confused with energy efficiency. In fact, energy efficiency tells what to buy, while energy conservation shows how to behave. Energy conservation refers to the reduction of total energy demand, while energy efficiency refers to the regulation of energy saving behaviors of individual consumers (EIA, 2020c; Gillingham, Newell, & Palmer, 2009). In this context, energy conservation behaviors are considered as adopting some behavioral patterns such as turning off unused electronic devices to reduce energy use, turning off the light when leaving the room, and using less electrical appliances (Karlin et al., 2014). Energy saving is considered as the focal point of incentive programs like other environmental behaviors. Methods applied to reduce the energy consumption of households have been tried and successful for years (Sintov, Desario, & Prescott, 2010).

The methods used for the dissemination of energy conservation on a global scale are based on technological developments. This situation causes to move away from the awareness that energy conservation is a behavior and to neglect the psychological dimension of this concept (Stern, 1992). However, it is stated that environmental knowledge, attitude, values and other psychological variables are effective in saving energy (Haron, Paim, & Yahaya, 2005). Many studies in the field of energy conservation psychology highlight the importance of informational strategies in promoting saving behavior. These strategies are generally used to encourage energy conservation activities where there are few contextual barriers to saving behavior and that do not require much time and cost effort (Steg, 2008). In raising awareness of saving, it is adopted that the primary step is to access scientific information. Therefore, the question of how the environmental knowledge levels of energy consumers in Turkey will affect this behavioral scheme comes to mind. Especially environmentalist behavior is a prerequisite for energy conservation in our country. In this context, behaviors such as the dissemination of environmentally friendly green products, saving in the consumption of natural resources, preferring public transportation, saving energy and water in houses and workplaces are evaluated within the scope of environmentally friendly behaviors (Koçak, 2020; Larson, Stedman, Cooper, & Decker, 2015; Steg, Lindenberg, & Keizer, 2015).

Saving energy is an extremely important requirement in order to leave a livable world to future generations. In this context, it is believed that we have to fulfill our duty by taking individual responsibility in accordance with sustainability, contributing to the continuity of natural resources and ending unnecessary consumption habits.

Zero Waste

With the increase of the world population, the amount of waste and carbon emissions are increasing rapidly. However, energy and raw materials are wasted, natural resources

are consumed excessively and underground / surface water resources become unusable due to pollution. The pollution of the air, the increase in epidemic diseases and the accumulation of waste on the soil appear as problems that need to be solved urgently (Erten, 2020). The environmental problems encountered in the last century and the rapid increase in carbon emissions and waste materials have brought the question of how to solve these problems. Human beings are making an intense effort and carrying out studies regarding a solution. Undoubtedly, one of the biggest studies done is zero waste applications (Maxwell, 2006).

Zero waste is defined as the recovery of all resources and materials from waste materials that can be reused or recycled without creating any waste residue. It is to systematically eliminate the volume and toxicity of waste materials. It means systematically designing and managing products and processes to conserve, recover, incinerate or bury all resources. Zero waste does not mean recycling. Zero waste is the prevention of waste even during production. It means reducing the production of all kinds of waste and garbage (Erten, 2019; ZWIA, 2018). Zero Waste aims to prevent waste, to use resources efficiently, to examine the causes of waste and to prevent them. In addition, it is a waste management process that expresses the collection and recycling of waste by separating it at the place where it is formed (Çalışkan, 2020).

Zero waste is used as an approach for the first time in the article published by George Washington Carver in 1893 and wastes are defined as other sources in disguise. In 1930, Henry Ford researched the industrial use of farm and forest resources with a zero waste approach and obtained products such as car horns and gear levers from soybeans. The term zero waste was first used in the name of Zero Waste Systems (ZWS), which was founded by Chemist Paul Palmer in the 1970s. It was realized in 1996 when New Zealand adopted the zero waste strategy by targeting 2010 (Yaman & Olhan, 2010). In recent years, zero waste studies have become widespread all over the world. Most of the research on this topic has mainly focused on cities' transition to zero waste management (Zaman & Lehmann, 2013). As in the whole world, population, industrialization, urbanization and consumption increase in Turkey, while natural resources are rapidly depleted accordingly. These developments are also reflected in consumption activities. The amount of waste increases rapidly and causes air, water and soil pollution. In addition, these wastes cause climate change and bring problems that will threaten life at the global level. Disposal of wastes without recycling causes serious resource losses. In this respect, the sustainable and efficient management of resources is seen as a necessity (T.C. Çevre ve Şehircilik Bakanlığı, 2017).

The Zero Waste Project in Turkey was announced in a publicity in 2017. It was introduced under the auspices of the Presidency and under the leadership of the Environment and Urbanization Presidency. The project was implemented for the first time in the

Presidential Complex and the Ministry of Environment and Urbanization. With the project, it is aimed to use resources efficiently, prevent waste, reduce the amount of waste, and ensure the recycling of wastes with an efficient waste collection system (Erdur, 2019). Following the introduction made in 2017, the Zero Waste Regulation was published in the Official Gazette dated 12 July 2019 and numbered 30829. The regulation is based on the effective management of raw materials and natural resources, the protection of the environment and human health. In addition, the regulation covers the principles regarding the establishment, dissemination, development, monitoring, financing, recording and certification of the zero waste system (T.C. Çevre ve Şehircilik Bakanlığı, 2019). The main objectives of the zero waste project are listed as follows: (Erdur, 2019);

- Awareness of the concept of waste in daily life,
- Prevention of waste,
- Reducing the amount of waste thrown away,
- Reducing the disposal costs of our garbage,
- Reuse of qualified wastes as raw materials,
- Raising environmental awareness of individuals,
- Extending the life of existing resources,
- Enabling all living things to live in healthier environments.

In this context, it is predicted that with the Zero Waste Project, both economic gain will be achieved and more livable cities will be left for future generations by protecting our environment. Zero waste practices make a great contribution to the environment and human health by eliminating the wastes at the source before they are formed. It provides great savings in terms of both energy and cost. Zero waste practices ensure the effective use of the resources owned by controlling the wastes. Adoption of the zero waste principle together with the sustainable development approach makes a great contribution to the economic and environmental development of Turkey, as well as transferring a livable world to future generations (Önal, Kaya, & Çalışkan, 2019; T.C. Çevre ve Şehircilik Bakanlığı, 2017). In this respect, the subject of zero waste should be included in the primary and secondary education curriculum. While this subject is included in the programs, support should be obtained from the experts of the subject. In order to understand this issue, training should be given to the whole society, especially teachers (Erten, 2019).

Activities

Activity 1. Below is a sample poster for energy saving. Considering the features in this poster, prepare an original poster for one of the topics you learned in this section.

Activity 2. Let's find the difference between an insulated house and an uninsulated house in terms of energy savings!

Please complete the activity by following the steps below.

- Build two simple houses from plywood.

- Glue foams on plywood to the wall of one of these houses.

- Then carefully put candles inside both houses.

- Place thermometers inside both houses to measure the temperature.

- After a certain time interval, measure the interior temperature of the houses with two thermometers.

- By looking at the difference, explain which house is more energy efficient and how much energy it saves.

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