Contributions to Economics

Hasan Dinçer
Serhat Yüksel *Editors*

Circular Economy and the Energy Market

Achieving Sustainable Economic Development Through Energy Policy

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Contents

Chapter 1
The Improvements in Hydrogen Energy Investments

Hasan Dinçer, Çağatay Çağlayan, and Mutaliyeva Lyailya Maratovna

Abstract Hydrogen is the most easily found element in the universe. It also has a simple structure consisting of a proton and an electron. In addition, it is possible to produce electrical energy from hydrogen in some different ways. As a result of gasification of fossil fuels such as natural gas and coal, hydrogen and carbon monoxide gas are released. Low cost is one of the most important advantages of this method. On the other hand, carbon monoxide gas formed in this process causes air pollution. It is possible to obtain hydrogen energy by using renewable energy sources. In this context, electricity obtained from renewable energy sources is used in the electrolysis of water. Hydrogen and sulfur can be separated because of electrolysis of hydrogen sulfide gas. It is possible to say that hydrogen has many advantages compared to other types of energy. First of all, the energy obtained from hydrogen is much richer than oil and natural gas. On the other hand, no carbon gas is released into the atmosphere due to the combustion of hydrogen. Only water is produced in this process. In other words, hydrogen is an extremely environmentally friendly form of energy. It is predicted that hydrogen will be used much more actively in the future due to its many important advantages such as being efficient, environmentally friendly, and safe. Many countries have taken important steps towards the use of hydrogen energy. In this process, it is vital to increase technological investments in hydrogen energy, which is gaining importance day by day. To achieve this goal, priority should be given to research and development investments for the acquisition, storage, and transportation of hydrogen. In this way, it will be possible to obtain and use hydrogen energy at a lower cost. This will take the countries one step further in their energy policies.

Keywords Hydrogen · Energy investment · Clean energy · Carbon emission

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1.1 Introduction

Carbon gas is produced because of the use of fossil fuels in energy production. This situation causes significant environmental pollution (Yüksel et al., 2020). Countries are trying to take some measures to prevent this situation. However, each planned action has its own advantages and disadvantages (Liu et al., 2020). In this context, a detailed cost-benefit analysis of the applications to be carried out is required (Shang et al., 2021). Otherwise, the steps to be taken will not be preferred by businesses as they will not be efficient. This situation will not contribute to the solution of the carbon emission problem (Kou et al., 2022).

The use of hydrogen energy is one of the applications to be carried out to solve the carbon emission problem (Zhao et al., 2021). With the use of hydrogen, it is possible to produce much higher quality energy (Zhu et al., 2020). This contributes significantly to energy efficiency. Hydrogen can be stored in both liquid and gaseous form (Yüksel et al., 2021a, b, c). This makes it easier to use hydrogen. Hydrogen can be produced using any energy source (Shaikh et al., 2021). This provides significant advantages to hydrogen.

Due to these advantages, increasing hydrogen energy investments is important for the energy policies of countries. In this way, countries will be able to produce their own energy. This will reduce the energy dependency of countries. On the other hand, thanks to hydrogen, it will be possible for countries to produce clean energy (Li et al., 2020). This will help countries to reduce their health expenditures (Xie et al., 2021). In addition, its ability to produce clean energy will positively affect the image of countries (Zhong et al., 2020). This will contribute to the arrival of foreign investors to the countries.

1.2 The Needs for Clean Energy

The world population has been increasing day by day. In response to the increasing population, the need for energy has been increasing day by day. The main reason for the increase in energy needs in parallel with the increasing population is that energy is one of the basic needs of people. When it comes to every human need such as shelter, nutrition, and transportation, people's energy needs arise. In parallel with the increasing energy needs, states have to constantly increase their energy production. Because a power outage that may occur will have extremely negative consequences on both human life and the economy of the country (Chang et al., 2007). In this context, the amount of energy produced in the countries should be at a level that can meet the energy demand of the country in question. In parallel with this, various sources are used in energy production in the world. Fossil fuels are one of them. Fossil fuels are relatively cheap, easy to access and do not require advanced technology compared to other energy sources, but all fossil fuels are carbon-based fuels. Therefore, the combustion of every carbon-based energy source such as coal

and natural gas produces a high amount of carbon emissions to nature. The carbon emission produced by each burning fossil fuel has various consequences on nature (Abas et al., 2015). For example, the burning of carbon-based fuels is among the main causes of air and water pollution. In addition, the burning of fossil fuels such as coal and natural gas accelerates global warming. The uncontrolled warming of the world causes dozens of negative consequences, such as shrinkage of agricultural areas, reduction of water resources, and loss of life from extreme heat (Luber & McGeehin, 2008).

One of the long-term effects of burning fossil fuels, such as global warming, is that it negatively affects human health in the long run. For example, various lung and respiratory diseases are more common in areas with intense carbon-based air pollution. The use of fossil fuels in these regions negatively affects human health and harms the country's economy (Kampa & Castanas, 2008). In these countries, health expenditures are constantly increasing, and a catastrophic amount of health expenditure is paid both from the budgets of the states and from the individual budgets. This situation reduces the living standard of people and makes the country's economies more fragile. Considering all these, an energy production based on fossil fuels with factors such as low cost increases social expenditures such as health and environmental expenditures, causing states to bear heavier costs in the long run. Thus, it can be said that the transition process from fossil fuels to cleaner and more efficient alternative energy sources should be faster (Uluer & Çağlayan, 2021).

Another energy source that meets the increasing energy demand is nuclear energy. Uranium, the element containing the most protons and neutrons, is used in nuclear power plants. The element uranium is broken down by the fission reaction, creating a large amount of heat. The resulting temperature reaches serious values. Therefore, the fission reaction, which takes place thanks to neutron traps, is kept under control. Uncontrolled fission reactions can cause nuclear power plant accidents that can cause serious loss of life and environmental damage (Yüksel & Çağlayan, 2020). The heat generated as a result of a controlled fission reaction turns the turbines by evaporating the water. Thus, the motion energy required for electrical energy is provided. The process of obtaining electricity from nuclear power plants is completely zero carbon. Since there is no carbon emission from nuclear power plants, it can be said that nuclear energy is an extremely clean type of energy (Xie et al., 2020). In addition to these, the advantages and disadvantages of nuclear energy can be mentioned.

One of the most important advantages of nuclear energy is that it produces electricity 24 hours a day. From this point of view, nuclear energy is a very efficient energy source. Another important factor is that the energy obtained from nuclear energy has the feature of being zero carbon. With this feature, nuclear energy is an extremely important energy source in the fight against global warming and environmental pollution (Dinçer et al., 2020). In addition to all these advantages, it is possible to talk about various disadvantages. First of all, it can be mentioned that the installation costs of nuclear energy are high. Since nuclear energy investments are big investments like all other energy investments, there may be problems in financing the investment (Yüksel et al., 2021a, b, c). Another disadvantage is the

problems that can be experienced in waste management. The disposal of radioactive waste from nuclear power plants can be costly and harmful to the environment. Finally, one of the most important disadvantages of nuclear energy is the risk of the explosion of power plants. Considering the nuclear power plant accidents in the past, it is obvious that a possible accident will have serious consequences. The explosion risk of nuclear power plants due to various reasons such as human error, natural disasters, and terrorist attacks makes it difficult for the public to accept nuclear energy. Therefore, it would be the right choice to use various renewable energies, especially hydrogen energy, together with nuclear energy.

Considering the disadvantages of fossil fuels and nuclear energy, renewable energies come to the fore. The renewable energy source is defined as the energy source that can be available exactly the next day in the evolution of nature (Twidell, 2021). It can be said that renewable energies are sustainable since the potential for depletion of reserves seen in fossil fuel sources is not in question in renewable energies. Renewable energy sources can be listed as solar, wind, biomass, geothermal, hydraulic, hydrogen, and wave energy. These energy sources are reassuring energy sources, but they also have various advantages. One of the most important features of renewable energies is that it does not harm the environment in the energy production process. In this context, it can be said that renewable energies have an effective share in the fight against global warming by preventing carbon emissions. The fact that renewable energies will not run out over time, like fossil energy resource reserves, has been one of the biggest motivations for large investments made or to be made in this field. Another important advantage of renewable energies is their low maintenance costs. For example, since flammable fuels are not used in energy types such as solar and wind energy, the maintenance cost of these energy sources is relatively low (Dinçer et al., 2021a, b). It is possible to come across renewable energies in rural settlements or metropolitan living areas. For example, people make small investments in solar panels to produce hot water or electricity. Thanks to these small investments, people save on energy costs in the long run and reduce carbon emissions by using fewer fossil fuels. One of the important advantages of renewable energies is that it is an energy source with high acceptance by society. It is one of the energy sources with the highest acceptance by society because it is extremely environmentally friendly and has a low-risk rate.

In parallel with this, it is possible to talk about various disadvantages of renewable energies. First of all, since renewable energies are obtained from nature, the amount of energy produced is affected by various natural conditions or weather events. Although these energy sources are available worldwide, the energy obtained from these sources is not uninterrupted 24 hours a day, 7 days a week throughout the year (Yüksel et al., 2021a, b, c). The fact that the weather is cloudy on some days, the sun does not shine at night and the occurrence of dry periods can be given as examples of nature-based factors affecting renewable energy production. Therefore, changing weather events and climate are the leading conditions that affect the efficiency of renewable energy. Another important disadvantage is the lack of storage capability of renewable energy. Since some renewable energy sources do not promise 24-hour energy, it is important to store energy. As technology

progresses, it seems possible that the energy storage capacity will increase and batteries will become more successful in accordance with the needs. Another important disadvantage that prevents the spread of renewable energies is the high installation costs of renewable energies. Therefore, there are problems in financing renewable energy projects. Considering all these conditions, it can be said that renewable energies are open to development and promising for the future, but it is a fact that the search for new energy sources will continue (Mohtasham, 2015).

1.3 The Advantages of Hydrogen Energy

Among renewable energies, especially hydrogen energy has a position that concerns all energy sources. The increase in prices with the decrease experienced after the excessive use of fossil fuel reserves and the damage these fuels cause to the environment have encouraged researchers to search for environmentally friendly alternative fuels that are abundant in nature. As a result of these studies, it is shown that hydrogen, the simplest and most common element in the universe, has most of the properties necessary for fuel. In parallel with this, researches are accelerating for hydrogen, which is promising to meet the energy needs of the current century (Momirlan & Veziroglu, 2002). Hydrogen, the first element of the periodic table, consists of a proton and an electron. It is the simplest and most common element on Earth. Hydrogen, which has an odorless, colorless, tasteless, and transparent structure, is the lightest chemical element in nature. Due to the instability in its hydrogen structure, it is not found in free form on earth and is included in different compounds. In the light of available information, it can be said that hydrogen has the highest energy content per unit of all known fuels. Apart from these, hydrogen is not a natural fuel. Hydrogen produced from sources such as water, biomass, nuclear and hydrocarbons is a synthetic fuel. For example, a water molecule consists of two hydrogen atoms and one oxygen atom. There are different numbers of hydrogen atoms in petroleum-derived organic compounds known as hydrocarbons. Hydrogen energy is chemical energy released in its molecules as a result of the decomposition of hydrogen in its pure form. This energy can be converted into heat and electrical forms by various methods (Veziroğlu & Şahi, 2008).

Production sources of hydrogen are plentiful and diverse. For example, it is possible to produce hydrogen from fossil fuels such as hydrocarbons, renewable energy sources such as biomass, and a wide variety of sources such as nuclear sources. There are many alternative hydrogen production technologies such as steam recovery, electrolysis during the production phase. Currently, most of the hydrogen is produced from fossil fuels, especially natural gas (labidine Messaoudani et al., 2016). Today, hydrogen is mainly obtained by the steam-methane method. In this production method, natural gas is exposed to steam at high temperature and hydrogen, carbon dioxide, and carbon monoxide are produced. In the next step, extra hydrogen and carbon dioxide are obtained by releasing carbon monoxide into the steam. As a result of this process, which is based on the production of hydrogen from

fossil sources, a large number of greenhouse gases such as carbon dioxide are released. Integrating emerging technologies such as carbon capture in hydrogen production from fossil fuels into this production process will offer significant benefits in minimizing environmental impacts.

Another method is the electrolysis of water. By applying an electric current to the water, the water is separated into hydrogen and oxygen, and this process is called electrolysis. The electrolysis process is carried out in units called electrolysers. Electrolysers consist of two electrodes, the anode and the cathode. The hydrogen ion, one of the charged particles formed after the electric current is applied, has a positive electric charge and is collected at the negative electrode (cathode). Since oxygen has a negative charge, it collects at the positive electrode (anode). The breaking of the bonds of hydrogen and oxygen atoms basically occurs as a result of this process. If the electrolysis method is applied using renewable energy sources, it will make hydrogen energy zero carbon. Therefore, it can be said that this method is quite environmentally friendly. Since the cost of electricity consumed in the electrolysis process is sometimes higher than the price of the hydrogen produced, the electrolysis method has a very small share in hydrogen production. Although studies continue to make the electrolysis method more economical, hydrogen production can also be produced with different and more economical methods (Ursua et al., 2011).

Existing nuclear power plants can produce high-quality steam at lower costs than natural gas and can be used in many processes, including steam reforming. However, it is possible to obtain hydrogen in high yield when this high-quality steam is electrolyzed and decomposed into pure hydrogen and oxygen. Large amounts of hydrogen are produced by the high temperatures released from advanced nuclear reactors. Nuclear energy facilities are considered to have the potential to support hydrogen production both while providing electricity to the grid and thanks to this heat released. In addition, since nuclear power plants do not cause carbon emissions, they are seen as a green energy source, and the hydrogen to be produced through these reactors is considered as green hydrogen. Considering all these, it can be said that hydrogen can be obtained with fossil fuels, renewable energies, and nuclear energy. Therefore, hydrogen energy has a different position compared to other renewable energies (Sorgulu & Dincer, 2018). In parallel, there are various methods for obtaining energy from hydrogen. The first method is the burning method. Hydrogen gasoline is a combustible fuel like natural gas, but it has advantages over fossil fuels. The biggest advantage of hydrogen over fossil fuels is the low carbon emission. No carbon dioxide is produced during the hydrogen combustion process. Another method used to obtain energy from hydrogen is the fuel cell method. A fuel cell is the reverse of the electrolysis process. Electric current is obtained by combining hydrogen and oxygen. This method is one of the preferred methods in all applications, especially automobiles. It can be said that it is a more efficient method than burning hydrogen. It has almost no harmful emissions to the environment.

1.4 How to Improve Hydrogen Energy Investments

Hydrogen energy is used in many places from transportation to industry, from space rockets to oil production. Various advantages of hydrogen energy can be mentioned, especially its high efficiency and being an environmentally friendly resource. First, hydrogen can be produced using any energy source, including renewable energy sources. Hydrogen can be produced using electricity and converted into electricity with relatively high efficiency. In the end-use, hydrogen has the highest efficiency when transforming into energy to be used, and hydrogen is a more efficient fuel than fossil fuels. One of the most important advantages of hydrogen is that there are various methods for its storage and transportation after its production. The transportation process is done by compressing the hydrogen in gas form or converting it into liquid form in a pressurized environment and then loading it into tankers (Salvi & Subramanian, 2015). However, due to the increasing need for hydrogen in the coming years, it is possible to transport hydrogen through existing natural gas pipelines. Because the capacities of pipelines between countries are sufficient to transport hydrogen. For storage, the priority is concentrated on methods that allow transportation. Methods that prioritize transportation for storage of hydrogen; liquid hydrogen, gaseous hydrogen, metal hydride and chemical storage. Hydrogen does not have any harmful effects on the environment while being transported or stored. As a result of the combustion of hydrogen or its consumption in the fuel cell, only water is produced as the final product. With these properties, hydrogen can be used as energy for households or production sectors or as fuel in cars, ships, and airplanes.

Considering all these advantages of hydrogen energy, it should be said that hydrogen energy investments should be increased. Therefore, various improvements should be made to increase these investments and support existing investments. States should cooperate with the private sector to encourage hydrogen energy investments with tax breaks and various subsidies. Investments in hydrogen energy with subsidies will increase (Haghi et al., 2018). Government incentive packages should cover universities as well as the private sector. Universities should invest in research on the transportation, storage, and recovery of hydrogen and advance existing technology and literature. Hydrogen energy investments are big energy investments like other energy investments. Therefore, investors can be supported at the point of financing. Providing low-cost funds to investors will increase hydrogen energy investments (Bai & Zhang, 2020). Another important point in the development of hydrogen energy investments is the qualification of the employees who will work in these energy investments (Baş et al., 2022). The high competencies of the employees who will work in hydrogen energy investments will increase the efficiency of these investments. At the same time, informing the employees who will take part in hydrogen energy investments about new technologies related to hydrogen energy and organizing training programs will provide extra support to the progress of investments and increase efficiency by increasing the qualification of the employees. Taking all these steps will support the development of the hydrogen

energy sector and literature, and will pave the way for the frequent use of hydrogen energy in the future.

1.5 Conclusion

Hydrogen energy contributes significantly to the solution of the carbon emission problem. In this way, the health expenditures of the countries will decrease significantly. Thus, the budget balances of the countries will be positively affected by this situation. The use of clean energy will also improve the image of countries in a positive way. This situation will contribute to the preference of foreign investors in these countries. Thus, it will be easier to solve many important problems such as unemployment. In addition, thanks to the use of hydrogen energy, countries will be able to produce their own energy. This will reduce the dependence of countries on other countries for energy.

On the other hand, there are some disadvantages in the use of hydrogen energy. For example, hydrogen gas is not easy to obtain. Hydrogen gas is actually abundant in nature. On the other hand, in order to obtain this gas, which is not in pure form, some applications such as electrolysis are required. This situation will also create extra costs. In addition, hydrogen occupies much more space, especially when compared to petroleum. Therefore, very large volumes are needed to store this gas. This leads to an increase in the costs of hydrogen energy investments.

As stated before, hydrogen energy investments need to be increased. In this case, it is important to eliminate these negativities. In this framework, priority should be given to research and development studies (Dincer et al., 2019). In this way, it will be possible to develop new techniques (Haiyun et al., 2021). This will contribute to reducing the costs of hydrogen energy production (Cheng et al., 2020; Yuan et al., 2021). In other words, thanks to developing technologies, it will be easier to decompose hydrogen and it will be possible to reduce the storage costs of this gas.

Another important issue for increasing hydrogen energy investments is qualified personnel. As can be seen, there are very comprehensive technical processes in hydrogen energy investments. In order for these processes to be carried out effectively, personnel who are experts in their work are needed (Zhou et al., 2020; Dinçer & Yüksel, 2019). Thanks to these personnel, it will be possible to solve the problems that may arise in investments effectively and quickly. This will help increase the efficiency of investments (Dinçer et al., 2021a, b). In this context, energy companies should pay attention to this issue in their personnel selection (Liu et al., 2021). In addition, the personnel working within the company should be provided with the training they need.

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Chapter 2
The Problem of Depending on Fossil Fuels in the Energy Policies of the European Union: A Strategic Analysis in the Eastern Mediterranean Region

Mehmet Ali Alhan

Abstract The Eastern Mediterranean geographical area consists of an area surrounded by Europe in the North, Asia in the East, the Middle East in the Southeast, and Africa in the South. The Republic of Turkey is the country with the longest coastline in this area. Recently, the discovery of increasing hydrocarbon reserves in this geography has whetted the appetite of the European Union (EU) countries that cannot meet their energy needs. Federal Germany, which has the largest industrial capacity among the European Union countries with energy dependence on the Russian Federation, had an urgent and important need for an alternative, reliable, and clean energy supply, especially during the Russia-Ukraine crisis. In this study, the European Union's process of closing nuclear and hydro-electric power plants for alternative, reliable, and clean energy and the depletion of fossil fuels will be discussed. It will be argued that energy domination has a very strategic meaning. In the process of liberation from fossil fuel, the search for gas hydrate and the political, economic, and cultural relations of the Republic of Turkey with Europe will be discussed.

Keywords Carbon emission · Energy dependency · Eastern Mediterranean · Energy diplomacy · Gas hydrate

2.1 Introduction

Developing industrial production and rapidly growing societies increase their energy needs. Therefore, countries holding energy reserves such as oil and hydrocarbons become regional and global power. This situation increases the importance of renewable and sustainable energy sources (Dong et al., 2022; Zhang et al., 2022; Kou et al., 2022). It is considered that the Republic of Turkey wants to use these energy reserves in the Eastern Mediterranean basin as a means of political and

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economic pressure. Gas hydrate reserves in the Eastern Mediterranean attract all attention as the fuel of the future with its large methane volume. Soviet scientists discovered that gas hydrate reserves could also be found in cold and high-pressure sea areas. With the observation of solid natural gas in West Siberian gas sediments in the 1960s, the world's perspective on this area changed. Simultaneously, the need for a reliable energy supply for the high industrial power of the European Union countries is absolute. Therefore, the first outlines of the new era are already visible: renewable energies and energy efficiency (Mukhtarov et al., 2022; Kostis et al., 2022; Bhuiyan et al., 2022).

At the same time, a new era is being entered in the European Union, especially in Federal Germany. Recent strategic initiatives by the Federal Republic of Germany include the High-Tech Strategy 2025, the National Industrial Strategy 2030, and the Exit Coal Strategy. It is aimed to go beyond market fixation and lay the foundations for a more active state. We can trace the changes in ordoliberal principles in the successful energy transition policies of the 2000s. The post-World War II German economic model has been defined as an expansion-oriented policy that is stable in the production and dissemination of knowledge and increases the international competitiveness of its companies. An industrial strategy that requires tackling major challenges like the climate catastrophe requires a reinvigoration of both private and public investment, innovation and collaboration.

In this process, the Greek Cypriot Administration (GCA) claimed rights against the Republic of Turkey and Northern Cyprus according to the 1982 United Nations Convention on the Law of the Sea (UNCLOS) (www.ung.org). It also complicates the energy cooperation in the region by causing tension with the Turkish Republic, while at the same time Greece and the Greek Cypriot Administration are trying to persuade the EU to implement comprehensive sanctions against the Republic of Turkey (Merz, 2020). Ankara, on the other hand, rejects the legal authority of Greek Cypriot Administration to conduct exploration in the exclusive economic zone of the entire island (Axt, 2020).

On the other hand, it does not accept the existence of the Turkish Republic of Northern Cyprus and its rights under the 1960 United Nations Convention on the Law of the Sea (UNCLOS) (www.turkishgreek.org). The United States of America officially requested a military base in the south of the island from the Greek Cypriot Administration (www.tr.sputniknews.com). The start of negotiations in line with the demand caused the power balance in the region to be turned upside down. On the other hand, the European Union is developing various cooperation projects with the countries in the region, both in terms of its energy security and in terms of regional military security policies (Kısacık & Erenel, 2019). The European Union (EU), Israel, Greek Cypriot Administration, Egypt, Lebanon, and the United States of America (USA) left Ankara out and started new formations such as the "Eastern Mediterranean Natural Gas Forum" (www.petroleum.gov.eg). While carrying out natural gas transportation projects within the scope of the Eastern Mediterranean Gas Initiative, it also reveals a security perspective for the region with the Permanent Structured Cooperation Agreement (PESCO) initiative (Peternelj et al., 2018). Therefore, as of 2018, the Republic of Turkey has started to take steps to claim the