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Hasan Dincer
Serhat Yüksel *Editors*

Economic Development and the Environmental Ecosystem

The Role of Energy Policy in Economic Growth

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Chapter 1
Evaluating Critical Points for the Improvement of Nuclear Energy Investments via Text Mining Methodology

Serkan Eti and Yaşar Gökalp

Keywords Nuclear energy · Energy investments · Text mining · Data mining · Energy economics

1.1 Introduction

The energy needed since the first day of human history is necessary for many things that are still used today to function. Energy is one of the main factors affecting the economies of all countries of the world (Martínez et al., 2022; Sun et al., 2022). With the increasing world population, the need for energy is also increasing (Kafka et al., 2022; Mukhtarov et al., 2022). Therefore, energy consumption tends to increase day by day. However, the energy supply is limited. This situation reveals the importance of the need for energy (Hong et al., 2020).

Energy has various forms. The history of humanity has started to use energy with muscle power. Subsequently, heat energy was discovered (Dong et al., 2022; Dinçer et al., 2022a, 2022b, 2022c). Later, energy types such as coal, oil, and natural gas, which are expressed as underground resources, were discovered. With the industrial revolution, energy use has been moved to a different dimension (Zhang et al., 2022; Yüksel & Dinçer, 2022). With the industrial revolution and the introduction of oil and electricity into human life, energy consumption has increased a lot (Gielen et al., 2019).

Energy is one of the most important elements that humanity needs. If the use of energy had not been developed at this level, many works would have to be done with manpower (Carayannis et al., 2022; Li et al., 2022a, 2022b; Yüksel et al., 2022a, 2022b). For this reason, every event related to energy has come to the fore among the

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issues that concern humanity. The limited energy resources, the imbalance in the distribution of these resources, and the ever-increasing population cause major problems (Mikhaylov et al., 2022; Eti et al., 2023; Li et al., 2022a, 2022b). These problems pushed the states to produce alternative solutions. One of the alternative solutions is renewable investments (Poudyal et al., 2019).

Renewable energy sources are energy sources that can be used continuously without any depletion problems. Solar energy, wind energy, water, and geothermal energy are examples of renewable energy sources. Renewable energy sources are environmentally friendly sources. However, the initial investment costs are quite high (Haiyun et al., 2021; Yuan et al., 2021). On the other hand, non-renewable energy resources are resources that are limited in nature and whose amount decreases as they are used. Examples of non-renewable energy sources are coal, oil, and natural gas. Non-renewable energy sources are also called fossil fuels. Most of the energy consumption in the world is provided by fossil fuels. The fact that fossil fuels are exhaustible causes problems due to environmental damage and imbalances in the distribution of resources (Fang et al., 2021; Kayacık et al., 2022). For this reason, countries are aiming to abandon the use of fossil fuels and switch to renewable energy. Accordingly, incentive policies are implemented for the use of renewable energy (Cantarero, 2020).

1.2 The Types of Energy Generation

Energy is not something that can be created out of nothing or destroyed while it exists. Energy can only be converted from one form to another. To explain this situation with an example; For vehicle fuels, we can talk about the conversion of oil to gasoline or the conversion of electrical energy into heat energy when cooking in the oven. In transformations, the energy source is oil and electrical energy. Resources that help to produce energy by various methods are called energy resources. It is possible to classify the energy sources that we encounter with different formations according to the place where they are used, the way they are obtained, and the purpose of use (Nabat et al., 2020).

One of the classifications used in the literature is the classification made according to whether they have changed or not. Accordingly, energy is examined in two separate classes, primary and secondary. Resources that are used as energy without undergoing any change, such as oil, natural gas, and coal, are included in the scope of primary energy resources. Energy sources such as oil, natural gas, and coal, and energy forms that are more suitable for use such as electricity and heat energy with conversion methods are called secondary energy sources (Lapi et al., 2022). In addition, primary energy sources are also examined as renewable and non-renewable energy according to the way they are obtained.

Renewable energy resources are resources that can be used continuously without any depletion problems. Solar energy, wind energy, water, and geothermal energy are examples of renewable energy sources. Renewable energy sources are

environmentally friendly. However, the initial investment costs are quite high. On the other hand, non-renewable energy resources are resources that are limited in nature and whose amount decreases as they are used. Coal, oil, and natural gas are examples of non-renewable energy sources (Olabi & Abdelkareem, 2022).

Most of the energy consumption in the world is carried out with fossil fuels. The exhaustion of these resources causes problems due to excessive damage to the environment and imbalances in their distribution (Eti et al., 2022; Dinçer et al., 2023). For this reason, countries are aiming to abandon the use of fossil fuels and switch to renewable energy. Accordingly, investments are made by the states, laws are enacted, and incentive policies are implemented for the use of renewable energy (Depren et al., 2022).

Non-renewable energy resources can be defined as resources that are completely dependent on natural processes. These resources, also called fossil fuels, are formed by the decay of plant and animal materials (Xu et al., 2022). However, the process of formation is quite long. It is foreseen that there will be no change in the reserves of non-renewable energy resources in the next few million years. Coal, uranium, oil, and natural gas are examples of fossil fuels (Mujtaba et al., 2022).

Since the industrialization process that started with the industrial revolution, fossil fuels have been widely used as a source of heat and motion. While wood and biomass resources were used in the first place, the use of coal, oil, and natural gas has become widespread due to the increasing need. When we look at today, it is seen that fossil fuel reserves are decreasing day by day (Bradu et al., 2022).

Oil is one of the non-renewable energy sources. Petroleum is made up of carbon and hydrogen. Fuels such as gasoline, LPG, diesel, diesel, aviation fuel can be obtained by passing petroleum through certain processes. Almost all transportation needs are met by petroleum and derivative products. This situation reveals the importance of oil for countries. However, the damage done by oil to nature is quite high, as is the case with other fossil fuels (Adekoya et al., 2022).

Natural gas is another non-renewable energy source. It is formed because of the exposure of organic wastes existing underground to various factors for millions of years. Natural gas is an energy source that can be used as it is extracted from the ground. Natural gas is transported to areas of use by pipelines or by being liquefied by tankers. The usage areas of natural gas vary widely. It is the main source of energy production in residential, commercial, and industrial areas. However, natural gas is an exhausting source of energy (Udeagha & Ngepah, 2022).

Coal is another non-renewable energy source. In the structure of coal, there are sulfur, oxygen, nitrogen, and hydrogen, mostly carbon. Coal undergoes many transformation processes in the formation process. It takes many years for coal to form as a fuel. The longer this formation time, the higher the quality of the coal. Coal mine detection and extraction are cost-effective. Therefore, the demand for coal is very high worldwide. However, the harmful gases that emerge after the burning of the coal mine cause global warming and harm the environment. Coal mine, in order according to the formation layer; is divided into varieties such as peat, lignite, hard coal, and anthracite (Solarz et al., 2022).

Renewable energy sources refer to energy sources that can be produced continuously and renewed themselves. It is foreseen that it will be the main energy that humanity will use in the future. Due to the damage caused by fossil fuels to the environment and the limited resources, the orientation towards renewable energy sources has increased. Considering today's conditions, it will not be possible to limit energy consumption. Therefore, it is quite clear that the energy demand will increase day by day. The most widely used renewable energy sources are solar energy, wind energy, hydroelectric energy, geothermal energy, and biomass energy (Li et al., 2020).

Solar energy is one of the largest energy sources. Thanks to the established system, the incoming sun rays are first converted into heat energy. Then electrical energy can be produced. One of the important features of solar energy is that it does not pollute the environment, as in all renewable energy sources (Bhuiyan et al., 2022; Kou et al., 2022). The important factor for a country to produce solar energy is the annual sunshine duration. Solar energy can be produced in two different ways. These are solar photovoltaics and solar thermals (Dinçer & Yüksel, 2019).

Solar energy is used in many areas of our lives. It is used in phones, recently produced hybrid cars, lighting, and many more. In the future, it is estimated that the usage areas will increase more. The use of solar energy and investments in it are increasing all over the world. When the change of solar energy installed power in the countries according to the years is examined, it can be said that it is an increasing trend (Schulte et al., 2022).

Wind energy, like other renewable energy sources, is a type of energy that does not harm the environment. Wind energy has an important place among renewable energy types. Air movement caused by the pressure and humidity difference in the air can be converted into energy by various methods. There are two important parameters for the conversion of wind into energy. These are the speed and direction of the wind. Wind turbines installed for wind energy generation convert the resulting air movement first into mechanical energy and then into electrical energy, making it usable. (Singh et al., 2022).

Two elements will provide the necessary air movement for countries to produce wind energy. These are climate and geographical location. However, the initial investment cost of wind turbine installation is quite high. Also, due to the weather, there is a variable energy generation capacity. Apart from these, the technology of wind turbines is simple. It does not harm the environment; it is nature friendly. Maintenance costs are also low (Kumar, 2022).

Hydroelectric energy is one of the renewable energy sources. Hydroelectric energy is formed by converting the movement of fluid water into energy. Similarly, the energy generated by wave and tidal movements is also considered within the scope of hydroelectric energy. In hydroelectric energy, the size of the energy to be produced is directly related to the flow of water and the rate of fall. Water pouring from a high place passes through turbines and provides energy production (Qu et al., 2022).

The operating and maintenance costs of hydroelectric energy are low. It does not harm the environment and does not create a greenhouse gas emission problem. The

water stored in the electricity generation process can also be used as drinking water. Apart from these, it also provides regular irrigation for agricultural lands. Its biggest contribution is energy production (Aldawoud et al., 2022).

Another renewable energy source is geothermal energy. As with other renewable energy sources, geothermal energy is an energy source that does not harm the environment. Geothermal energy is a type of energy obtained by converting the heat formed because of the accumulation of heat and pressure underground. Geothermal energy sources are formed by feeding from the heat in the core. To produce electrical energy from geothermal resources, the source in question must be suitable for this generation. However, most of these resources are not suitable for electricity generation. Apart from electricity generation, geothermal resources are also used for health and tourism (Romanov & Leiss, 2022).

Biomass energy is one of the renewable energy sources. Biomass energy refers to the energy created using biological formations obtained from different organisms. Formations produced because of agricultural residues and solid organic wastes can be given as examples of biomass energy. If efficient biomass energy generation is aimed, long-term planning is required. The materials and wastes that can store solar energy in themselves may be used in the biomass energy generation process. Biomass energy has the potential to be converted into heat, electricity, and liquid fuels (Yana et al., 2022).

Biomass energy is the fourth largest energy source after coal, oil, and natural gas in terms of quantity. Among the renewable energy sources, it is the energy source with the greatest potential. It also has the potential to be used with other energy sources. It never harms nature; it is an environmentally friendly type of energy (Amjith & Bavanish, 2022).

1.3 General Information About Nuclear Energy Investments

Electricity is produced with nuclear energy by heating water in boilers using the energy released from the fission of atoms in a reactor. The rotation of the turbines caused by the created water vapor results in the production of electricity. In nuclear power plants, water vapor turns turbines, which transfer mechanical energy to the generators, which convert it to electrical power. Production of nuclear electricity consists of two distinct processes: fission and fusion. Nuclear fusion involves the combining of two light atoms to produce a heavy atom, whereas nuclear fission involves the splitting of an atom in half (Alwaeli & Mannheim, 2022).

Atoms with a high number of protons also have a high number of neutrons, whereas the opposite is true of atoms with a low number of neutrons. For a given number of protons, the amount of energy needed to keep them together grows proportionally, as each proton repels the others. Neutrinos can't be influenced by voltage. However, a powerful nuclear force holds all the atom's neutrons and

protons together. This means that keeping protons within the atom may be achieved by increasing the number of neutrons, which in turn promotes atomic stability (Mathew, 2022).

Nuclear fission refers to the process of splitting the nucleus of an atom in two, whereas nuclear energy refers to the energy released during this process. Since radioactivity demonstrates that the nucleus of an atom is inherently unstable, fission opens the door to an infinite supply of energy. In fission, as opposed to radioactivity, the atomic nucleus divides in half. Massive amounts of energy are released during this fragmentation, leading to the dissolution of the tightly connected clusters of protons (Rehman et al., 2022).

The process of nuclear fusion involves the merger of two smaller atomic nuclei to create a larger and denser nucleus. The power of the sun and other stars comes from a process called nuclear fusion. This mechanism, through which the sun generates its energy, serves as the basis for all other energy generation methods, including nuclear fusion and renewable energy. Unlike nuclear fission, in which energy is lost in the splitting apart of heavy atoms, nuclear fusion releases energy in the form of light atoms (Majeed et al., 2022).

On our planet, nuclear fusion is most readily accomplished by joining together deuterium and tritium, two isotopes of hydrogen. Hydrogen, with only one proton and one electron, is the least dense element. Heavy water, or deuterium water, is created when one of the hydrogen atoms in regular water (H_2O) is replaced with deuterium, which contains an additional neutron in its nucleus. Since tritium contains two additional neutrons in addition to the one that makes up its atomic weight, it is three times as heavy as hydrogen. The combination of tritium and deuterium in a fusion cycle produces helium, the second-heaviest element in the periodic table, and a free neutron (Bandyopadhyay et al., 2022).

Nuclear power is quite useful. The health industry is perhaps the most important of these. It's a vital part of the diagnostic process, particularly for illness. In addition to conventional medicine, nuclear medicine is employed in certain cases. Nuclear energy has many applications and advantages, including the creation of nutritious food. For instance, nuclear energy is used to remove hazardous chemicals from food. It's also possible to use nuclear power in farming. Insects and other pests that cause damage to crops may be effectively removed. The use of radiation ensures that food is prepared without spoilage. In conclusion, nuclear energy is useful in many areas of science, including chemistry and biology, construction, the detection of oil tank leaks, and the development of certain types of aerospace technology, ships, and airplanes (Korkmaz & Önöz, 2022).

The use of fossil fuels in production is far more cost-effective. A similar level of output is achievable throughout the year. It is unaffected by changes in weather and other environmental factors. You can always give it your all and reach your full potential in the workplace. As a raw material, it has advantages over fossil fuels. When compared to similar power plants, it generates much more energy. It maximizes energy output while decreasing infrastructure footprint (Brown, 2022).

1.4 An Evaluation of Nuclear Energy Investments with Text Mining

The study aims to determine the developments in nuclear energy. In addition, it is aimed to determine strategies for future study and research areas. For this purpose, the studies in literature are included in the scope of analysis. In the literature, studies with the keyword "nuclear energy" in the web of science database have been taken into consideration. When the studies were examined, it was seen that there were 333 articles on nuclear energy between 1993 and 2022. In recent years, the interest of researchers on this subject has increased and text mining methods have been used to determine the subject or topics discussed. In this context, the KNIME (Konstanz Information Miner) program was used. The bag of Word and ngram nodules in the text mining add-in in the program in question and the texts in the abstract sections of the studies were analyzed. Bag of Word and (term frequency) TF nodules were used for word frequency in the abstract sections, while ngram nodules were used for double and triple word groups.

Text mining is a method of data mining that aims to reveal previously unknown hidden meanings in unstructured texts and to obtain regular data. Since the abstract texts considered in the analysis are not structural, they were analyzed by the text mining method for analysis. Many studies mine texts by considering the studies in the literature (Yüksel et al., 2022a, 2022b; Eti, 2019; Song & Chambers, 2014; Delen & Crossland, 2008).

In text mining, since the texts are not structural, pre-processing of the texts is required first. In this context, the data are made ready for analysis by performing operations such as turning letters into lower/uppercase letters, removing punctuation marks, deleting words that do not make sense (and, so, etc.), and separating the words into their roots. Case converter, punctuation erasure, stop word filter, and stemmer nodules in the KNIME program were used for these operations, respectively. As a result of these nodules, the tightness of the words in the regular and standardized texts was determined.

As a result of the analysis made for the frequency of the words in the abstracts of the articles containing the keyword nuclear energy, it is seen that words such as renewability, economy, emissions, development, and growth come to the forefront. The most common ten words from the words obtained with Bag of Word and TF nodules are given in Table 1.1.

Similarly, the double and triple word groups in the articles containing the keyword nuclear energy were analyzed by the Ngram method. As in single words, it has been seen that word groups such as renewable energy, economic growth, energy consumption, carbon emission, clean energy, and climate change come to the fore in binary word groups. In Table 1.2, ten most repeated binary word groups are summarized.

When the triple word groups are examined, the concepts of renewable and clean energy as well as carbon emission and causality testing attract attention. As a result, it is seen that academic studies on nuclear energy compare this energy source with

Table 1.1 The ten most frequently repeated words and their frequency

Term	f
Energy	1984
Renewable	648
Economy	626
Emission	612
Development	524
Growth	502
Hydrogen	502
Consumption	480
Effect	448
Carbon	384

Table 1.2 The most frequently repeated binary groups of words

2Grams	f
Renewable energy	526
Energy consumption	380
Economic growth	370
Hydrogen product	200
Carbon emission	162
Energy source	136
Nuclear energy	98
Climate change	80
Clean energy	78
Natural gas	70

renewable and clean energy. It was also concluded that they investigated the effects of nuclear energy on the country's economy and its reflections on economic growth. In addition, especially according to the 3Gram analysis, causality, and energy investments were seen to be among the research topics of academics.

1.5 Conclusion

In this chapter, it is aimed to determine the developments in nuclear energy. In addition, it is aimed to determine strategies for future study and research areas. For this purpose, the studies in literature are included in the scope of analysis. In the literature, studies with the keyword "nuclear energy" in the web of science database have been taken into consideration. When the studies were examined, it was seen that there were 333 articles on nuclear energy between 1993 and 2022. It is seen that the studies on nuclear energy have increased after 2015. In recent years, the interest of researchers on this subject has increased and text mining methods have been used to determine the subject or topics discussed. As a result of the analysis made for the frequency of the words in the abstracts of the articles containing the keyword nuclear energy, it is seen that words such as renewability, economy, emissions,

development, and growth come to the forefront. It is seen that academic studies on nuclear energy compare this energy source with renewable and clean energy. It is also concluded that they investigated the effects of nuclear energy on the country's economy and its reflections on economic growth.

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Chapter 2
The Critical Recommendations for Providing Energy Efficiency

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Keywords Development · Ecosystem · Economic growth · Energy technologies · Clean energy

2.1 Introduction

Despite the widespread introduction of the international standard in the field of energy management systems, which regulates the basic principles and aspects of systems operation, there is an urgent need to develop methods and approaches for its implementation in the context of continuous modernization of fixed assets of metallurgical enterprises and the transition from generally accepted business processes to management using digital transformation and digitalization technologies. The key problem, in my opinion, is that the majority of large metallurgical enterprises, when upgrading their main production equipment, ignore the issues of modernization of the energy system and insufficient involvement of personnel in the process of energy saving. This situation leads to a lack of consistency in the volumes of resources produced and consumed, a low level of energy consumption culture and, as a result, a decrease in energy efficiency in general.

The list of the most promising areas for improving management approaches, in addition to managing the infrastructure of energy farms, includes the development of

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incentive tools for energy conservation and improving the quality of innovation activities of personnel.

The energy power and security of a country, the development of the economy and the standard of living of the population are determined by the amount of extraction, production and consumption of fuel and energy resources. Current trends in the development of modern industrial production, despite the relatively low prices for energy resources in Russia, in comparison with the prices of the world market, the value of fuel and energy costs in the cost of production ranges from 15 to 35%, depending on the type of growth. In total, industrial enterprises consume 125–130 million, which is more than a third of the country's fuel and energy resources and more than 50%7 of the electricity generated. According to the data of GDP growth dynamics, which reflect the main result of the functioning of industry, we can conclude that the Russian industry is lagging behind the industry of developed countries, such as the United States and China.

Energy efficiency is vital for the profitability of businesses to be sustainable (Eti et al., 2023; Li et al., 2022a, 2022b; Haiyun et al., 2021). In this context, it is necessary to determine the ways for businesses to carry out the same work with less energy (Li et al., 2022a, 2022b; Yüksel et al., 2022; Mikhaylov et al., 2022a, 2022b). In this way, it is possible to reduce energy costs. Thanks to the use of less energy in the production process, it will be possible to increase the profit margins of the enterprises. In this study, it is aimed to propose the necessary applications in order to ensure the energy efficiency of the enterprises.

2.2 Literature Review

In the context of existing trends for technological modernization of the country's economy and the introduction of innovations, the need to improve energy efficiency is becoming an important direction for the development of technologies and improving organizational processes for managing energy efficiency. The pace of development of information and telecommunications technologies leads to an increase in the growth of energy consumption in non-manufacturing industries, such as the development of information technologies, significantly outstripping the average growth rate of energy consumption. In these conditions, given the importance of the availability of electric energy as a limiting condition for infrastructure development, the current vector for digitalization of the economy leads to an increasing urgency of energy conservation and energy efficiency issues. In many developed countries, over the past decade, the energy intensity of the economy has decreased by 15–20%, while previously planned plans for improving energy efficiency have to be revised upwards (Nie et al., 2020; Bhuiyan et al., 2021; Dong et al., 2021; Mikhaylov, 2021a, 2021b; Barykin et al., 2022a; Liu et al., 2022a, 2022b; Bhuiyan, 2022b; Danish et al., 2022a, 2022b; Saqib et al., 2021; Mukhametov et al., 2021; Candila et al., 2021; Mikhaylov & Grilli, 2022; Li et al., 2022a,2022b, 2022c).