

Assessing the Economic Impact of Renewable Energy from a Technology Perspective

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Abstract. With the rapid development of society, the demand for energy is increasing. At the same time, the consumption of energy is increasing. According to the data, the proven oil on the earth can be used for human beings for 30~50 years, natural gas for 60~80 years and coal for 100~200 years. When these fossil energy is exhausted one day, mankind will face unprecedented difficulties. Therefore, it is urgent to develop renewable energy and renewable energy technologies. In this review, the author first analyzes and discusses the background of research and development of renewable energy technology. Then it classifies some renewable energy technologies and discusses their relationship with economic development. Finally, the impact of renewable energy on economy is analyzed, and the full text is summarized.

Keywords: Energy; Economics; Renewable energy technology.

1. Introduction

Since the discovery of fossil energy, it has been used so far, especially with the continuous development of the industrial age, the consumption of fossil energy is particularly huge[1]. According to statistics, the discovered fossil energy can still be used by humans for about 100 years. What about 100 years later? For the sake of social development and the well-being of future generations, people began to explore, develop and use new energy and constantly develop new technologies[2-4], hoping to replace non renewable energy, realize the long-term sustainability of energy and achieve economic prosperity and stability.

Non renewable energy refers to fossil energy such as coal, oil and natural gas[5]; Renewable energy refers to non fossil energy such as wind energy, hydro energy and marine energy[5]. Compared with traditional energy, renewable energy is not only inexhaustible, but also clean and pollution-free. At the same time, it can also produce great economic benefit, as shown in Figure 1. Renewable energy can not only replace traditional energy and then protect resources and environment, but also promote social and economic sustainable development. Renewable energy technology refers to the method of collecting renewable energy and converting it into other forms of energy output for human activities. The rapid development of this technology is conducive to energy utilization and social and economic development. This review summarizes renewable energy technologies and their impact on economic development.

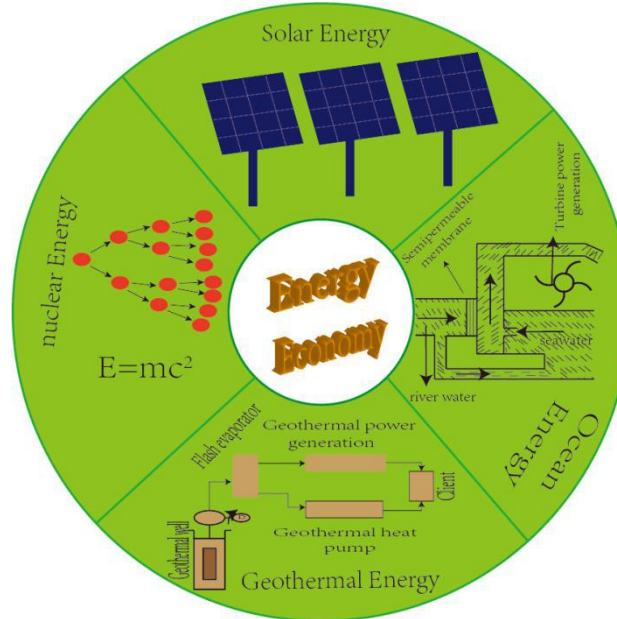


Figure 1. Conceptual diagram of energy and economy

2. Background of renewable energy technology

With the continuous development of the industrial revolution, steam engines and internal combustion engines have come out one after another, and coal and oil have gradually become the main energy sources. With the continuous development of science and technology and the emergence of various high-power machines, the consumption of non renewable resources such as coal, oil and natural gas is increasing, and their reserves on the earth are becoming less and less. Since the 20th century, many countries have realized the crisis of resource depletion and began to protect these resources. In particular, the "oil crisis" in the early 1970s objectively stimulated people's sense of anxiety about the security of energy supply. Some developed countries invested a lot of human, material and financial resources to get rid of the passive situation of relying on oil import in energy supply, thus setting off an upsurge of scientific and technological innovation and development in the development and utilization of solar energy and other renewable energy to replace oil[6].

Renewable energy includes non fossil energy such as hydropower, wind energy and solar energy. Although these energy can be seen everywhere, to harvest them to ensure the healthy and stable development of society, we must rely on advanced renewable energy technologies. The development of renewable energy technologies should not only realize the efficient and reasonable development of energy, but also be economic and environment-friendly. The history of technology development shows that renewable energy technologies can not only provide clean energy, but also promote the development of equipment manufacturing and other related industries. It is an effective way to accelerate the transformation of economic development mode and economic structure adjustment in the post international financial crisis period[7]. The development and utilization of renewable energy is of great significance for ensuring energy security, protecting ecological environment and realizing sustainable development[8]. This paper will analyze various renewable energy technologies and their impact on the economy.

3. Renewable energy technology

Renewable energy refers to non fossil energy such as wind energy, hydropower, solar energy, geothermal energy and biomass energy. For sustainable development, compared with fossil energy, renewable energy is essential, and renewable energy can be widely used, which can be harvested

economically and environmentally friendly[8,9]. Renewable energy is a green and low-carbon energy and an important part of the energy supply system. It is of great significance to improve the energy structure, protect the ecological environment, deal with climate change and achieve sustainable economic and social development. Renewable energy technologies are advanced technologies for the rational development and utilization of renewable energy. The development of this technology is an important guarantee for the effective development and utilization of energy. Extensive development and use is an important part of the transition to a carbon free society[7].

3.1 Nuclear technology

Nuclear energy (or atomic energy) is the energy released from the nucleus through nuclear reaction, which conforms to Einstein's mass energy equation $E=mc^2$ (E: energy, m: mass, c: speed of light). Nuclear energy can be released through one of three nuclear reactions: I) nuclear fission, and heavy nuclear fission releases nodule energy; II) nuclear fusion, where lighter nuclei aggregate to release nodule energy; III) nuclear decay, the release of energy during the spontaneous decay of atomic nuclei.

As a clean, safe, low-carbon and efficient base load energy, nuclear energy has been continuously developed in major nuclear countries in the world[10]. Nuclear energy also plays an active role in coping with climate change. The nuclear energy community is also actively exploring and developing advanced nuclear energy technology to solve the economic, safety and environmental problems in the development of nuclear energy[10]. Advanced nuclear energy technology should comprehensively consider the three aspects of nuclear fuel, nuclear waste and nuclear non-proliferation, so as to realize the safe development and utilization of nuclear energy. At the beginning of this century, the Generation IV International Forum (GIF) candidate six reactor technologies for further research and development, including lead cooled fast reactor (LFR), molten salt reactor (MSR), gas cooled fast reactor (GFR), supercritical water cooled reactor (SCWR), very high temperature reactor and sodium cooled fast reactor (SFR)[11,12].

The continuous development of advanced nuclear energy technology is an effective guarantee for the safe use of nuclear energy in the world. In today's environment of serious shortage of resources in the world, the development of advanced nuclear energy technology can't wait, and all teams are constantly tackling difficulties and solving some problems. For example, scaling is an important issue in nuclear reactor safety analysis. Since Carbiener and Cudnik[13] and Nahavandi[14] developed linear scaling methods for different equations (carbiener and cudnik (1969) and nahavandi et al independently developed a linear scaling method with different equations, after continuous research, Yun[15] et al proposed an improved linear scaling method, and the improved linear scaling method has the same geometric similarity criteria as the linear scaling method . It is believed that through continuous research and development, nuclear energy technology will become a safe and economical new energy technology.

3.2 Solar energy technology

Solar energy refers to the thermal radiant energy of the sun, mainly in the form of solar light. It is the radiant energy from the sun, which is generated by the huge nuclear energy released by the hydrogen helium fusion of hydrogen atoms in the sun. Solar energy is the energy generated by the continuous nuclear fusion reaction inside the sun. The average solar radiation intensity in earth orbit is 1,369 W/m², and the energy obtained by the earth can reach 173,000 TW. If these energy are stored and utilized with advanced technology, it will bring great benefits to resource and environmental protection and social and economic development.

As a typical and important renewable energy, solar energy has advantages in cost-effectiveness, cleanliness, availability and efficiency. It is considered to be the best alternative and the most promising development direction for future energy prospects[16,17]. Solar energy technology includes solar photothermal utilization technology and solar photoelectric utilization technology. Solar photothermal utilization technology is widely used in heat collecting elements and solar

thermal utilization systems. It is one of the solar energy utilization methods and technologies with the highest degree of commercialization, the most common promotion and application, the most promising and most likely to replace fossil energy consumption in the field of renewable energy technology. Solar photovoltaic technology is mainly solar photovoltaic power generation. Its basic principle is: the electronic device such as solar cell can effectively absorb solar thermal radiation and convert it into electric energy. The research of solar energy technology will greatly promote the development of energy conservation and new energy technology.

3.3 Geothermal energy technology

Geothermal energy is the natural heat energy extracted from the earth's crust. This energy comes from the lava in the earth's interior and exists in the form of heat. The simplest and most cost-effective way to use geothermal energy is to directly use these heat sources and extract their energy. The best utilization of high-temperature geothermal resources is geothermal power generation. Geothermal at 200 ~ 400 °C can be directly used for power generation. The development and application of geothermal energy technology will greatly alleviate the pressure caused by resource consumption.

Geothermal energy is a new energy with great potential, but the current geothermal system is still in the early stage of development. The maturity of geothermal energy technology requires long-term strategic methods and a large amount of R & D investment, and comprehensive and interdisciplinary research plans to solve the technical, economic, ecological and security challenges in the process chain of geothermal system[18]. In the process of geothermal energy development, enhanced geothermal systems (EGSs) technology plays a key role[19-21]. It uses engineering technology to build fracture network in underground high-temperature rock (rock mass is dense without natural fractures) or improve the original fracture network (there are natural fractures in rock mass, but the permeability is not enough). The constructed or improved fracture network has sufficient permeability, The rock volume and fracture surface area are large enough to make the temperature of cold water injected from the surface rise after returning to the surface through the fracture network, and flash or double cycle power generation / heating is used. The maturity of EGS technology will have a far-reaching impact on environmental protection and sustainable development of resources.

3.4 Ocean energy technology

Ocean energy refers to renewable energy attached to seawater. The ocean receives, stores and emits energy through various physical processes. These energy exist in the ocean in the form of tidal energy, wave energy, temperature difference energy, salt difference energy, ocean current energy and so on. Ocean energy technology refers to the use of certain methods and equipment to convert all kinds of ocean energy into electric energy or other available forms of energy. As marine energy has the advantages of renewability and no environmental pollution, it is a new energy of strategic significance that needs to be developed urgently[22].

Marine power generation technology is a key technology for the utilization of marine energy. It includes tidal power generation, offshore wind energy, wave power generation, ocean current power generation and marine thermal power generation. It is considered to be the key to achieve the long-term goal of reducing carbon dioxide emissions[23]. Among them, tidal power generation is the most mature technology and the largest utilization scale in marine energy, The total installed capacity of tidal power stations in the world is more than 265 MW. Marine energy is a clean and economical renewable energy. The development of marine energy power generation technology will greatly reduce the consumption of fossil energy and make great contributions to world environmental governance / resource protection and economic development[23,24].

4. Economic impact of renewable energy

Today's world economy is not only dominated by knowledge, but also based on energy. The dependence of national economic and social development on energy is also increasing. Energy is an important basis for national economic development and a basic material guarantee for production and life. The fundamental purpose of the research and development of renewable energy is to reduce the consumption of fossil resources, protect and save resources, and realize the sustainable development of resources. In the process of renewable energy technology development, how to weigh the relationship between renewable energy and economic development is a problem that people must think carefully.

The rapid development of renewable energy technology is bound to drive economic growth, but we must not destroy the balance of world economic development in the world environment and achieve balanced and sustainable economic growth. Considering the steady state of the economic balanced growth path and the relationship between the growth rate, the growth rate and the output of resource semi-finished products, as well as the influence of stability, are important factors for the regeneration of resources to economic growth. IRENA reports explained the role of renewable energy investment in promoting the economy and pointed out that by 2030, the share of renewable energy in the global energy structure will double, driving the increase of global GDP by 1.1%. In addition, the significant benefit of renewable energy investment is to affect trade, contribute to trade balance and increase GDP.

5. Conclusion

This paper is a brief overview of renewable energy technology and the relationship between renewable energy development and economic development. In today's world, fossil resources are basically exhausted, and the research and development of new energy technology is imminent. Many countries have issued corresponding policies to provide a strong guarantee for the development of renewable energy. With the strong support of the state and people, the development of new technologies has driven the development of social economy at the same time. At the same time, the balance between energy development and economic development should be considered, and the sustainable development of energy and economy should be realized at the same time. At present, solar energy and marine energy technologies are becoming mature, nuclear energy and geothermal energy technologies are also developing continuously, and the world economy has a bright future. Compared with traditional energy, renewable energy has a more far-reaching impact on social economy. Renewable energy technology has been an important technology to promote social development. The maturity of renewable energy technology will mean the sustainable development of resources and economy.

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