A Brief Study on Clean Energy

Dong Zhang[1,a,*]

Pepperdine University, Malibu, United States
zhangdongzjb@gmail.com

***Keywords*:** clean energy; productivity; GDP

***Abstract*:** Nowadays, clean energy has become a hot topic, and many countries have approved new policies on clean energy. In this research, we would introduce different types of clean energy, and discuss the positive relationships between clean energy, production, and productivity. On this basis, we will further clarify the important role that clean energy in the development of Gross Domestic Product (GDP) from the expenditure approach. Last but not least, we would give suggestions on global cooperation on clean energy.

1. Introduction:

Nowadays, the world is highly depending on energies, such as fuel, coal, and other high demand traditional energies. Energies lead the modern world to develop faster and move forward. However, traditional energies are limited and non-renewable. Therefore, as we always can learn from the news, many countries are fighting over on energies' supplies and consumptions; Because of every country's technology development and economy development are building upon energies. Due to the limitation of traditional energies, the new concept of clean energy, which also to be called renewable energy, becomes a really hot topic around the world. According to U.S. Energy Information Administration (EIA), clean energy could generally defined as "energy from sources that are naturally replenishing but flow-limited". The most popular and well-know clean energies are wind, solar, and hydropower. There are also lots of other clean energies are using for different purpose of development. According to International Energy Agency (IEA), the production of clean energy and consumption of clean energy have been increased dramatically in the last few decades. As a result of new clean energy technology progress, the supply of clean energies has been increased and clean energies have been widely used in many aspect of our life. The consumption of clean energies has been increased for many developed and developing countries, such as China, United States, and Europe. Moreover, depending on the data on the Organization for Economic Co-operation and Development, many countries' production and Gross Domestic Product (GDP) has boost up in the last of couple decades, such as China, United States, and Europe. The usage of clean energy and new clean energy technology may play important roles in the countries' production and economy development. In the research, we want to discuss and learn different types of clean energy. Furthermore, we would study the correlation between countries' clean energy consumption and countries' production and Gross Domestic Product (GDP). At the last, we would discuss how the world could develop all together from clean energy aspect.

2. Categories of Clean Energy:

According to the data from IEA, the total amount of clean energy supply has been increased in the last decade. Also, depending on the trend, the statistic data predicts that the supply of clean energy would be keep increasing in the next five years. For the increasing supply of clean energy, different clean energy supply technologies are playing huge roles, and variety clean energy supply technologies are using for many different aspects in our life. The major three usage of clean energy are electricity, heat, and transport. Moreover, depending on many factors, such as geography, technology cost, and other variable factors, many countries are using different technologies for clean energy supply. We are going to learn more about the clean energy supply technologies in this section.

（1）Bioenergy

Bioenergy takes a huge percentage in the clean energy technology world. According to the new statistic data on clean energy from IEA, the Bioenergy supplies almost 9% of the world energy consumption, and take half of the clean energy supply. Bioenergy is also called as Biomass Energy technology, which could simply defined as “the energy from organic matter”. In the traditional usage for Biomass is for cooking and heating, which cause lots of environment problems and pollutions. However, the modern bioenergy technology is playing a huge role in clean energy. According to the Renewable Energy World, the bioenergy would also split into three catalogs, which are Biofuels, Biopower, and Bioproducts. Biofuels is a technology that “converting biomass into liquid fuels for transportation ”. The other usage of Biomass is to burning biomass directly to generate electricity, which is concluding as Biopower. Moreover, Bioproducts is to convert biomass into chemicals for making products. The Bioenergy is widely using for transportation, heating, and electricity. According to the 2017 data from IEA, the clean energy consumption by bioenergy is 460.1Mtoe, and experts predict that the consumption by bioenergy would increase by 75.90Mtoe in 2023. Moreover, European Union is the top consumer for bioenergy, and followed by United State and Brazil. In 2017, European Union consumed 116.3Mtoe in bioenergy, which takes over 25% of the world bioenergy consumption.

（2）Hydropower

Hydropower is the second major clean energy supply technology in the world. It is the largest resource of clean electricity in the world. According to the IEA, hydropower producing around 16% of the world electricity. According to the study, after Bioenergy covers 50% of clean energy consumption, Hydropower responsible for 31% of the world clean energy consumption in 2017. The hydropower technology could generally define as “flowing water creates energy that can be captured and turned into electricity.” According to the Renewable Energy World, the most knowable technology of hydropower is to use a dam on a river to save water in a reservoir. The reservoir flows through a turbine, in which the generator could produce electricity. In 2017, the hydropower has generate and product 283.5Mtoe of energy. Professions believe that in the next five years the consumption of hydropower would increase by 31.4Mtoe. Hydropower is a mature technology, and it has been keep developing in the most recent of years. China is the top user for hydropower. The country consumes 84.7Mtoe in 2017 and the number would increase to 92.2Mtoe in 2013. Hydropower takes almost 50% of China’s clean energy consumption and China also has the top technology on hydropower.

（3）Wind

Wind technology is the third biggest clean technology in the world. According to the IEA, in 2017 the Wind technology consumption covers 9%, which is 84.7Mtoe, of the world clean energy consumption. In the next year, the coverage of wind energy would increase to 12%, which increase by 58.4Mtoe. The wind energy is one of the most traditional clean energy in the human history. People from hundreds of years ago were using windmills to pumping water. In the modern world, countries

use wind turbines to generate electricity. There are two different types of generation methods, which are onshore wind turbines and offshore wind turbines. The main different between those two methods is the location of the wind turbines. The offshore project is usually building in the ocean, which has the better wind resources than the onshore sites. The top consumers for wind energy are European Union, China, and United States. Due to different countries policy and technology development on Wind energy, Experts expect the wind power consumption would make huge progress in the next five years.

（4）Solar

Solar energy technology is a hot topic and developing more comprehensive in the last decades. The concept of solar energy is "the conversion of sunlight into usable energy forms". Due to the progress in the solar technology development, the solar system is widely using in many aspect of our daily life. The solar energy technology is including Solar photovoltaic (PV), solar thermal electricity, and solar heating and cooling. According to the statistics data, solar takes 8% of the market share in clean energy consumption of 2017. In 2023, the experts predict that the consumption on Solar would be increase to 12%, which takes bigger role in the clean energy world. Between all solar technologies, Solar Photovoltaic technology is the most popular technology and widely used for people's daily life. In 2017, Solar PV technology consumption is 34.2Mtoe and may increase to 58.1Mtoe in 2023. Solar Photovoltaic is a technology could directly convert solar energy into electricity. The advantage of Solar PV technology is that the module could be done in both large plants and small individual applications. For example, many countries have using solar PV technology to build utility scale power generation facilities, which also apply to concept of economies of scale. Moreover, solar PV system also can apply to calculators and road lights. The most common usage of solar PV system is household solar panel, which installing in each household to provide electricity for daily use of the family. This system could reduce the household's electricity bills, and also be more productive in electricity. Nowadays, European Union is the biggest consumer for solar energy. However, the due to projects development, experts are predicting that China consume in solar energy would be double than European Union in 2023 and become the biggest consumer in solar energy.

（5）Others

There are also lots of other commonly used clean energy technologies, such as Geothermal and Ocean energy. Even though those clean energy supply technologies take small market shares in the clean energy world, these still produce a huge quantity of clean energy and use widely in many aspects of our life. For example, geothermal energy generally usage is "providing heating, cooling, and base-load power generation from high-temperature hydrothermal resources, aquifer systems with low and medium temperatures, and hot rock resources". Due to more limitation than other clean energy technology, the geothermal energy consumption in 2017 is 21.7Mtoe, which is lower than other types of clean energy. Moreover, Ocean energy takes the smallest portion of clean energy world, because it is still in the developing phrase. The major five ocean energy technologies in development are tidal power, tidal currents, wave power, temperature gradients, and salinity gradients. Those new clean energy technologies are looking in a bright future.

3. The Relationship Between Clean Energy, Production, and Productivity

There are many economics indicators and methods to analyze countries' economic positions and economic situations. One of the main economics indictor is Productivity. Productivity is an important factor to measuring economics efficiency and economics development trend. Productivity is commonly defined as the ratio of output per unit input, such as land, capital, and labor. Many research studies and statistic studies indicate that clean energies have positive effect on countries' productivity and countries' production. After study into the topic, there are four main factors to

explain the positive relationship between clean energy and productivity, which are more jobs, energy efficiency, economic of scales, and human welfare.

（1）More job opportunity

As a common knowledge, a new industry would bring many new businesses and new job opportunities to the world and every country. For clean energy, many new clean energy technologies would expand as many new industries and bring many investors to open their own businesses, such as solar companies, new energy auto companies, and many other companies that involve in clean energy field. Those new businesses would provide job opportunities to many different types of workers, from skilled workers to unskilled workers. This would help more unemployment workers to get job offers and to start producing for those clean energy technology companies. With more job opportunity that created by clean energy industries, countries' unemployment rate may starts to decreasing for the most recent of years. In the contrast, with more clean energy industries' job opportunity, the countries' labor force participation rate would begin to increase in the most recent of years. With increasing labor force participation rate, companies' production amount and countries' production amount would both grow to a new level.

（2）Energy efficiency

The traditional energy sources, such as fuel, coal, and other commonly used non-renewable energies, are limited and very costly. However, energy is essential for most of the companies and manufactories during their operation and development. Therefore, many businesses and manufactories have huge energy expenses, which take a huge part from their limited capitals and resources. For example, according to the statistic data from EIA annual energy outlook 2019, the average energy cost by coal is $0.12-0.13/kW-hr. On the other hand, the average energy cost by Solar PV is $0.038/kW-hr. As we can see the clean energy cost is much cheaper than the traditional energy. With the same amount of output, the clean energy would be more efficiency than the traditional energy source. Thus, companies could save huge part of their capital by using clean energy technology. Companies could relocate their capital and resources to other aspects, such as buying new equipment, hiring more employees, and building more plants. By relocating companies' capital and resources to other development, those companies could increase their production and maximize their profits.

（3）Economic of scales

Economic of scales could generally be explained as that cost per unit would decrease when companies' production becomes more efficient. Economic of scales could also apply to clean energy manufactories. Clean energy manufactories usually open a huge plant, where they build solar PV or wind turbines as many as possible in one plant. Those huge plants would generate more solar or wind energy at the same time, which is more productive and efficient than other individual facilities. Furthermore, big clean energy manufactories would use the same amount of equipment to convert more clean energy into electricity or other form of energies, which lower the cost of good for each unit of power. This strategy would help those manufactories to maximize their production and minimize their cost, which achieve the economic of scales and increase their profit at the same time.

（4）Human Welfare

Clean energy technology would also improve human welfare in many aspects. First of all, as we all know, using traditional energy, such as burning coals, would produce different gases, which increase the temperature and cause global warming. The global warming would bring negative effect on many countries. The problem would not only affect on people's life quality, but also effect on countries' economics and production. In the short-term, global warming problem takes lots of skilled workers to discover a way to solve the issue, in which those skilled workers could be more valuable on countries' production. In the long-term, global warming issue would higher the sea level. This could cause many countries loose their productivity lands, which decrease those

countries' production. Therefore, promoting clean energy to the world could help with global warming problems, in order to increase productivity and production for many countries. Moreover, for many developing areas and countries, clean energy technology could increase the coverage rate on electricity. For example, in many developing countries, some of the areas do not have electricity covered. Their living is only based on basic agriculture and minor unskilled labor work. With solar PV or wind turbines technology build into the area, those places would have electricity covered, which would improve the people's life quality and areas' economics. With electricity and more energy, people could adopt better technologies into their production process, which achieve higher work efficiency and greater productivity. Also, with clean energy technologies, developing areas would be closer to rest of the world, thus people in those areas could join the labor force and contribute to productions.

4. Clean Energy Production and GDP

After learning about clean energy, we have a better picture on how clean energy affect on people's life and countries' production. Furthermore, people believe that clean energy technologies would also bring many positive influences on countries' economics. For example, clean energy technologies may have positive relationship with countries' Gross Domestic Product (GDP), which is a main indicator for countries' economic position. There are three approaches on GDP calculation, which are expenditure approach, production approach, and income approach. We would focus on discussing the relationship between clean energy technology and GDP from expenditure approach.

From the expenditure approach, Gross Domestic Product (GDP) = consumption + investment + government expenditure + exports – imports.

According to data, many developed and developing countries are still imports huge amount of fuels from middle-east countries. Those developed and developing countries' majority of traditional energy is highly depending on imports. However, with fast development on clean energy technology, many countries have slowly decrease imports energy from other countries, such as China, European Union, and United States. According to the equation, we assume other variables stay the same, decreasing in import of traditional energy would increase the country's GDP. In the long term, with more advanced clean energy technologies, the production on clean energy would increase. Therefore, with greater clean energy technologies and higher clean energy output, many countries may ideally start to involving in clean energy exports and cutting traditional energy imports at the same time. Both actions would move countries' GDP at the same direction and boost countries economics position.

5. Conclusion:

After study and learn about clean energy in the modern world, we believe that clean energy would bring positive affect on countries' production and countries' GDP. It also would improve people's life quality and help the world to develop in many aspects. Nowadays, due to more advanced technology and more skilled workers, developed countries, like European Union, have clean energy widely used in many aspects of their daily life and economic developments. Therefore, developed countries are the top consumers of clean energy, and they take majority of market shares on clean energy industries. On the other hand, developing countries should start to pay more attention on clean energy technologies, since those technologies would bring bright future for countries' development and help improve the environment problems at the same time. Besides, environment problems are global issues, which every country in the world is responsible for them. Therefore, developed countries should guide other countries moving forward in the field of clean energy and promote the overall t progress of global economic and environmental development.

References

1. *Abolhosseini, S. (2014, April). A Review of Renewable Energy Supply and Energy Efficiency Technologies. IZA.*
2. *IEA - Shaping a secure and sustainable future for all. (n.d.). Retrieved from https://www.iea.org/*
3. *Organization for Economic Co-operation and Development. (n.d.). Retrieved July 19, 2019, from https://www.oecd.org/economy/*
4. *U.S. Energy Information Administration. (n.d.). Retrieved July 19, 2019, from https://www.eia.gov/energyexplained/?page=renewable_home*
5. *Bio Energy. (n.d.). Retrieved July 19, 2019, from https://www.renewableenergyworld.com/bioenergy/tech.html*
6. *Ritchie, H., & Roser, M. (2017, December 17). Renewable Energy. Retrieved from https://ourworldindata.org/renewable-energy*