Global Energy Interconnection and Environmental Protection

Xin-Dan ZHANG
North China Electric Power University, Beijing, China
18210860834@163.com

Keywords: Development Strategy, Global ENERGY Interconnection, Environment, Feasibility, Problems.

Abstract. The paper discussed a new development strategy—Global Energy Interconnection—and analyzed its role in promoting environmental protection. Typical serious environmental issues are presented at the beginning to show the irresistible and inevitable trend of clean and renewable energy replacing fossil energy in the future. Secondly, definition and key links of global energy interconnection based on Internet technology and clean energy are introduced. Thirdly, feasibility of global energy interconnection as well as positive effects it has on natural environment are analyzed. Besides, we can conclude some obstacles still exist which hinder GEI from developing on a large scale, like financial difficulties and secure obstacles, and give some suggestions on tackling these problems effectively and efficiently.

Introduction

Over the past three decades, the mass exploitation and utilization of fossil fuels has contributed to rapid evolution of human society from agricultural civilization to industrial civilization. However, it also resulted in a series of global environmental issues such as pollution and climate changes. Recently it was reported that global fossil energy consumption, almost four times than that in 1950, accounted for approximately 85% of total energy consumption in the 21st century, which undoubtedly laid a much heavier burden on our environment. Therefore, it is extremely urgent that our development pattern of excessive dependence on fossil energy should be improved and changed.

Due to non-regeneration and limited reserves of fossil energy, it is an irresistible and inevitable trend that clean and renewable energy will gradually take the place of fossil energy in the future. However, clean energy is not evenly distributed all around the world. On the one hand, many desolate places, located far away from load centers, are usually abundant with solar energy or wind energy. On the other hand, countries such as China and the United States, which require a large amount of power to support their industrial manufacture and social development, are relatively short of clean energy. This uneven distribution to a large extent hinders us from making full use of green energy. Therefore, from a long-term perspective, we are in urgent need of a new development strategy so as to achieve sustainable development of global energy and optimize the allocation of resources.

Aided by the third industrial revolution based on Internet technology, the idea of global energy interconnection emerges at the right moment with powerful scientific and technological supports. This concept was initially put forward in The 1st Global Energy Interconnection Conference held in March, 2016. On the basis of ultra-high voltage AC/DC and smart grid technologies, it is practicable and feasible to rely on GEI to ensure reliable energy supply for people all over the world and to promote environmental protection. However, financial difficulties and complicated international relations still remain big obstacles.

Analysis of Environmental Issues

Brief Introduction of the Current Situation of Environmental Issues

From a global perspective, the severity and seriousness of environmental problems have put us
in a dilemma. According to a worldwide survey in 2010, the carbon dioxide emitted by burning fossil fuels accounted for 56.6 percent of total greenhouse gas emissions and 73.8 percent of total carbon dioxide emissions. The density of carbon dioxide in the air has increased from 278 ppm to 400 ppm since the beginning of The Industrial Revolution in 1750. Besides, average land surface temperature had risen by 0.85°C from 1880 to 2012. If no quick and effective action is taken, the density of carbon dioxide in the air will exceed the alarm value of 450 ppm, in the meanwhile, global temperature will rise up to 4°C by the end of this century.[1]

A Widespread Environmental Problem—Smog

Smog, as a combination of smoke and frog, is a typical environmental issue which reflects the damaging effects of human activities on natural environment.

![Figure 1. Beijing’s Air Quality in 2013.](image)

Fig. 1 above is composed of 365 small photos taken by a citizen, which recorded Beijing’s air quality in 2013 vividly. Through careful observation, we will come to an obvious conclusion that Beijing was not shrouded in haze and fog only in 40 days! What’s more, among those 40 days with clear skies, almost one-third were in a period when the 22nd APEC Economic Leaders’ Meeting was held, during which tough policies were strictly implemented to limit daily production and manufacture of industries that are energy intensive or highly polluting.

![Figure 2. A Building in Smog.](image) ![Figure 3. Tian’an Men Rostrum in Smog.](image)

It is hard for us to recognize and identify the tourist attraction from Fig. 2 because the building was tightly wrapped by heavy smog. But if we uncover its mysterious veil by drawing distinct and clear outline, Tian’an men Rostrum, one of the most famous places of interest in China, is obviously presented to us as shown in Fig. 3. It indicates that the air was so foul and filthy that such a well-known historical site seemed to be invisible.

The Culprit of Environmental Issues

Environmental problems such as smog emerge one after another in recent years due to excessive emission of vehicle exhaust and industrial gas, which contributes to almost 80 percentage of PM 2.5. Therefore we may wonder where does exhaust come from and what is the real culprit of air
pollution. In fact, we depend on fossil energy to keep our homes warm in the winter, cool in the summer, and lit at night. It is the mass exploitation and utilization of fossil fuels that should be accountable and responsible for deteriorating environment. Consequently, taking aggravation of pollution and growing depletion of traditional fossil energy into consideration, we are in increasingly urgent need of environmental-friendly and renewable energy so as to achieve sustainable development.

GEI—An Effective and Efficient Way to Protect Our Environment

Definition of Global Energy Interconnection

The 1st Global Energy Interconnection Conference was held in Beijing, March, 2016. According to the former chairman of State grid called Zhen-ya Liu, global energy interconnection is a globally interconnected strong and smart grid with ultra-high voltage grid as the backbone, which will serve as a platform for extensive development, deployment and utilization of clean energy globally.[2] In brief, GEI is an integrated system covering smart grid, ultra-high voltage and clean energy.

The Reason to Choose Global Energy Interconnection

Finite and Non-renewable Fossil Fuels. In the light of BP (refers to British Petroleum) Statistical Review of World Energy (2014) by the World Energy Council, the total reserves of coal, oil and natural gas in 2014 was 891.5 billion tons, 238.2 billion tons, and 186 trillion cubic meters respectively, which are available for only 113 years, 53 years, and 55 years if energy consumption rate remains constant and steady. In addition, the amount of fossil fuels is limited and we cannot exploit or obtain extra fossil energy after running out of it. Therefore it is an irresistible and inevitable tendency that fossil energy will eventually be replaced by clean and renewable energy in the future.

Uneven Distribution of Clean Energy. Clean energy, including wind energy, hydro power and solar energy and so forth, are unevenly distributed all over the world. For instance, the strong gale in the Arctic has an annual average wind speed of 19 meters per second, which is twice as much as that of a typhoon of 12 force. On the other hand, in the tropics, particularly desolate deserts in equatorial areas, solar energy is extremely abundant because of long-time illumination of ultraviolet ray. Nevertheless, few or even no people settle in these areas while countries such as China and the United States, which usually lack clean energy, require a large amount of power so as to maintain or promote their economic and social development. So what is the effective remedy for uneven distribution of green energy? How to make full use of clean energy in an efficient way? Global Energy Interconnection emerges at the right moment.

Some Key Points of Global Energy Interconnection

Smart grid and ultra-high voltage are two indispensable and significant parts of global energy interconnection. Smart grid serves as a fundamental unit while ultra-high voltage plays the role of a carrier in power transmission.

Smart Grid. Smart grid is an electrical grid which includes a variety of operational and energy measures covering smart meters, smart appliances, renewable energy resources, and energy efficiency resources.[3] In a word, smart grid is the combination of reliable grid and advanced Internet technology.

What is known to us all is that Internet to a large extent contributes to the booming of electronic business, like Taobao and taxi-hailing Didi. It is quite obvious that Internet has provided us with much more convenience and substantially improved our living standards.

So what will happen if we combine Internet with electrical grid? Electricity will become a commodity of electronic markets where everyone is both producer and customer. For example, you can use social media such as Facebook, We-chat to sell redundant solar energy on your roof to a stranger who is waiting to charge his/her electric vehicle. Furthermore, in a drought year, you can also use hydro power which may be transmitted from the Amazons to meet daily needs.
Ultra-High Voltage. As a backbone, ultra-high voltage plays an important role in achieving electricity transmission with the maximum amount of efficiency and the minimum amount of loss.

Ultra-high voltage refers to high voltage ranging from 500 kilo-volt to 1000 kilo-volt. At the beginning, lower-grade voltage can be transformed into ultra-high voltage via transformers so as to improve transmission efficiency. Then electricity with higher-grade voltage will be transmitted from energy-intensive areas to load centers that lack clean energy, through underground or overhead transmission lines. After reaching the destination, in order to meet requirements of industrial and domestic activities, ultra-high voltage should be transformed into lower-grade voltage by grading decompression.

Through analyzing the following two equations, we can draw the conclusion that ultra-high voltage has an advantage in minimizing the loss of power during transmission.

\[ Q = I^2RT. \]  
\[ P = UI. \]

According to Joule law (Eq. 1), on the premise of constant resistance and time, the heat loss during transmission is directly proportional to the square of the current (\( Q \propto I^2 \)), so there is a strong incentive to reduce the current by as much as possible. In light of Eq. 2, for a given amount of electric power, the current is inversely proportional to the voltage. As a consequence, the higher the voltage becomes, the lower the current is, so is the heat loss in transmission lines.

It is proved that within an entire country, energy resources are usually located far away from load centers. Take China for example. The majority of hydropower resources are in the west, and coal is in the northwest, but huge load centers are in the east and south. Based on the uneven distribution of natural resources, it is a far-sighted and reasonable strategy for China to go for ultra-high voltage transmission so as to reduce transmission loss to a manageable level. As the State Grid Corporation of China announced at the 2009 International Conference on UHV Power Transmission in Beijing, China will invest RMB 600 Billion (approx. USD 88 Billion) into UHV development between now and 2020. [4]

Environment Benefits

Global energy interconnection can help to reduce carbon dioxide emissions by half and prevent global warming from getting more serious. It is well-known that global warming has resulted in various kinds of abnormal phenomena, for example, rapidly melting glaciers in polar regions, rising sea levels and frequent coastal flooding, and even catastrophic natural disasters. Besides, temperature fluctuations continually give rise to habitat destruction and climate change, which to a great extent increase the risk of species extinction.

It is predicted that by 2050 when global energy interconnection is basically constructed and global clean energy supply is equal to 24 billion tons of standard coal, carbon dioxide emissions will be controlled within 11.5 billion tons, about half of that in the 1990s, so that the goal of controlling the temperature rise within 2°C will be realized.

Feasibility of Global Energy Interconnection

In China, ultra-high voltage technology could be a powerful foundation for building global energy interconnection. In 2009, the world's first ultra-high voltage transmission line operated for commercial use was born in China. If we focus on China's power grid construction nowadays, ultra-high voltage is undoubtedly the most prominent and indispensable component. For instance, "three alternating current and four direct current" project is under construction; 16 large ultra-high voltage transmission lines stretch across the north and south, east and west.

In a global view, Europe gives an excellent example of interconnecting national energy grids across borders for mutual benefits, including load leveling or sharing between utilities, increased system reliability, improved frequency and voltage control, deferral of additional generation, and emergency options for system operators.[5]

Therefore, with advanced technology and sophisticated management system, global energy
interconnection enjoys huge market potential and has good prospects for development.

**Obstacles to the Development of GEI**

Although global energy interconnection is proved to be promising, it is inevitable that many problems may arise such as fund shortage, technical difficulties, and potential safety hazards. Among those obstacles, lack of finance and security may be the most difficult and tough to tackle.

**The Financial Problem**

Who will pay for the construction of such a huge global energy interconnection? Relatively poor and developing countries that require adequate and reliable energy supply, or rich and developed nations? Take our country for example, China's per capita Gross Domestic Product ranked only 80 in the world and 200 million people have not been lifted out of poverty until now. We can go nowhere without powerful support of sufficient finance.

**The Secure Problem**

Global energy interconnection must be established on the basis of mutual tolerance and cooperation among nations. However, different countries differ in their political systems and social values, as well as national core interests and major concerns. If conflicts or even war occur between countries, global energy interconnection will become the prime victim, that is to say, it will break down immediately.

What’s more, it is most likely that terrorists will attack and damage global energy interconnection if it is built. The whole power grid around the world will collapse in a short time and it will take a long time to repair the loophole. Without power supply to meet daily demands for electricity, the whole world will fall into chaos with unrest and protests emerging endlessly.

**Advice on Solving These Obstacles**

It is necessary for us to strive to create an international cooperation organization dealing with matters about global energy interconnection. The establishment of cooperation organization will play a significant role in building effective international cooperation mechanism among different nations and various fields. Global energy interconnection will be promoted by the convergence of global wisdom and cohesiveness of global strength. As for our country, China’s cooperation with other countries should be in accordance with the national strategy---"the Belt and Road". Only in this way can we implement policies on GEI more effectively and realize our common interests.

In addition, we should reinforce intelligent terminal protection with the purpose of ensuring safety. Professional technicians should be appointed to check intelligent terminals carefully in the manufacturing process, and point out the division between terminal management permissions and user rights, as well as make sure that the terminal intrusion warning system is sophisticated by improving intelligent terminal encryption level and updating management system regularly.

**Summary**

Due to increasingly deteriorating environment and gradually exhausted fossil fuels, people always look for a development strategy of energy with greater reliability and lower pollution. With adequate investment as well as support from both government and international cooperation, global energy interconnection has a booming prospect by virtue of smart grid and ultra-high voltage, and will to a large extent contribute to environmental protection efficiently and effectively.

**Acknowledgement**

The research was financially supported by the No.261 of Undergraduate Training Program for Innovation and Entrepreneurship Foundation of the North China Electric Power University.
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