

Making Tremendous Efforts to Promote the Development of Wind Power Generation Centering on Low-carbon Cities

1. Foreword

With the continuously inadequate supply of energy sources, wind energy, as a type of clean and renewable sources of energy that can be supplied forever, is attracting more and more attentions from all the countries in the world. China is abundant in wind energy resource, which is mainly distributed at “Three-North” areas (northwest, north and northeast of China) and coastal regions in the east China, known as wind energy belts. Kyoto Protocol requires the industrially developed countries to cut down the emission of greenhouse gases such as CO₂ on a large scale; which urges people to make more efforts to explore other renewable alternative sources of energy. Wind power becomes one of main alternative energy resources, especially for the coastal islands, meadows, mountainous areas and plateaus where the supply of water and fuels is lacking and the traffic is inconvenient. Therefore, it will be surely promising to utilize wind power to produce electricity according the local practical conditions.

2. Basic concepts and advancement

2.1 Theories on low-carbon cities

The development of low-carbon cities means to keep energy consumption and CO₂ emission at a low level under the speedy growth of economy. Isabelle, president of WWF at the Asian-Pacific region once pointed out: “with the fast development of economy and increase in energy consumption, China is playing a very important role in reducing the emission of greenhouse gases. Low-carbon projects are one example; governments, enterprises and non-government organizations should work together and take actions to seek solutions for climatic change”.

The low-carbon cities should be constructed on the following principles: development of low-carbon energy offers basic guarantee for the construction the low-carbon cities; clean production is a key link for the construction of low-carbon cities; circulative utilization is an effective means for the construction of low-carbon cities; sustainable development is the final target for the construction of low-carbon cities^[1].

2.2 Theories on wind power generation

Wind energy, as a type of clean and renewable sources of energy, is chiefly utilized either as the power directly or by converting it into power energy. Utilization of wind energy is attracting extensive attentions from all the counties in the world. As wind energy is an endless resource producing no poisonous and harmful wastes as well as greenhouse gases, a majority of countries have listed it into their state development planning as a new type of alternative energy in the 21st century. In the

face of various problems caused by the globalization, the international communities attach much importance to the utilization of new renewable sources of energy. Among them, wind energy is considered as a renewable source of energy with the lowest price and most sophisticated technology.

Wind power resource is a clean and renewable source of energy, and wind power generation has become one of power-generating means boasting of the most sophisticated technology, most favorable conditions for large-scale development and the optimal commercial prospects. Many countries in the world, especially the developed countries, have got a full knowledge of the importance of wind power in adjusting energy mix and mitigating environmental pollution and they have paid more attentions to the development of wind power generation.

3. Planning for wind power generation

Scientific urban planning is pre-requisite to the construction of low-carbon cities. As China's urban planning shows strong rigidity, that is, it's hard to alter once formulated and implement. Therefore, the planning and design of low-carbon cities should aim at more economic vigor of the cities, superior environmental quality and ecological conservation, convenient and smooth traffic, enjoyable green buildings, clean and effective low-carbon energy resources, as well as healthy and sober-minded. life styles^[2]. Energy consumption in cities will exert a direct effect on the environmental quality in the neighborhood; consequently, in the urban planning, we should not only give consideration to the characteristics of an individual city, but attach importance to the construction of low-carbon cities in combination of the regional and national development strategies.

In the urban planning for development, we should decelerate the development of the high-carbon industry and raise its development quality; accelerate the adjustment of economic structures; make more efforts to update techniques, equipment and eliminate enterprises resulting in pollution; raise standards for emission from various enterprises; enhance the conditions for access to such industries as iron and steel, non-ferrous metals, construction materials, chemical industry, electric power and light industry, which is to say, we should ensure the principle of sustainable development in conformity to overall planning at headstream, and impel the development of city to the way of low-carbon at planning stage.

4. Necessities of Wind Power Generation

4.1 Driving force of Environment

The environmental benefit of wind power mainly include no emission of any harmful gas and no consumption of water resource thereby reduce pollution caused by coal combustion, such as soot and other inhalable particles, diseases caused by SO₂, nitrogen oxides, and other toxicants and harmful gases. SO₂ and nitrogen oxides in the air will be converted into acidic substance and form acid rain, which does harm to plants and animals in the water body and destroys the ecosystem. Moreover, CO₂ emitted during coal combustion is a kind of greenhouse gas affecting global warming. Coal-fired power plants with their technologies are able to realize de-sulfide and

de-nitrification so to reduce emission of SO₂ and nitrogen oxides. However, emission of CO₂ can not be avoided. Therefore, the main contribution of wind power generation is reduction in the emission of CO₂ in environment

Besides such regional pollution as smoke and SO₂ that people early knew, more and more people in the world get acquainted with the adverse effects of global warming caused by the massive emission of CO₂ and other greenhouse gases on the human society, such as iceberg ablation, rise of sea level, frequent eruption of natural disasters caused by atmospheric circulation, ocean anomaly and land desertification. The obvious effect of "earth village" urges every country to take measures simultaneously to slow down and affect this change. In order to mitigate global warming, representatives from 84 countries discussed and approved *Kyoto Protocol* at the 3rd conference of parties to United Nations Framework Convention on Climate Change held at Kyoto of Japan in 1997. This protocol requires the industrially developed countries to cut down emission of greenhouse gases such as CO₂ on a large scale. This also urges people to make more efforts in exploring other renewable alternative energies, among which, wind power during energy conversion process produces no effluent so it not only cannot cause regional pollution such as smoke and SO₂ but also cannot result in worldwide environmental pollution^[4].

4.2 Evaluation of Environmental Benefits

To generate electricity with wind power instead of high-carbon fuels so as to reduce emission of CO₂. Emission rate of CO₂ caused by coal combustion is as follows:^[5]

$$G_{CO_2} = B \times Q \times E \times K_{CO_2} \times \lambda_{CO_2}$$

In the above formula, where

G_{CO_2} ——Emission rate of CO₂, kg/t ;

B ——Coal consumption, kg ;

Q ——Calorific value of 1kg coal, MJ/ kg ;

E ——Carbon emission of calorific value of 1kg coal, t/TJ ;

K_{CO_2} ——Oxidation ratio of carbon in the fuel

λ_{CO_2} ——Mole mass ratio between CO₂ and C, about 3.667.

The average value of China's coal based on measurement: calorific value of 1kg coal is 21.2 MJ/ kg; potential emission of carbon E is 24.74 t/TJ; oxidation ratio of carbon K_{CO_2} is 0.9. According to the above data, the emission rate of CO₂ is 1731 kg/t.

With advance of technologies, wind power generation can commercially compete with coal-fired power generation. At present stage, wind power generation is forming its competitive advantages over coal-fired and hydraulic power generation in the aspect of performance-price ratio. Wind power generation is characteristic of one-fold increase in generating capacity, 15% reduction of cost. That is to say, with domestication of wind power generating units and large-scale of power generation,

cost reduction is expected. So, more and more investors vie with each other to rake profits from wind power generation.

4.3 Necessities

To develop wind power generation can help adjust structures of energy sources. Coal-fired power generation, among all the power supply structures, accounts for up to 75%, which requires us to urgently increase the proportion of clean power such as wind power. In particular, wind power is an effective measure to reduce emission of CO₂ as well as other greenhouse gases and mitigate global warming. Although the coal-fired power plants can be equipped with de-sulfide devices, it's still hard to control the emission of CO₂.

Wind power resource is clean energy source without pollution. With its considerable environmental benefits and successively reduced generating cost, wind power certainly becomes important power of China in this century. Besides from power generating, wind power plants can also gain profits from sales of the reduced CO₂ emissions. This benefits from the flexible mechanism to reduce greenhouse gases---clean development mechanism (CDM) stated in Kyoto Protocol.

In the long history of human's utilizing energy sources, the conventional ones such as petroleum, coal and natural gas are after all for ephemeral use. China is the most populous country and second-largest energy consumer in the world. But China's energy consumption per capita is relatively low, which made it quite necessary to develop wind power generation. Both the fact that natural resources will run out and the concept of environmental protection requires developing wind power generation necessarily.

5. Conclusion

Wind power generation as a safe and reliable energy source, with characteristic of mature technologies and short construction periods, has become an energy product with largest development potential in the 21st century. In order to share clear sky more often and more sustainable energy sources, wind power generation in recent years has become a hot topic in terms of development of new energy sources in China. Relying on the advantage in respect of wind power resource, China is quickening its development in wind power generation industry, and blazes a new trail to sustainable development emphasizing on both energy conservation and reducing discharge. With its considerable environmental benefits and reduced generating cost, wind power certainly becomes important power of China in this century.

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Information for Authors

1. Pan Hongbo female, engineer of Liaoning North Environmental Protection Co., Ltd. Liaoning, china;

2. Zhu Jinghai, male, dual PHD degree, doctoral advisor, Part-time research fellow and vice director of Liaoning Provincial Bureau of Environmental Protection, member and executive director of Chinese Urban Planning Association; (Registered)

3. Fan Jijun, male, graduate student for master's degree, majoring in Urban Planning and Design at Shenyang Jianzhu University. (Registered)

4. Pan, Bo, female, graduate student for master's degree, majoring in Urban Planning and Design at Shenyang Jianzhu University.

Pan Hongbo¹ Zhu Jinghai² Fan Jijun³ Pan Bo⁴

1、 engineer of Liaoning North Environmental Protection Co., Ltd. Liaoning, China

2、 deputy director of Liaoning Provincial Department of Environmental Protection, professor, Ph.D. Supervisor Liaoning, China; (Registered)

3、 post graduate studying for doctor's degree, Shenyang Jianzhu University, Liaoning, China; (Registered)

4、 assistant teacher Shenyang Jianzhu University, Liaoning, China;