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OFFSHORE WIND POWER POTENTIAL IN EAST CHINA SEA

中国东部海域海洋风能潜力

吴晨生 刘 如 潘 伟 编著

兵器工业出版社

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内 容 简 介

中国面临着能源短缺的潜在威胁和与能源有关的空气污染严重的问题。推广风力发电是缓解这两个问题的关键措施。本书首先介绍了风力发电、离岸风力发电及其在全球的发展；其次分析了风能资源和风力发电在中国的发展；然后对上海最新海上风能项目进行个案研究，分析其给该地区带来的利益；最后对中国东海整个沿海区域扩大海上风力发电场，并在尊重能源生产和减少排放情况下，对其产量潜力进行了评估，提出在中国东海地区扩大离岸风力发电的建议。

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List of abbreviation

BT- billion tons

CBA- Cost Benefit Analysis

CEAA- Canadian Environmental Assessment Agency

CREIA- Chinese Renewable Energy Industry Association

CWEA- Chinese Wind Energy Association

EWEA- European Wind Energy Association

GW- giga watts

GHG- Green House Gas

IEA- International Energy Association

MT- mega tons

MW- mega watts

NDRC- National Development and Reform Commission

NPV- Net Present Value

NREL- National Renewable Energy Laboratory

OCD- Offshore Center Denmark

OECD- Organization for Economic Cooperation and Development

O&M- Operation and Maintenance

RERL- Renewable Energy Research Laboratory

SERC- State Electricity Regulatory Commission

TW- trillion watts

UNFCCC- United Nation Framework Convention on Climate
Change

WWEA- World Wind Energy Association

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Chapter 1 Introduction

1.1 Energy issues that China is facing

The concern of energy security in China is that Chinese economy is extremely reliant on a constant supply of energy and cannot abide the slightest interruption or shortfall. Since the early 1990s, China has become a net oil importer. In 2005, 182 million tons of crude oil was produced in China, which counted for only 56% of its total consumption (Zha Daojiong, 2006). Later in 2006, the consensus in the world oil market was that domestic oil production in China is set to stagnate or decline, making it increasingly integrant for China to seek supplies abroad to meet its energy needs.

On the other hand, coal has been a dominant energy source in China for decades and will continue ruling China's energy system, according to Chinese central government's pillar of its energy strategy. (Zha Daojiong, 2006) However, environmental and social consequence of China's coal industry is gathering. Coal-based power plant in China is emitting large amount of hazardous gases such as SO_2 and CO_2 . Coal mining accidents have made the fatality of coal mining 39% of total workplace accidents in China (Zha Daojiong, 2006).

Energy interruption has long been a potential concern in China, although there has not been a single case of deliberate interruption of energy moving from abroad. Supply interruptions could occur if the movement of foreign energy resources into China becomes problematic. Therefore, China is still facing potential concern of energy

shortage (Zha Daojiong, 2006).

Apart from energy security issues, energy related air pollution in China has caught more attention worldwide as China has become the world largest CO₂ emitter. Large amount of CO₂, SO₂, and NO_x from heavy industry, power plants, and transport sectors are released in the air and exasperated the environment in China and the sectors are released into the atmosphere and exacerbated local and global environment.

1.2 Addressing energy issues in China

In addressing these energy issues, China has been putting large effort on clean coal technology development, which can improve efficiency of coal combustion, reduce hazardous gas emission and hence mitigate air pollution. China is also doing research on carbon capture and storage technologies as a measure of reducing CO₂ emission in the atmosphere. However, as coal is a limited and the “dirtiest” energy resource, it cannot be relied on in the longer term with a sustainable development perspective. Based on that reason, Chinese government also set goals of achieving considerable energy consumption share of renewable energies including hydropower, biomass energy, wind energy, solar energy, and geothermal energy. Among them, wind power is mainly developed in north, northeast, and east part of China. Since the 1990s, China has developed large amount of onshore wind power, which contributes to both in-grid and off-grid electricity consumption. In recent years, China started to build offshore wind turbines in the East China Sea near Shanghai. On the other hand, the east part of China which includes Shanghai municipality, Jiangsu, Zhejiang, An-

hui and Fujian provinces, is largely dependent on the central and north part on energy supply because conventional energy sources are lacking in this region (OECD, 2006). By pursuing the approach of both energy security and clean energy, wind power is an excellent choice for China as the wind potential in China is estimated at 1,000 GW including onshore and offshore wind resources.

1.3 Wind power

Wind power is perceived as the answer to the global crisis. Apart from energy and environmental crisis, mankind is also facing a finance crisis. It is believed being able to offer a domestic, reliable, and clean energy supply. Offshore wind power has been developed mainly in Europe since the 1990s. Denmark is the precursor in this area. Many other European countries followed the step and became world leading offshore wind countries such as the UK and Germany. Offshore wind power has advantage upon the onshore in respect of larger capacity, more efficient energy generation, less impact to local residence. The trend of applying offshore wind power is nowadays wide spreading over the world. China has the initiative of implementing and expanding offshore wind power capacity to a significant amount. China has made constitution and plan of implementing renewable energy. Wind market in China is becoming mature with the governmental incentives and the participation of more domestic and foreign wind companies.

1.4 Problem formulation

We selected East China with dense population and economic as our research target. Since there is an offshore wind power project under construction just beside the East China region, we decided to take that project as a case study and finally give some suggestions for the country in achieving a blueprint of developing offshore wind power in the east coastal region of China.

Problem formulation

How to make it more feasible for China to implement offshore wind power along the east coast of China?

Sub-questions

What are the advantages and obstacles of implementing offshore wind power along the east coast of China?

What should be done in order to optimize wind power implementation along the east coast of China?

Chapter 2 Methodology

2.1 Project design

This is a literature based project. Information comes from multiple channels including energy authorities such as IEA, WWEA, CWEA, Chinese energy and planning officials, Danish energy journals, as well as individual articles and some online resources. We will unwrap our project by firstly take a closer look at some basics of wind power in chapter 3. Then offshore wind power and its development worldwide will be introduced in chapter 4. After that, we will study wind resource and wind power development in China including technology development and policy setting as well as the advantages and obstacles in chapter 5. Thereafter we plan to make a case study of the most current offshore wind power project in Shanghai to find out what benefit it can bring to the region in chapter 6. The case study will cover a cost-benefit analysis and a stakeholder analysis. The cost-benefit analysis aims to find out the economic mechanism involved in the project. The stakeholder analysis is an overall study of all players and their interests and influences to the project. In that way we will know which parts are soft spots and need to be strengthened. Then we will look into the whole coastal region of the East China Sea to make an assessment of expanding offshore wind farms in the coastal region and its potential yield in respect of energy production and emission reduction in chapter 7. Based on the technology and policy framework, as well as Chinese wind market that have devel-

oped so far, we will give our suggestions for expanding offshore wind power in the East China Sea region in the final chapter. Figure 1 is an outline of our project. In order to achieve our ultimate goal of making an assessment for the East China Sea region, we will start with the broadest sense which is on the top-left of the chart and continue with following the arrows to approach the core of our problems and try to solve it with all the information we will learn through the process.

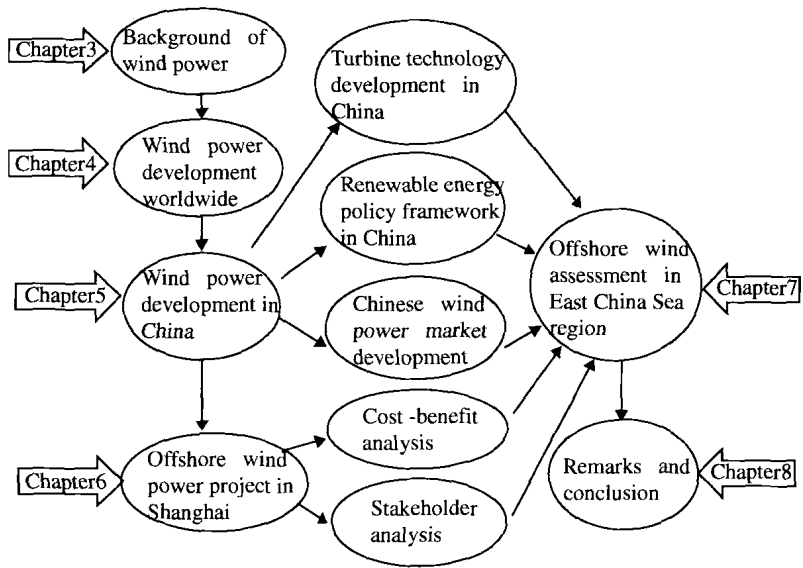


Figure 1 Flow chart of project design

2.2 Theories and concepts

2.2.1 Environmental assessment

Since we are attempting to make an environmental assessment,

we would like to firstly ensure that we understand what environment and assessment signify and what an environmental assessment involves.

Environment is a mixture of what physically exists and what is ruling the existing nature of the world. A combination of nature, policies, and planning, is understood as environment (H.S. Marcussen, 2003). In our case, we will be dealing more with policies and planning.

The general definition of assessment is a judgment of someone or something with respect to its value (WorldNet). In this case assessment will be a judgment of wind power potential along the east coast of China in term of amount of electricity and contribution to the entire consumption.

Environmental assessment is therefore an integration of judgment of nature, policies, and planning. It is a process to predict environmental risks and benefits of an initiative, and the measures to mitigate the risks (CEAA). This project is our attempt to make an assessment of offshore wind power in east China. The main task is to find out whether to implement offshore wind power in China is a feasible approach from technology, policy, economy, and stakeholder's standpoints.

2.2.2 Cost-benefit analysis

In this project, we will try to make a cost-benefit analysis (CBA) in the case study. A project has to be economically feasible to be implemented, especially offshore wind project with huge demand of initial investment cost. Due to the huge cost, investors are facing huge

risk of losing money in the business. Therefore a CBA is necessary to be made in order to obtain a vision for the investors throughout the project lifetime. CBA will be used in the case study and in our case the CBA will be calculations on all the positive and negative impacts of the whole project period and see which is grater to determine if the project is advisable or not (F. John Reh, 2009). Calculations will be in a broad sense just to acquire a general understanding of the economics embedded.

2.2.3 Stakeholders and stakeholder analysis

As always, when carrying out a project, there are different groups involved. They could have influence on the project, or be benefited or affected by the project. They are so-called “stakeholders”. In this project, a stakeholder analysis shall be done, uncovering that which stakeholders exist or may count, and their various equal degree of involvement. A stakeholder analysis is a method used to facilitate a planning (most often, a reformation) process by taking account of those who have a “stake” or an interest in the reforms. Reform advocates can choose how to best accommodate stakeholders who either have interests or oppositions, so that they may assure that policies adopted are politically realistic and sustainable. A stakeholder is any entity who has or may have interest or stake in a policy concern. The selection of stakeholders varies depending on the complexity of the reform area and the type of the reform. Stakeholders can be any form including international actors, national or political actors, public sector agencies, interest groups, commercial/private for-profit, nonprofit organizations, civil society members, and uses/consumers (World

Bank).

The stakeholder analysis will also be used in the case study. The aim is to have a better understanding of each stakeholder's position and influence on the project and among the stakeholders themselves. The analysis will end up with suggestions on how to make good use to positive influences and mitigate negative influences.

2.3 Limitations

As this project deals with wind turbine technologies as well as cost-benefit analysis, which is technological and economic intensive, we are not able to make detailed research into those areas, for instance how a turbine is made and how each component works. Due to limited time and knowledge barrier, researches about wind turbine and cost-benefit analysis will be quite plain and simplified. The aim is to get an idea or understanding of the pros and cons of developing offshore wind power in China. Besides, we did not have the chance to go to the news release conference of the wind project in Shanghai, nor could we interview any relevant Chinese officials about the future plan. To implement offshore wind power project is brand new in China. Though there are preferential policies made for renewable energy as a whole, no policies or institutions have been established exclusively for this area. Information of our case study is very limited as the project has just launched this year. We have to use some similar data from other authorities other than China when making calculations in CBA. All above makes our project challenging.