IMPERIAL COLLEGE LONDON

Faculty of Life Sciences

(University of London)

Centre of Environmental Policy

The way forward for the wind turbine industry of China

By

Lan YU

A report submitted in partial fulfillment of the requirement for the MSc and/or the DIC

September 2006

AUTHORISATION TO HOLD ELECTRONIC COPY OF MSc THESIS

Thesis title: The Way Forward for the Wind Turbine Industry of China

Author: Lan YU

I hereby assign to Imperial College London, Centre of Environmental Policy the right to hold an electronic copy of the thesis identified above and any supplemental tables, illustrations, appendices or other information submitted there with (the "thesis") in all forms and media, effective when and if the thesis is accepted by the college. This authorisation includes the right to adapt the presentation of the thesis abstract for use in conjunction with computer systems and programs, including reproduction or publication in machine-readable form and incorporation in electronic retrieval systems. Access to the thesis will be limited to ET MSc teaching staff and students and the can be extended to other College staff and students by permission of the ET MSc Course Director/Examiners Board.

Signed:___________________ Name printed:___________________

Date:_____________________

DECLARATIN OF OWN WORK

I declare that this thesis:

……………………………………………………………………………………….

……………………………………………………………………………………….

……………………………………………………………………………………….

is entirely my own work and that where any material could be construed as the work of others, it is fully cited and referenced, and/or with appropriate acknowledgement given.

Signature:…………………………..………………………………………..

Name of student:………………..…………………………………………

Name of supervisor:………………………………………………………

ABSTRACT

With the continuous development of wind power in China, Chinese government is starting to make efforts to support the establishment and development of local wind turbine industry.

In order to answer the question of why and how to promote the local wind turbine manufacturing, first of all, this thesis summarizes the up-to-date situation of wind turbine industry in China, and explores the potential benefit and barriers brought by the realization of large-scale local manufacturing. It also analyzes the international experience and lessons learnt in the field of wind turbine industry development from four typical country cases, concluding a stable local wind power market is the precondition for the development of local turbine manufacturing and indirect policies will help to create this stable local market.

Moreover, based on the semi-structured interviews with some of the professionals in China's wind power industry, the thesis identifies some key issues preventing the development of China's local wind turbine industry and proposes some priorities for further development.

Last but not the least, this thesis recommends that the feed-in tariff should be applied in China at this stage, and some other strategic recommendations are also suggested.

ACKNOWLEDGEMENTS

First of all, I would like to express sincere appreciation to my supervisor Robert Gross, for his valuable comments, guidance and continuous patience throughout the thesis period.

Meanwhile, I am grateful to all the interviewees listed in this report, for their unique views about China's wind power industry and up-to-date information provided. Without their help, it is almost impossible for me to get a relatively clearly understanding of China's wind power industry in such a short time.

I would also like to thank my parents and best friends for their love and support, which helped me to get through the hardest emotional experience in my life, in the summer of year 2006.

Finally, please allow me to take this thesis as a memory of both my life in London, and four years love with Plato, which are colourful, painful and unforgettable.

TABLE OF CONTENTS

Authorization to hold electric copy of MSc thesis	ii
Declaration of own work	iii
Abstract	iv
Acknowledgements	v
List of figures and tables	ix
List of Abbreviations	x

1 Introduction

1.1 Topic Introduction	1
1.1.1 Energy Demand and the Environmental Issues	1
1.1.2 Huge Market for Wind Power	2
1.1.3 The Importance of Wind Turbines	3
1.2 Aims and Objectives	4
1.3 Report Structures	5

2 Methodology

2.1 Primary Data Collection	7
2.2 Secondary Data Collection	9
2.2.1 Critical Literature Review	9
2.2.2 Case Study	10
2.2.3 Conference Attendance	10
2.3 Statement of Limitations	11
2.3.1 Objective Limitations	11
2.3.2 Subjective Limitations	11

3 Development Situation of Wind Energy Industry in China

3.1 Situation of Wind Farms in China	12
3.1.1 Installed Capacity	12
3.1.2 Wind Turbine Size	13
3.1.3 Market Shares of manufacturers	13
3.2 Situation of China's Wind Turbine Industry	14
3.2.1 Key Domestic Producers and Their Development Models	14
3.2.2 Technology and Standard Progress	16
3.2.3 International Manufacturers in China	17
3.3 Supportive Policies	18
3.3.1 Direct Policies	18
3.3.2 Indirect Policies	19
3.4 Conclusions	21

4 Benefits and Barriers of Local Manufacturing
4.1 Potential Benefits 22
4.1.1 Cost Reduction 22
4.1.2 Domestic Economic Development and Employment 24
4.1.3 International Exports 25
4.1.4 National Pride and Technological Achievement 26
4.2 Barriers of Localization 27
4.2.1 Technological Maturity 27
4.2.2 Lack of Skilled Turbine Design Staff 28
4.2.3 International Competition 28
4.2.4 Difficulty in Technology Acquisition 29
4.2.5 Unstable Wind Power Market 29
4.2.6 Lack of Certification and Testing Methods 30
4.3 Policies to Support Wind Industry Development 30
4.3.1 Direct Policies 31
4.3.2 Indirect Policies 33
4.4 Conclusions 35

5 Case Study
5.1 Traditional Wind power Market and Manufacturer—German Case 36
5.1.1 Wind Industry Overview 36
5.1.2 Direct Policies 38
5.1.3 Indirect Policies 40
5.1.4 Conclusions 41
5.2 A Successful Later Comer—Spanish Case 41
5.2.1 Wind Industry Overview 41
5.2.2 Direct Policies 43
5.2.3 Indirect Policies 44
5.2.4 Conclusions 45
5.3 India—Pioneer of Developing Countries 46
5.3.1 Wind Industry Overview 46
5.3.2 Direct Policies 47
5.3.3 Indirect Policies 48
5.3.4 Conclusions 49
5.4 Is Policy Always Working Well?—UK Case 50
5.4.1 Wind Industry Overview 50
5.4.2 Direct Policies 51
5.4.3 Indirect Policies 51
5.4.4 Conclusions 52
5.5 Conclusions 52

6 Findings from Semi-structured Interviews
6.1 Technical Barriers 56
6.1.1 Lack of Professional Staff 56
6.1.2 Disconnection between R&D and Production 57
6.1.3 Passivity of Enterprises 58
6.2 Unstable Policies 58
6.3 Mechanism Barriers 60
6.3.1 Formulation of Laws 60
6.3.2 Disconnection between Energy and Industry Strategy 61
6.3.3 Traditional Way of Thinking 61
6.3.4 Contrived Element 61
6.4 Issues for Further Development 61
6.4.1 The Importance of Local Manufacturing 62
6.4.2 Risk of Wind Power Development 62
6.4.3 Certification System 63
6.4.4 Offshore Wind Power 63
6.4.5 Indirect Policy Reform 63
6.4.6 Training Model 64
6.5 Conclusions 64

7 Discussions
7.1 Aims of Wind Power Development 65
7.2 Planning Strategy of Wind Power 66
7.2.1 Wind Resources Assessment 67
7.2.2 Power Grid Construction 67
7.2.3 Power Generation 68
7.3 Aims and Path for Wind Turbine Manufacturing Development 69
7.3.1 Strategy for Wind Turbine Manufacturing 69
7.3.2 Path of Local Manufacturing Development 70
7.4 Comparison of Three Potential Indirect Policies 71
7.5 Capacity Building 74
7.6 Conclusions 74

8 Conclusions
8.1 Summary of the Study 76
8.2 Strategic Recommendations 78

References 80
Appendix 86 – 94

LIST OF FIGURES AND TABLES

Figure 1.1 Annual Growth Comparison between GDP and Energy Consumption of China, 1980—2004

Figure 3.1 Cumulative and Annual Installed Capacity of Wind Farms in China 1985—2005

Figure 4.1 Annual Wind Energy R&D Budget by Country 1974-2003

Figure 5.1 Annual & Cumulative Installed Capacity of Wind Energy in Germany 1990-2005

Figure 5.2 Market Shares of Wind Turbine in Germany 2005

Figure 5.3 Development of Electricity Prices, Representative Household Customers, Euro2004/MWh

Figure 5.4 Market Share of Spanish Wind Power in 2005

Figure 5.5 Annual and Accumulative Installed Capacity of Wind Energy in India 1990-2005

Figure 5.6 Annual and Accumulative Installed Capacity of Wind Energy in UK 1990-2005

Figure 5.7 Market Shares from 2003—2005

Figure 5.8 Top 10 Suppliers and Their Market Shares in 2005

Table 1.1 Installed Capacity of Wind Energy in 2005

Table 3.1 The Cumulative Market Share of Manufacturers to 2005

Table 4.1 Preliminary Quoted Prices of WTG in Chinese Wind Concession Projects

Table 4.2 Export Ranking of Manufacturers in 2005

LIST OF ABBREVIATIONS

CRESP	China Renewable Energy Scale-up Program
EEG	Renewable Energy Act
EFL	Electricity Feed Law
FYP	Five-Year Plan
GDP	Gross Domestic Product
GHG	Greenhouse Gas
MNES	Ministry of Non-Conventional Energy Sources
MOF	Ministry of Finance
MOST	Ministry of Science and Technology
NDRC	National Development and Reform Commission
NFFO	Non Fossil Fuel Obligation
RE	Renewable Energy
REL	Renewable Energy Law
RO	Renewables Obligation
RPS	Renewable Portfolio Standard
SETC	State Economic and Trade Commission
TCE	Tonne of coal equivalent
VAT	Value Added Tax
WTO	World Trade Organization

1 INTRODUCTION

1.1 Topic Introduction

The global challenges of our time are to simultaneously tackle the issue of climate change, meet the growing demand of energy and safeguard the security of energy supply. All these will be staggering challenges to any nation but in China, they will be more serious.

1.1.1 Energy Demand and the Environmental Issues

In the past twenty years, China presented an attractive phenomenon of economic growth to the whole world. Its Gross Domestic Product (GDP) increased from RMB 717 billion of 1984 to RMB 13,687 billion of 2004 (National Bureau of Statistics, 2005) , and energy consumption amount of 2004 is 1,846 Mtce, which is over 2 folds of year 1985. Moreover, it is especially to be noticed that the elastic ratio of energy consumption of last three years is over 1(see Figure 1.1), which means the growth rate of energy consumption is faster than GDP growth rate.

Meanwhile, as coal combustion contributes over 67% to the primary fuel mix, China is also facing serious environmental problems such as air pollution. China is now the second largest energy consumer in the world and its greenhouse gas (GHG) emission per TCE (Tonne of coal equivalent) is 50% higher than the average level of the world

(Li, 2005). It is somewhat believed that China will be the largest country of energy consumption worldwide in the coming few years (Li, 2005). So how to continuously power this economic locomotive to sustain the sound growth, and secure the safe and independent national energy supply is one side of the challenge. And the other side is to avoid the potential environmental disasters which will threaten the social and economical development.

Figure 1.1: Annual Growth Comparison between GDP and Energy Consumption of China, 1980—2004.
Source: The China Sustainable Energy Program (2005)

1.1.2 Huge Market for Wind Energy

It is widely believed that renewable energy (RE) is one of the best answers to solve the above problems and wind energy is the most commercial viable renewable technology among all the available ones. In the past five year, the cost of wind energy per kWh was reduced by 20% and in some places, it could even compete with the coal electricity (Global Wind Energy Council, 2002).

As a result, more and more international and domestic investments are now injecting into wind energy sector since it is regarded as one of the most attractive emerging markets. As predicted by BTM Consult, the value of world wind energy market during the period of 2006 to 2010 will be some US$ 132.4 billion and China will be one of the four growth centers of wind energy installation worldwide. For wind energy in China, the installed capacity increased in year 2005 is about 500 MW (see Table 1.1) (Shi, 2006) and the cumulative installed capacity is 1,264 MW (BTM, 2006). In addition, the National Development and Reform Commission (NDRC) of China has already set the target of 5GW for wind energy by 2010 in its renewable energy development strategy. A huge potential market of wind energy in China is now presenting to the whole world.

Manufacturer	Increased Capacity (KW)	Percentage of the Total Increased Capacity	The Biggest Manufacturer and its Share	
Foreign Manufactures	354,650	70.6%	Gamesa	35.7%
Domestic Manufactures	147,700	29.4%	Gold Wind	26.4%
Total	**502,350**	**100%**		

Table 1.1: Installed Capacity of Wind Energy in 2005. Source: Shi, 2006

1.1.3 The Importance of Wind Turbine

With the rapid investment increase in the wind energy, issues of how to make the investments more cost-effective and how to maximize benefits from this emerging market are being studied and practiced worldwide. Wind turbine manufacturing is a highly labor intensive industry and the turbine itself contributes about 70%-80% of the total cost of wind energy investment (UNESCAP, 2004). Therefore, local production of wind turbines might be one of the best ways to reduce the overall cost of wind power investment, especially for developing countries like China, since this will save not only the transportation expenditure but also labor cost in developing countries (Li, 2005).

However, although China has already noticed the importance of local manufacturing and made some steps to promote it, as we can see from Table 1.1, the imported ratio of wind turbine in 2005 is still as high as 70.6%.

1.2 Aims and Objectives

The overall aim of this thesis is to answer the question of how to utilize direct/indirect policies to promote and ensure the healthy development and deployment of China's local[1] wind turbine industry. The word 'local' here is only defined in a narrow scope because Chinese government is aiming not only to reduce the cost of wind turbines through local production, but more importantly to establish an industry with its own property rights (Wang, Zhao and Gao, 2006). And what differs this paper from others is that it also focuses on the quality of the development of wind turbine industry, instead of only discussing about the quantitative increase. Therefore, the following objectives will be included:

- ✧ To summarize the situation of wind turbine industry in China and the potential benefit brought by the realization of large-scale local manufacturing capability;
- ✧ To identify the barriers of local manufacturing of wind turbines;

[1] Local here means the wind turbine manufacturing enterprises are totally owned by Chinese or controlled by Chinese parties.

- ✧ To analyze and summarize the international experience and lessons learnt in the field of wind turbine industry development;
- ✧ To propose feasible strategy recommendations for the wind turbine industry of China based on unique situation of China's wind energy sector and taking into account of the international experience.

1.3 Report Structures

This report consists of 8 chapters. Chapter 1 explains the reasons for which the topic is chosen and identifies the various key objectives under this topic. Other chapters are ordered in respect to these objectives.

Chapter 2 describes the methodology utilized to fulfill the aim and objectives of this paper. Limitations under the methodology are also clarified.

Chapter 3 provides the background information on the general situation of wind energy sector in China. The development situations of wind energy and turbine industry are concluded, and the direct/indirect policies which have been applied to promote the wind turbine industry are described specifically.

Chapter 4 figures out the benefit and barriers of local manufacturing of wind turbine in China. In addition, policy incentives which are popular in most of other countries to overcome all these potential barriers are introduced briefly.

Chapter 5 presents the varied experience of wind turbine industry development from four selected case countries. The key reasons for their success or even failures are summarized, which will contribute to the final discussion and conclusions.

Chapter 6 explores the main findings from semi-structured interviews, which are presented as unit issues according to ‘grounded theory’. They offer substantial information and views for the further discussion.

Chapter 7 integrates all the information gathered through literature review and semi-structured interviews, discusses the critical factors that should be taken into account during further policy making process.

Chapter 8 summarizes the key findings of the study and provides strategic recommendations to the policy makers to promote the healthy development of China’s wind turbine industry.

2 METHODOLOGY

This chapter discusses the research methodology utilized in this paper, showing how the research aims and objectives proposed in Chapter 1 are achieved. In order to answer the central research question of how to promote the local wind turbine manufacturing industry through policy incentives, and fulfill the proposed objectives, the research strategy combined with primary and secondary data collection is applied to the thesis. These methods and their validities are described in the following sections.

2.1 Primary Data Collection

Semi-structured interview was adopted as the primary data collection method since this thesis presents a qualitative piece of work, and semi-structured interviews are explanatory and exploratory which are suitable for qualitative research (Saunders, Lewis and Thornhill, 2003). Moreover, as Saunders (2003) argues, semi-structure interview is more preferable when the research is to answer the questions of not only “what” and “how” but also “why”. It is the case for this paper since it will not only provided “what” policies have been formulated to support China’s local wind turbine industry and “how” they works, but also allowed the emphasis to be placed on exploring “why” further steps are needed to ensure the healthy and stable development of wind turbine industry.

The interviews were mainly conducted in four weeks from June to July 2006 in Beijing, and each of them lasted for 60 to 90 minutes. In order to achieve views as wide as possible, the stakeholders were initially classified into six key groups according to their different contribution to the wind turbine industry chain. These six groups are national and/or industrial policy makers, manufacturers, investors, researchers, international organizations and consultancy. Senior representatives from each group were identified and there are totally 14 interviews conducted. Appendix 1 provides a full list of the interviewees.

Meanwhile, the following methods have been used to reduce the bias during interviews and increase the reliability of the information obtained, they are:

- ✧ Well preparation and readiness for the interviews. General information about the research topic and interviewee's interests are well accessed before interviews since a well informed interviewer has a basis for assessing the accuracy of some of the information offered (Saunders et al, 2003);
- ✧ Interview questions are phrased clearly in simple words and most of them are open questions (Saunders et al, 2003; Easterby-Smith, Thorpe and Lowe, 2002) because open questions can encourage the interviewees to provide an extensive and developmental answer, and may be used to reveal attitudes or obtain facts (Grummitt, 1980). Sensitive questions are left until near the end of interview because this allows a greater time for the respondent to build up trust and confidence in the researchers (Healey and Rawlinson, 1994);

Appendix 2 provides the full interview questions;

- Whole-process audiotape recording is adopted to ensure the accuracy of the information obtained and full interview transcripts are made right after the interviews. However, due to the interviewees' request, the transcripts remain confidential.

2.2 Secondary Data Collection

Secondary data collection consists of three components which are critical literature review, case study and conference attendance.

2.2.1 Critical Literature Review

The fundamental function of critical literature review is to "form the foundation on which our research is built" (Saunders et al, 2003, p44) and it is the case of this thesis too. The literature review provided substantial background information about China's wind turbine industry and the wind market during the preliminary stage of the research and was expanded and diversified in an iterative response to the semi-structured interviews. Primary (government reports, legislations, past theses and personal communication via emails) and secondary (academic journals and books) are the main sources for secondary data.

2.2.2 Case Study

In order to compare the experience from the wind turbine industries of other countries, case study was also adopted as a secondary research method. Four cases were identified based on the initial literature review, and each of them represented a different development model. The four models include the traditional wind energy market such as Germany, a successful later comer case of Spain, representative from developing countries such as India and the unsuccessful case from Unite Kingdom. Conclusions are based on the cross-comparison of each case and contributed substantially to the final discussion and conclusions.

2.2.3 Conference Attendance

The author attended two conferences. The first one was held in Beijing from 8th to 9th June and named as “The 2nd Annual China Power & Alternative Energy Summit 2006”. It is the most high profile event dedicated to alternative energy in China and various high-level stakeholders working in the field of electricity attended. The other one was entitled as “The 3rd Asian Wind Power Exhibition & Conference” held in Beijing from 28th -30th June. This international conference is the first-level discussing about the wind energy issues of Asia and more than 110 exhibitors worldwide displayed their advanced technologies related to wind energy.

2.3 Statement of Limitations

Although great efforts have been made during the whole process to improve the overall quality of the thesis, there are still some inevitable limitations. They are categorized as objective and subjective limitations which are described as the followings:

2.3.1 Objective Limitation

First of all, according to Robson (1993), the lack of standardization in the semi-structured interviews may lead to concerns about the reliability. Totally different results might arise in this thesis if alternative interviewees are identified because their different position or experience.

Secondly, due to the fact that the main research was conducted in China, the information about the four cases were primarily obtained from literature. Quantitative data may not be the latest one and the criticism may even be biased.

2.3.2 Subjective Limitations

The semi-structured interview requires the interviewer’s high level skills. Lack of extensive formal trainings, it is somewhat difficult for the interviewer to make sure the high reliability of the interview results. Various bias such as interviewer’s own bias or demonstration bias in the way the interviewer interpret responses might both increase the limitation of this project.

3 DEVELOPMENT SITUATION OF WIND ENERGY INDUSTRY IN CHINA

With the approval of Renewable Energy Law in year 2005, the wind energy market in China attracted tremendous interest from international and domestic investors, developers and manufacturers. This chapter summarizes the updated information about the development situation of wind energy in China, which covers the aspects of wind farms, wind turbine manufacturing and the policy incentives. All these will be helpful to understand the overall situation of wind power market and manufacturing in China and establish the sound basis for further research and discussion.

3.1 Situation of Wind Farms in China

3.1.1 Installed Capacity

Since the installation of the first wind turbine in Hainan Province in year 1985, the overall installed capacity of wind farms in China is increasing gradually. Until the end of year 2005, the cumulative installed capacity is 1,266MW, contributed by 1864 turbines in 62 wind farms. Figure 3.1 shows the cumulative and annual installed capacity during the past 20 years. Meanwhile, Appendix 3 provides further explanation of how these 62 wind farms are distributed by province. For the single year 2005, the installed capacity increased is 503MW, which is 2.5 times of 2004. And the power connected to the grid is about 1.53 billion kWh (Shi, 2006).

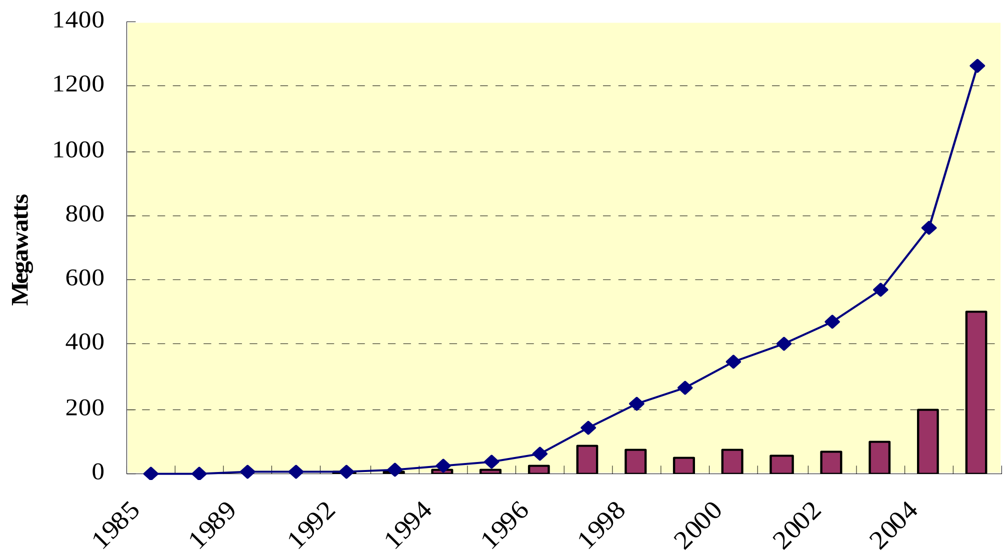

Figure 3.1 Cumulative and Annual Installed Capacity of Wind Farms in China 1985—2005

3.1.2 Wind Turbine Size

The 503MW installed capacity increased in year 2005 is contributed by 592 turbines which means the average power of each turbines is still less than 850kW (Shi, 2006). In addition, although more and more big size turbines, such as 1.3MW and 1.5MW turbines are installed in China, all of them are produced by foreign producers. Appendix 4 provides the detailed information of all the wind turbines installed in year 2005.

3.1.3 Market Shares of Manufacturers

Although the market shares of domestic manufacturers increased dramatically in 2005, which hold 29.4% of the newly increased installed capacity, the foreign manufacturers still dominate China's wind turbine market. They contribute 77.3% to the cumulative market share to the end of 2005, among which the Spanish Gamesa is the largest one with 21.5% of the total installed capacity. The domestic manufacturers only occupy 22.7% of the total installed capacity, and the Xinjing Goldwind is still the largest contributor. See Table 3.1 and Appendix 5 for detailed information.

Manufacturer	Total Installed Capacity(KW)	Percentage of the Total Capacity	The First Three Big Manufacturers and Their Shares	
Foreign Manufactures	979070	77.3%	Gamesa	21.5%
			Vestas	13.7%
			NEG Micon	12.0%
Domestic Manufactures	286840	22.7%	Gold Wind	17.5%
			Xi'an-Nordex	2.3%
			Windey	1.1%
Total	**1,265,910**	**100%**	**68.1%**	

Table 3.1 The Cumulative Market Share of Manufacturers to 2005. Source: Shi, 2006

3.2 Situation of China's Wind Turbine Industry

3.2.1 Key Domestic Producers and Their Development Models

Driven by the huge potential interest of wind power industry, over 20 enterprises transferred or established their business strategy to wind turbine manufacturing in 2004 and 2005. It is estimated that there are over 30 enterprises working in the field of turbine manufacturing all over China (Wang, 2006). However, most of them are still beginners and without even one turbine produced. Until the end of 2005, there are six key producers of wind turbine and 10 key enterprises producing components. And the market share of these six is 22% of the cumulative installed capacity.

Besides the quantity of the producers, the issue of various development models of different producers is also worth to be noticed. There are three main models for development of domestic industries--original R&D, license purchasing or technology importing (including the following absorbing, joint development and self-innovation) (He, 2006)). For the case in China, five producers out of the six, such as Goldwind, Windey and DFSTW experienced the third model and became the competitive players in the market (He, 2006)).

The first two models are not feasible in China (He, 2006)). China tried to obtain the design and production technology through “Riding the Wind Program” in 1996. The key objective of this program is to achieve the ability of producing large scale wind turbines through the way of giving several big wind power projects to wind turbine joint ventures. The program was failed finally, and by the end of 2000, the total installed capacity is 346 MW, only one third of the target set in the Program. Meanwhile, due to the complexity and high speed of development of wind power technology, it is difficult and even impossible for China to start from the very beginning and develop everything by its independent intellectual property rights (He, 2006)).

3.2.2 Technology and Standard Progress

China has made some progress in technology R&D of wind power industry. Domestic producer such as Goldwind and Windey have obtained the capability to produce 600kW and 750 kW turbines with 90% localization ratio. But only a few producers are capable of design and produce MW-scale turbines. For example, Goldwind is capable of producing the prototype of 1.2 MW direct driver turbine which is now being inspected in Xinjiang Dabancheng wind farm. 1MW turbine with variable speed and constant frequency is also produced and inspected in Liaoning Xianrendao wind farm. And the Chinese producers are still in the process of prototype production instead of commercial production (Qi, 2006). The main technology progresses of components include the capability to develop MW-scale blade, produce fixed pitch, 750kW gearbox and generator.

However, China has not yet obtained the ‘key’ technologies of large scale turbine design and production and there are still relatively huge technical differences between domestic and international manufacturers (Qi, 2006).The technologies utilized widely by international manufacturers are to produce larger blades, variable pitch, variable speed & constant frequency, direct driver and large scale turbines. All these technologies improve the efficiency and ensure the stability of the turbines.

In addition, China has not established a well-structured industrial standard and certificate system for wind turbine yet. Although there are 57 standards applied in wind turbine industry, most of them are for off-grid turbines or based on European standards, without considering the real geographic and weather conditions of China (CRESP Program, 2005). Most of the turbines installed in China have been certificated by international certification systems such as Germanischer Lloyd (GL) and Det Norske Veritas (DNV) have been applied in European countries and America, since they are produced by international manufacturers. There is the possibility to apply these systems in China, however, according to some research in America, the local manufacturers will suffer from technical barriers during international trade, if non-domestic certification systems are utilized in their countries (CRESP Program, 2005).

3.2.3 International Manufacturers in China

In order to reduce the cost and increase their competitive ability, and also to satisfy the requirement of local production of wind turbines under concession projects in China, most of the big international manufacturers have established factories in China in the forms of joint venture or exclusively foreign-owned company. These manufacturers include Vestas, GE Wind, Nordex, Gamesa and Suzlon etc. This might not be a bad way to inspire the competition awareness of domestic manufacturers, but it will be more correct to regard it as a threat to the development and even survival of local wind turbine industry due to the advanced technologies and the huge market share obtained by international producers (Wang et al, 2006).

3.3 Supportive Policies

Due to various reasons, the development step of China's local wind turbine industry is still slow. However, we should notice that some efforts have been made by Chinese government through direct and indirect policies/programs.

3.3.1 Direct Policies

China has taken several steps since 1990's to encourage local manufacturing, including policies to encourage joint ventures and technology transfers, local content requirement, differential customs duties favoring domestic turbine assembly, and public R&D.

- State Development and Planning Commission (now the NDRC) began "Ride the Wind Program" in 1996, aiming to carry out technology transfers through gradually increased local content requirement (Lew, 2000). Meanwhile, the program was supported by State Economic and Trade Commission (SETC)'s National Debt Wind Power Plan, in which national debt with favorable interest subsidy was provided to build wind farms with locally manufactured turbines. By 2000, this program had established four demonstration projects with a total installed capacity of 73 MW (NREL, 2004).

- China is also experimenting with local content requirements in its wind concession projects. In the last three phases of concession, the local content ratio of each new wind farm has been increased to 70%.

- ✧ The custom duty levy on wind turbine has been changed several times over the past 15 years, reflecting the attitude of Chinese government on the development of wind power industry. Now it is 8% for whole turbine and 3% for component importing.

- ✧ The Ministry of Science and Technology (MOST) has subsidized wind energy R&D expenditures at varied levels over time (Liu, Lin and Zhang, 2002). It funded research to develop technologies for 600 kW machines during the 9th Five-Year Plan (FYP, 1996-2000). The R&D program to develop megawatt-scale wind turbines with variable pitch rotors and variable speed generators is also supported by MOST through “863 National Plan”.

3.3.2 Indirect Policies

In addition to direct policies, Chinese government has also carried out some indirect policies to create sound environment for wind power industry development, including formulating renewable energy law, implementing concession projects and VAT tax reduction.

- ✧ The Renewable Energy Law (REL) which was into effect on 1st January 2006 is the first piece of legal document to show the government’s ambitions to promote renewable energy. It regulates the responsibilities of government and society in developing and deploying renewable energy and requires the grid enterprises to purchase the power produced by renewable energy within the coverage of their power grid, and provide gird-connection service. The confidence of international and domestic investors on China's wind power industry was tremendously inspired and increased by the Law. But it is still a general regulation of wind power, lack of detailed and operational methods.

- Three phases of government leaded tender projects, named as Wind Concession Program were conducted since 2002. These tendering projects are some relatively operational programs under REL. The initial objective of tendering policy is to promote the high speed development of wind power through cost reduction, since the lowest price of all the biddings is the most critical condition for winning. Tendering might be a good way for the competition of individual enterprise in the whole market, but not for the sustainable development of the whole infant wind power industry (China5e, 2006). Some unprofitable bidding prices were shown in the first few projects which influenced the confidence of investors and the orderly development of wind power market.

- In 2002, the Ministry of Finance (MOF) and the State Duty Bureau implemented a new tax policy that reduced the Value Added Tax (VAT) for wind generation from 17% to 8.5% (NREL, 2004).

3.4 Conclusions

The development of China's wind power market in 2005 is the fastest among all these years, both in installed capacity and turbine manufacturing. Nonetheless there are huge difference between China and other countries. Qualitatively speaking, most of the technologies utilized in China have already been phased out by other countries. Quantitatively speaking, almost three fourth of the market shares of wind power in China is occupied by international manufacturers; and the development speed of installed capacity in China is less than the other countries with similar situation. For example, although China and India have almost the same installed capacity at the beginning of 1990s, by the end of 2005, the cumulative installed capacity of India has already reached 4,430MW, over 3 times of China's capacity (He, 2006)). However, it is needed to notice that the power generated is really low comparing to this huge installed capacity (Albrecht, 2006). The reasons will be discussed detailed in the section of Indian Case in Chapter 5.

Moreover, the less clear and inconsistent policies in wind power industry did not create a stable environment for the sound development of wind power industry. The cumulative installed capacity by 2005 has only reached the target set for year 2000, which provided little benefit to the development and deployment of the domestic turbine manufacturing.

4 BENEFITS AND BARRIERS OF LOCAL MANUFACTURING

In addition to the cost reduction brought by local manufacturing of wind turbine, there are also other potential benefits figured out in this chapter. Some of the benefits could be regarded as common benefits for both narrow definition and broad definition of local manufacturing. Meanwhile, this chapter analyzes the key barriers which will be faced by China on the way to manufacturing localization, and summarizes policy incentives utilized universally to support the development of wind industry.

4.1 Potential Benefits

4.1.1 Cost Reduction

Generally speaking, the cost of the turbine itself is about 70-75% of total installed costs for onshore projects or 40-50% for offshore (Joanna and Ryan, 2005). The remaining costs primarily include construction costs (foundations, grid connection, roads, and sea cables), development and legal costs and land acquisition costs, and there will be variation in these remaining costs depending on the location of the wind farm site. The cost reduction which can be brought by localized production will vary greatly from country to country, normally it can be realized through 1) a reduction in labor cost; 2) a reduction in transportation cost; and 3) a reduction in raw materials cost. In addition, the improved servicing and response times which is provided by local manufacturers may further reduce costs and improve operations (Joanna et al, 2005).

Compared to European and American counterparts, China, a country with lower wage rates expects to be able to realize cost savings through domestic manufacturing of wind turbines. This cost reduction is potentially significant for those turbine components that are particularly labor intensive. For example, a research by Helios Center for Sustainable Energy Strategies indicates local production of rotor blades will save up to 64% of the original labor cost (Krohn, 1998).

Due to the high cost of international shipping, transportation costs could also be reduced from in-country production, especially for sizable and heavy equipments. The Canadian Wind Energy Association (CanWEA, 2004) estimated that transport costs for wind turbines, composed of both overseas shipping costs and on-land freight transport, represent 5-10% of the entire system cost for imported turbines, and 3-5% for domestically made turbines. As a result, towers are often the first component to be manufactured in a local market, since they are also not as technically sophisticated as other components (Li, 2005)

Reduced delivery lead times for wind turbines and components are another cost-saving factor in local manufacturing. Better customer service and faster access to customer service staff and technical staff as well as spare components in case of mechanical problems may further reduce costs or improve project operations.

Some initial studies have estimated that local production of wind turbines could reduce the cost by anywhere from 20 to 40% (Robert and Susan, 1998). In reality, it is almost the same as predicted. The preliminary quoted prices of wind turbines under concession projects of China are given in Table 4.1. It shows that the foreign wind turbines, except for G58 Model of Gamesa, are more expensive than domestic ones by roughly 30%.

Company	Model	Quoted Price Excluding Tax (USD/kW)
GE	1.5sle	695
Gamesa	G58	516
Vestas	V80	707
REpower	MM82-80	694
Suzlon	S66	585
Goldwind	S48	550
Goldwind	S43	500

Table 4.1 Preliminary Quoted Prices of WTG in Chinese Wind Concession Projects. Source: Shi, 2006

4.1.2 Domestic Economic Development and Employment

As any emerging industry, wind power industry creates new domestic job opportunities. A research from National Wind Coordinating Committee of America estimates that wind power creates 27 percent more jobs than the same amount of energy produced by a coal plant and 66 percent more jobs than a natural gas combined-cycle power plant. According to a report written by WorldWatch, generating one billion kilowatt-hours of electricity from coal or nuclear fuels requires only 100 to 116 workers, while a wind farm provides 542 jobs. In addition, as calculated by European Wind Energy

Association, the total number of direct and indirect jobs in the EU created by the wind industry (including manufacturing, installation and maintenance) is 72,275 for 2002, and 1.8 million jobs will be created by wind power industry to year 2020(Global Wind Energy Council, 2005).

At present, there are over 4000 staff working in the field of wind power industry in China (including manufacturing of turbines and components, wind farms maintenance). If 30 to 40 GW wind capacity would be installed in China until year 2020, it will provide 150 to 200 thousands new jobs (Li, 2005).

In addition, most of the areas with abundant wind sources are naturally poor conditions and the local economic is under developed. Wind power industry might be the only way to realize poor alleviation. For example, Huiteng Xile wind farm in Inner Mongolia contributes over 70% of the local avenue each year (Li, 2005). Some related industries such as tourism and special local products processing are also developed which increase the income of local people.

4.1.3 International Exports

Many countries aspire to create a domestic wind turbine manufacturing industry so that they can export their turbines overseas and tap into the expanding global market for wind energy. Denmark's Vestas, the largest turbine supplier in the world, sold over 99% of its turbines outside of Denmark in 2005, as did Siemens (BTM, 2006). Some wind companies focus a large part of their sales within their home countries such as GE Wind, where almost one quarter (25.5%) of their turbines are exported or manufactured overseas (BTM, 2006). Table 4.2 is the top 10 exporters of wind turbines in 2005.

Company	Installed 2005 MW	Domestic 2005 MW	Export 2005 MW	Export Share %
Vestas (DK)	3186	22	3164	99.3%
Enercon (GE)	1501	781	723	48.1%
Gamesa (ES)	1474	832	642	43.5%
Siemens (GE)	629	0	629	100%
GE Wind (US)	2025	1508	517	25.5%
RePower (GE)	353	98	255	72.2%
Mitsubishi (JP)	233	63	170	73.1%
Nordex (GE)	298	142	157	52.1%
Suzlon (Ind)	700	670	30	4.3%
Ecotcnia (ES)	239	214	25	10.5%
TOTAL	10,649	4,329	6,311	59.3%

Table 4.2: Export Ranking of Manufacturers in 2005. Source: BTM, 2006

4.1.4 National Pride and Technological Achievement

Like China’s automobile production industry, local manufacturing of wind turbines is also regarded as a symbol of national pride. It shows the world the great technological progress has been achieved by the nation in wind turbine industry, which represents its success in engineering field. Or China will only be a plant for turbine manufacturing, without its own property rights. Moreover, it is also a symbol of national green development model. Most countries favor domestically-manufactured products when given a choice between domestic and imported products if quality is perceived to be equivalent (Li, 2005).

4.2 Barriers of Localization

Although there are many potential benefits brought by local manufacturing, there are also many challenges to develop this new industry. This section describes the key barriers to entry into the wind turbine industry in detail.

4.2.1 Technological Maturity

After the development of several decades, the wind power industry has already become a relatively mature industry, with larger turbine size and more advanced technology. In addition, in order to ensure the quality of wind turbines installed in wind farms, so that to improve the quality and quantity of electricity generated, high standards are always utilized by local government regarding the turbine quality. These continuous advancements and high quality requirements create a key barrier to new comers that may struggle to catch up to the best available technology. As discussed in Chapter 3, there are some technological differences between Chinese and international manufacturers regarding turbine design and production. Thus, the technological maturity might be a key obstacle.

4.2.2 Lack of Skilled Turbine Design Staff

As mentioned in Chapter 3, there are only 4,000 staff in the wind power industry in China, and most of them are working in manufacturing and maintenance, instead of designing. There might be various reasons behind this, but weakness in basic science research of wind power is one of the key reasons. There is no any specialized wind power R&D institution in China until now (CRESP, 2005), the only few skilled staff distribute in several organizations which can't establish a comprehensive network for smooth information communication and research ability improvement. With the further development of wind power industry, the demand of specially trained and skilled staff in turbine design, production, installation and maintenance will be increased dramatically. The development of wind power industry will be restricted to some extent if the demand of professional stuff could not be satisfied (CRESP, 2005).

4.2.3. International Competition

Due to the high requirement of upfront costs of wind turbine industry, most of the new comers into this industry are big companies such as General Electric Company and Siemens. Also with the merger between companies such as Vestas & NEG Micon, Gamesa & Made, the players in this field are becoming increasingly larger and the industry is being consolidated. According to BTM report, until the end of 2005, four big turbine manufacturers contribute over three quarters of global wind turbine sales. They are: Vestas, GE Wind, Enercon and Gamesa (BTM, 2006). These companies either have spent years building strong global reputations, as in the cases of Vestas and

Bonus, or provide a unique product such as Enercon's gearless turbine, or are affiliated with a company that already has renowned internationally such as GE Wind. New entrants like China will need to compete with these companies with strong reputations and dominant positions in this industry.

4.2.4 Difficulty in Technology Acquisition

The acquisition of technology from overseas companies is one of the easiest ways for a new company to obtain advanced technology and produce turbines. However, the internationally renowned manufacturers hesitate to license their technology, since this might help to bring up competitors. This is particularly true for technology transfer from developed to developing countries, such as China, since its lower labor and raw material costs are the crucial conditions for producing cheaper turbines. The result is most of the manufacturers are willing to build full foreign investment factories, and local manufacturers can only obtain technology from second or third tier wind power companies that have less to lose in terms of international competition but more to gain in fees paid for the licenses.

4.2.5 Unstable Wind Power Market

A stable and continuing development wind power market is the precondition of local manufacturing (Joanna et al, 2005). It will enhance the confidence to wind investors and provide market for the locally produced turbines. Meanwhile, as mentioned above, one of the key advantages of local manufacturing is the lower cost. However, if the local wind market is fluctuating and discontinuous, the lower cost will be weakened and even become disadvantage. Were the policies in China for the past 20 years continuous and stable enough to promote the wind power market? And will the policies applied right now or in the future be able to reach this objective? There are still lots of uncertainties to be clarified.

4.2.6 Lack of Certification and Testing Methods

Certification of wind turbine is regarded as the third party's identification of turbine's quality and essential for the sustainable development of individual manufacturer and the whole industry. In addition, the testing and demonstration of turbines are also the necessary procedures before the turbines entering into the market. Until now, China has not established its quality certificate system and is lack of testing methods. No party is willing to bear the risk of demonstration testing of locally-produced turbines, and this will be a constraint to the technical improvement instead (CRESP Program, 2005).

4.3 Policies to Support Wind Industry Development

Policy incentives to support the development of wind industry are normally grouped into two categories: direct and indirect measures. Direct measures refer to the policies which could influence the development objectives of local wind manufacturing industry, while indirect measures are more macro-policies could indirectly create an environment suitable for a local wind manufacturing industry.

4.3.1. Direct Policies

Local content requirement

Requiring the use of certain percentage locally-produced wind turbines in domestic wind projects is a way to promote the development of a local wind manufacturing industry. This policy will force the manufacturers to establish manufacturing plants in the country whose market they are interested in or to outsource components used in their turbines to domestic companies (Joanna et al, 2005).

Preference for local content

This is also a policy to encourage the use of locally-produced turbines, but not compulsory. It includes providing low interest loans to the projects using turbines made locally, preferential tax to those wind companies that relocate their manufacturing facilities locally, or subsidies to wind farms generating power with locally-made machines (Joanna et al, 2005).

Preferential customs duties/tax

Preferential customs duties creates a favorable market for firms trying to manufacture or assemble wind turbines domestically by allowing them to pay a lower customs duty on importing components than importing full, foreign-manufactured turbines.

There are many forms of tax incentives to support local manufacturing. Local government could use them to encourage the involvement of local companies in wind industry, and/or increase the competition ability of domestic turbine manufacturers.

Export credit assistance

This is provided by governments to support the expansion of domestic industries operating in overseas markets. It can be in the form of low interest loans or conditional assistance to the countries purchasing technology (Joanna et al, 2005).

Certification and testing programs

This is a fundamental way to promote the quality and credibility of a new manufacturer's turbines and meet the international standards. There are currently several international standards applied for wind turbines, and the most common two being is Danish approval system and ISO 9000 certification.

Research, development and demonstration programs

It has been showed by many studies that sustained public research support for wind turbines can be crucial to the success of a domestic wind industry (Joanna et al, 2005). And it will be more effective if the close cooperation between private enterprises and public research institutions could be conducted, since it combines the comparative advantages of each organization together, and could make the research results to be commercialized to the maximum level (Joanna et al, 2005). The performance and reliability of newly produced turbines could be well tested under demonstration and commercialization programs before entering into commercial production.

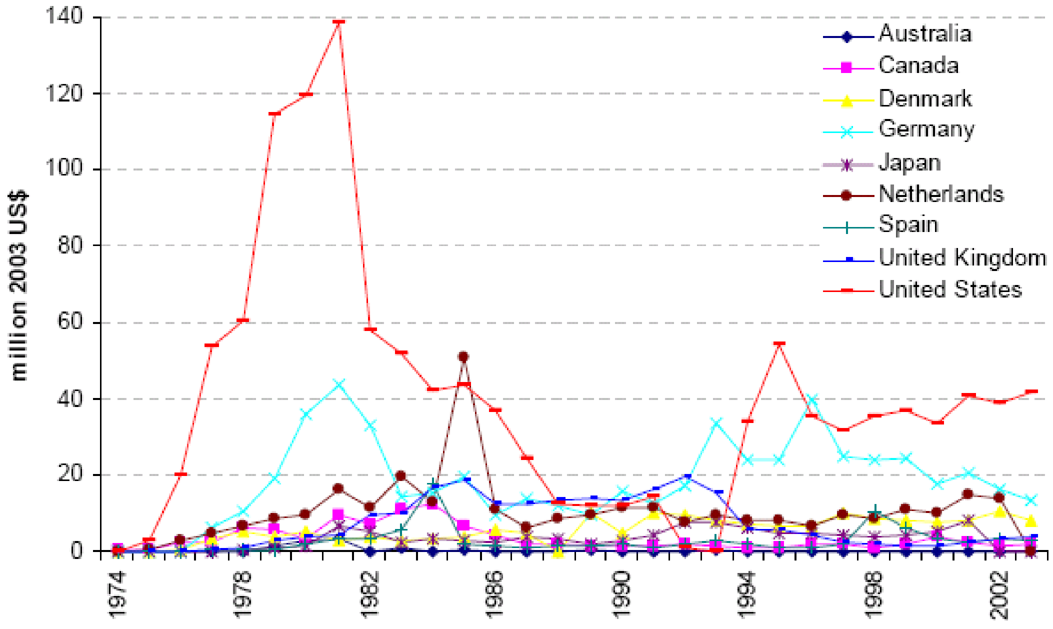

Figure 4.1 Annual Wind Energy R&D Budget by Country 1974-2003. Source: Joanna et al, 2005

4.3.2. Indirect Policies

Feed-in Tariff

A feed-in tariff is a price-based policy that specifies the price for grid owners or operators to buy from renewable energy sources. It offers renewable energy developers a guaranteed power sales price, coupled with a purchase obligation (a guaranteed market) by electric utilities. Regulators may amend the power sales price periodically to reflect the falling renewable energy costs or other market conditions. But they should ensure the price level and duration of the sales contract is sufficiently attractive to create reasonable pay back for RE investments (Wiser, Hamrin and Wingate, 2002). Feed-in tariff could provide a stable and profitable market, which is the most fundamental condition for the success of domestic wind manufacturing. If well designed, including a long term and sufficient profit margin, it has been shown to be extremely valuable in creating a signal of future market stability to wind farm investors looking to invest in long-term wind technology innovation (Joanna et al, 2005).

Renewable Portfolio Standards

Generally speaking, renewable portfolio standard (RPS) is government-mandated policy designed to create a market for RE development. However, unlike the feed-in tariff, RPS is a quantity-based policy that requires a quantitative target of RE to be included in the electricity mix by a specific date. An RPS also specifies operators' responsibilities for obtaining RE and stipulates penalties for non-compliance. Under an RPS, a country or state requires all utilities or retail suppliers to purchase a certain amount of renewable energy. As currently implemented, RPS policies tend to be silent on price and leave that to be determined by the market (Wiser et al, 2002).

Tendering policies

Tendering policy is defined as one that uses government-overseen competitive processes to meet a planning target through long-term power purchase agreements with renewable generators. Tendering policies are a variation of feed-in tariff and RPS, the key difference is that the price and the eligible projects are selected through a competitive bidding process. Like feed-in tariff, tendering policies guarantee to purchase the output of a qualifying renewable energy facility at a specified price for a specified period of time. The difference between these two policies is how the price is set, and which renewable energy generators can participate. While the feed-in tariff sets a price and guarantees to purchase the renewable energy output from any eligible facility at that price, a tendering policy uses competitive bidding to select projects that offer the best price. These projects are then awarded power purchase agreements for their output. As with feed-in tariff, this guaranteed power purchase agreement helps reduce investor risk and helps the project secure financing (More detailed introduction of these three major indirect policies are concluded as Appendix VI) .

Tax incentives

This would help to promote investment in renewable power generation in the form of a corporate income tax reduction for investment in wind power technology. Power generation companies could also be an audience of tax incentives such as reduced income tax or a reduction in VAT that must be paid per kWh of power generated.

4.4 Conclusions

Local manufacturing of wind turbines will bring various benefits, but China has to face lots of barriers when establishing this industry as well. Quantitatively speaking, China has already utilized many direct and indirect policies to promote the local manufacturing industry. However, the question is most of these policies are not continuous or well designed, formulated and performed, providing unstable or unprofitable market for wind power. The reasons behind it will be discussed in Chapter 6 and 7.

5 CASE STUDY

Partly due to the various policies utilized in different countries and also their varied performance, the local wind turbine industries in these countries are developed to different levels. This chapter chooses four countries which represent the typical situation of wind power industry to some extent. They are Germany, Spain, India and UK.

The situation of wind turbine industry and the policy mechanisms used in these countries are discussed detailed in the following sections. The aim is to determine the importance of different policy mechanisms in promoting the development of a local manufacturing industry, based on both the successful and failed experience. The key findings from case studies are concluded in section 5.6.

5.1 Traditional Wind Power Market and Manufacturer—German Case

5.1.1 Wind Industry Overview

Germany has shown a gradually increased and sizable wind power market since 1990s. Until the end of 2005, the total installed capacity is 18,445 MW, of which 1,808 MW was installed in that year (BWE, 2006). See Figure 5.1 for detailed information.

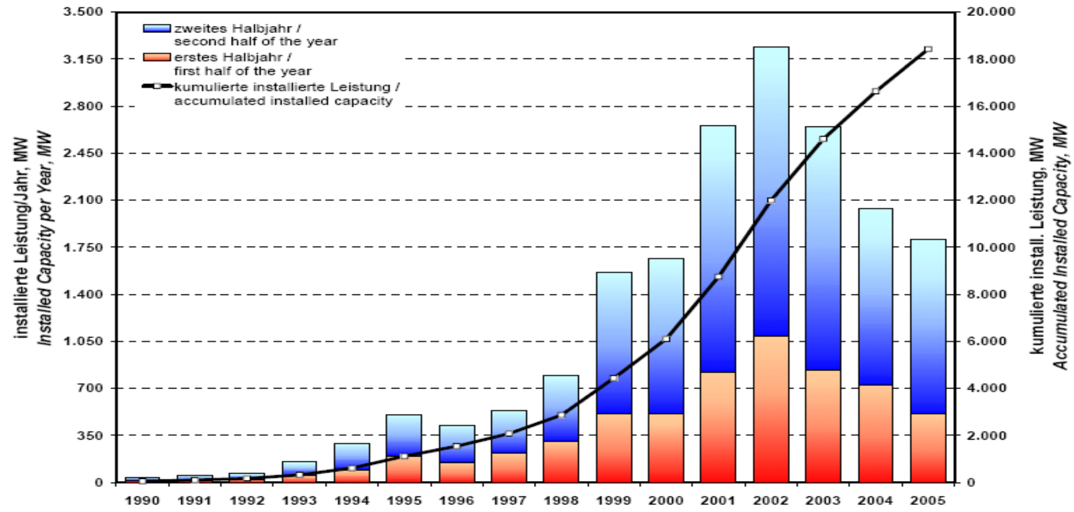

Figure 5.1:Annual & Cumulative Installed Capacity of Wind in Germany 1990-2005.Source: BWE, 2006

Germany is home to several key large wind turbine manufacturers, such as Enercon, Nordex, REpower, and Fuhrlander. These four producers contributed 57.6% to the wind power market of Germany in 2005, in which Enercon had the largest share of 41.7%, Nordex with a share of 7.8%, REpower with a 5.5% share and Fuhrlander with a share of 2.6%. The remainder market was mainly supplied by Vestas with a 26.8% share and GE Wind with a share of 8.1% (Figure 5.2).

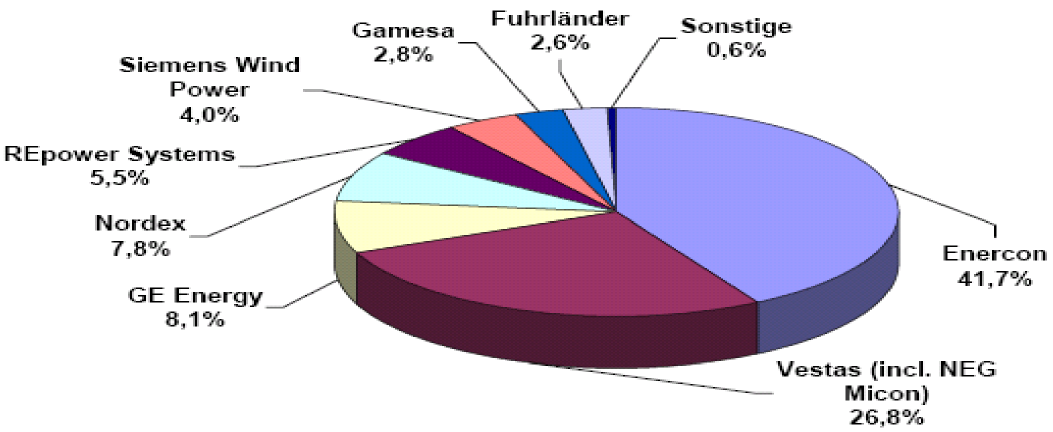

Figure 5.2: Market Shares of Wind Turbine in Germany 2005. Source:BWE, 2006

Regarding the 11,407 MW international wind market in 2005, German producers held almost 19% shares and Enercon is the third biggest supplier with a share of 13.2% (BTM, 2006). Enercon is also the largest in-house components manufacturer in the industry and its patent on the gearless turbine technology has given it a competitive advantage over many other manufacturers (Joanna et al, 2005). Nordex and REpower, with a 2.6% and 3.1% global market share respectively, both have an overseas presence and have participated in joint-ventures and technology transfers. REpower has subsidiaries in several European countries and has transferred technology to China, Australia and Canada; Nordex has established subsidiaries in 17 countries including the Weide joint venture in Xian, China.

5.1.2 Direct Policies

R&D input on large wind turbines, tax subsidy and export assistance are the key direct drivers in developing local wind turbine manufacturing industry of Germany.

From 1974 to 2003, German government has the second largest national input in wind energy R&D worldwide, and the highest levels of funding were allocated in the 1980s. Most of the R&D expenditure was spent on large wind turbine research and recently on developing large scale wind projects. Germany also benefits from the funding of European Community, particularly on MW-sized turbine R&D (Anna and Staffan, 2002).

From 1989, the German Ministry for Research and Technology conducted two wind power demonstration programs. The programs offered 10-year federal tax subsidy for those turbines that demonstrated they would help raise the technical standard of German wind R&D and selected projects were required to participate in a measurement and evaluation program. Although the program had a limited research it enabled manufacturers to sell their turbines with a higher price and put extra money into their own private R&D. In conjunction with the Renewable Energy Act (EEG), these programs provide a good environment for domestic investment in wind turbine technology and wind farms (Joanna et al, 2005).

German government also has several international aid programs which provide financial support to the joint ventures between Germany and other developing countries, to develop wind farms using turbines produced by Germany. The subsidies went to the equipment manufacturer directly, instead of the project developer. One particular purpose of this program is to test the performance of German turbines under different climatic conditions, providing data for further technology innovation. Germany has pursued a design assessment and type certification program, and all turbines installed in Germany must be certified by accredited institutions (Woebbeking and Nath, 2004).

The structure of German industrial policy is a model with a built-in interdependence between financing, industrial and government institutions, which permits government's intervene in sectors where it wishes to stimulate its development (Joanna et al, 2005).

5.1.3 Indirect Policies

The success of Germany's wind industry has been primarily attributed to its profitable and stable feed-in tariff program (Joanna et al, 2005). The Electricity Feed Law (EFL), introduced in January 1991, mandated the utilities to connect the wind electricity to their grids and purchase the electricity at 90% of the domestic market price, nearly 17pf/kWh (Till, Tim and Robert, 2003).

The EFL was replaced in April 2000 by EEG which guaranteed a premium price for electricity that was generated from wind into the grid, independent of the market electricity prices. The payment is guaranteed for 20 years and even longer for off-shore wind projects. Coupled with EEG was a specific target of reaching 12.5% renewable electricity supply by 2010, and 50% by 2050. In 2000, the tariff under EEG was 9.10c/kWh for the first five years. After five years, turbines that did not achieve 150% of reference output continued to receive this rate, while those exceed it subsequently earn 6.19c/kWh. The tariff is reevaluated very two years by ministries of Economy, Environment and Agriculture based on technology and market developments, thus the tariff is being reduced by 1.5% per year since 2002 (Till et al, 2003).

However, some studies believe that EEG system has created extra financial burden to customers, which includes not only the high cost of renewables itself but also the additional tax (See Figure 5.3). It is estimated that the tax caused by EEG increased from 0.87 $Euro_{2004}$/MWh in 1998 to 5.10 $Euro_{2004}$/MWh in 2004. And they are predicted to increase further in the future (Christian and Felix, 2005).

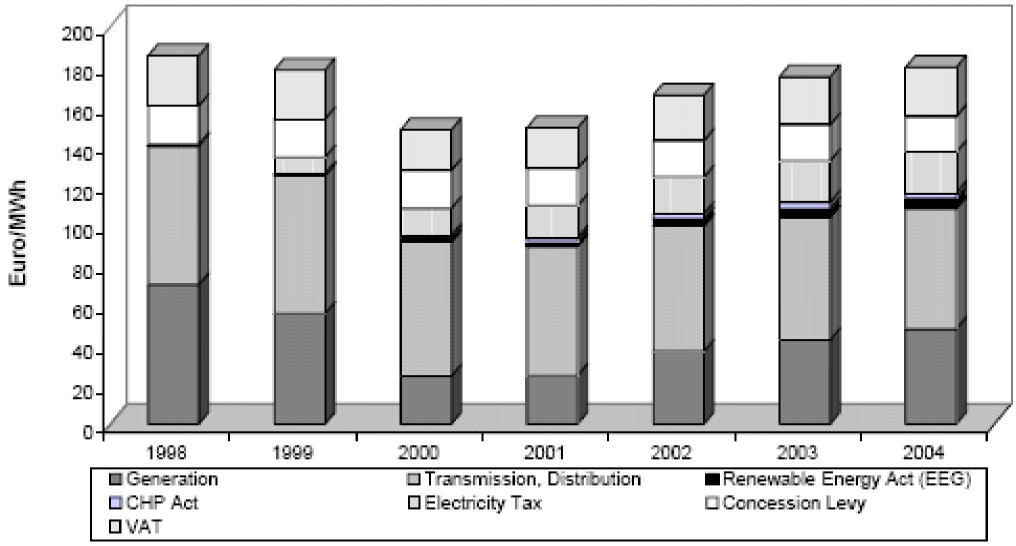

Figure 5.3: Development of Electricity Prices, Euro2004/MWh. Source: Christian et al, 2005

5.1.4 Conclusions

The R&D projects and feed-in tariff are the two crucial elements for the success of Germany's local manufacturing. R&D projects, together with certificate policy, contributed substantially to the technology development of wind turbine industry (Joanna et al, 2005). While the continuous feed-in tariff created a sizable and stable market for the local turbine industry. However, the issue of additional cost to customers needs to be carefully considered when China is applying this policy.

5.2 A Successful Later Comer--Spanish Case

5.2.1 Wind Industry Overview

The Spanish wind power industry is on a roll. By the end of 2005, Spain became the second largest country of wind power with total installed capacity of 10,027 MW, 1,764 MW of which were installed in year 2005 (BTM, 2006). Spain meets 6% of its national electricity demand from wind power and is expected to increase (EWEA, 2005). Spanish turbine manufacturer Gamesa had the largest market share in Spain of any manufacturer in 2005 again, with almost 43% of the market, followed by another major Spanish manufacturer, Ecotecnia, with 19.82% (Figure 5.4). Gamesa also had about 12.9% of global market share in 2005 (1,474 MW), of which 642 MW was sold overseas (BTM, 2006).

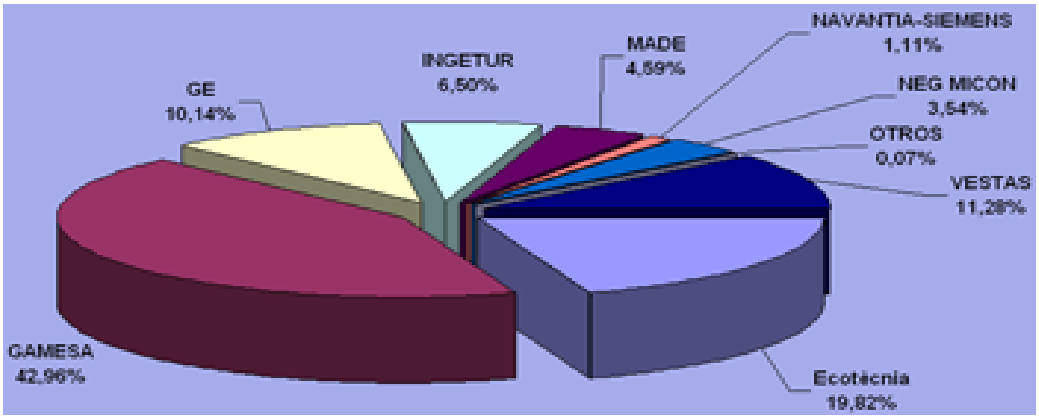

Figure 5.4: Market Share of Spanish Wind Power in 2005. Source: AEE, 2006

Gamesa has 21 manufacturing facilities around the world that make turbines and/or blades (Gamesa, 2006). In 2003 Made was acquired by Gamesa, which helped to solidify Gamesa as the dominant Spanish manufacturer and position it to be a major player in the world market. Gamesa’s turbine technology is based on that of Vestas, since it began as a Vestas joint venture and only became independent in 2003.

In addition, there are many foreign wind companies who are currently manufacturing their turbines in Spain, including the US manufacturer GE Wind; Germany's Enercon, Nordex and REpower.

5.2.2 Direct Policies

Although Spain is a relative latecomer to the wind power scene, its policies to encourage foreign companies to shift manufacturing base to Spain in return for access to the domestic market have not only increased the installed wind capacity, but also developed a competitive local wind industry, with the representative of Gamesa (Li, 2005).

Spanish government agencies have required the incorporation of local content in wind turbines installed in Spain. The purpose of the cooperation between Vestas and Gamesa is to comply with regulations requiring a percentage of local content in order to participate in the subsidized wind development in Spain at that time. This requirement is still being mandated today by several autonomous regional governments such as Navarra, Galicia, Castile & Leon etc (Joanna et al, 2005).

The government provides financial incentives for local manufacturing. For example, the provincial government of Chubut offers an incentive of $0.005/kWh if local content percentages are met; the federal government also offers a $0.01/kWh incentive. These local content percentages increase from 30% in January 2001, to 60% in January 2003 and 80% in 2005. From January 2007 all the equipment must be from local companies if a project is to qualify for the incentive. The Spanish government has played important role in creating a domestic wind industry, and the success of Gamesa and other manufacturers is very likely related to these direct policies (Joanna et al, 2005).

Some studies stress that the policies that require the use of domestically produced turbines, such as these applied in Spain could be regarded as a trade barrier (Joanna et al, 2005) and China might also face this kind of problem if the local content policy is also applied, since China has already been a member of WTO. However, it is argued by Chinese professionals who are working to formulate roadmap for wind power development that this can not be regarded as anti-competition or breaking of WTO rules, since it is the Chinese consumers who finally pay the extra bills for wind power. This is still a question needed to be clarified.

The Spanish government also provides consistent support for R&D in wind technology under the Research Centre for Energy, Environment and Technology (CIEMAT), the main public R&D organization in wind energy. Private wind companies invest heavily in R&D, estimated at about 11% of their gross value added, which is above average for other sectors and companies in Spain (IEA, 2004).

5.2.3 Indirect Policies

Another reason of Spain's rapid emergence as a center for wind manufacturing is due to its feed-in tariff policy, which made the wind power as a attractive investment and wind market relatively stable. Spanish utilities are obligated to pay a fixed, guaranteed price for wind power for 5 years that includes a bonus incentive; this price and bonus are set each year based on variations in electricity market prices.

Originally Spain adopted the European target of 12% of primary energy demand from renewables for a national target by 2010, and has set a target for wind of 21.5 terawatt hours per year by 2010, or around 9,000 MW installed capacity. Now the target has been raised to 13,000 MW by 2011, or 28.6 terawatt hours per year (IEA, 2004). Wind is further benefited by the deferral of tax payments on earnings for 15 years.

5.2.4 Conclusions

Spain's direct policies for local content requirement and its feed-in tariffs established a sizable and stable market for local manufacturers, who are now dominating the domestic wind market and also moving into the global markets. The success of the leading Spanish manufacturer, Gamesa, is certainly in part due to its strategic decision to form a joint-venture with Vestas and later purchase the rights to Vestas' technology and end Vestas' involvement in Gamesa's operations. Spain's wind industry combines a healthy mix of both leading international companies locally manufacturing foreign technology, and Spanish companies locally manufacturing Spanish-owned technology. It is likely that this combination creates a constructive environment for learning and innovation (Joanna et al, 2005).

5.3 India—Pioneer of Developing Countries

5.3.1 Wind Industry Overview

India is currently the pioneer of developing countries in wind turbine manufacturing capability, and in total installed wind capacity. By 2005, India has overtaken Denmark as the fourth largest wind market in the world, with a total installed capacity of 4,253 MW, of which 1,253 MW were installed in 2005 alone (Figure 5.5). Suzlon was the largest supplier in India in 2005 with a share of 53%, and its annual share of global market increased gradually from 2.5% of 2003 to 6.1% of 2005, ranked the 5th worldwide (Suzlon, 2006)).

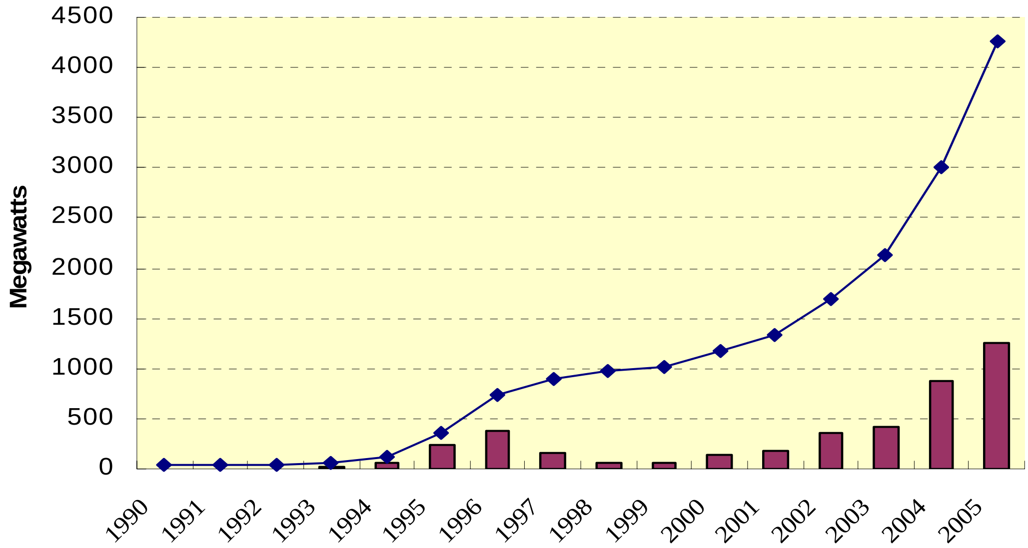

Figure 5.5: Annual and Accumulative Installed Capacity in India 1990-2005. Source: BTM, 2006

Suzlon established its international headquarters in Aarhus, Denmark, strategically selecting Denmark due to its base of wind energy expertise and extensive network of components suppliers. It held a ground-breaking ceremony for its USD 60million investment in an integrated manufacturing facility in Tianjin of China in 2006, and also signed breakthrough orders for 100MW of wind turbine capacity from China (Suzlon, 2006).Suzlon has also developed sales offices in Australia, China and the US (as well as India) and R&D centers in Germany, the Netherlands, and India.

The leading rotor blade supplier, LM Glasfiber, is in the process of manufacturing blades for large turbines at its Indian facility in Bangalore, which will be sold to turbine manufacturers throughout Asia (Joanna et al, 2005). NEG Micon expanded its manufacturing facilities in Chennai and Pondicherry in 2004 to include production of large turbines, including an additional $5.5 million to upgrade plant and equipment, with plans to supply the Indian market and export throughout Asia.

5.3.2 Direct Policies

The primary driver of wind power in India was from Ministry of Non-Conventional Energy Sources (MNES). It also developed a national certification program for wind turbines, based in large part on international testing and certification standards.

More important, India has taken several direct steps to encourage local manufacturing. For example, India has levied preferential customs duties on importing wind turbine components instead of complete machines. There is no customs duty on special bearings, gearboxes, yaw components and sensors for the manufacture of wind turbines, or on parts and raw materials used in the manufacture of rotor blades. There is a reduced customs duty on brake hydraulics, flexible coupling, brake calipers, wind turbine controllers and rotor blades for the manufacture of wind turbines, and the excise duty is exempted for parts used in the manufacture of electric generators (Rajsekhar, Van and Jansen, 1999).

5.3.3 Indirect Policies

In the 1990s, India's market experienced a significant boom as a result of various tax incentives, and some preferential loans (Joanna et al, 2005). For example, 100% depreciation of wind equipment was allowed in the first year of project installation, and a 10-year tax exemption was applied. All these incentives encouraged private investment in wind projects which accounted for 97% of the total installation cost. The national Guidelines for Clearance of Wind Power Projects implemented in July 1995 required that all state electricity utilities make plans ensuring grid compatibility with planned wind developments. The sound cooperation between government and private sectors promoted the high-speed development of wind industry (Joanna et al, 2005).

However, this policy also has a number of negative impacts, and the worst is it placed no reward on the actual performance of wind turbines, but only the installation amount of wind turbines. Either the windmills are well sited, or the wind turbines are efficiently operated has never been accounted as a condition for tax breaks (Victor, 2001).

In addition, due to the inaccurate resource data, poor installation practices and poor power plant performance, a dramatic slowdown of installed capacity occurred in the Indian market in the late 1990s and early 2000s (Rajsekhar et al, 1999). In order to improve the situation, State governments in India are running concession programs in recent years, and have already planned 50 sites for wind farm development. In Gujarat the government has signed agreements with Suzlon, NEG Micon, Enercon and NEPC India to develop wind farms on a build-operate-transfer (BOT) model. The MNES established national wind speed monitoring system which could assess and calculate the wind potential and figure out the appropriate areas for wind development.

5.3.4 Conclusions

India's policy scheme, in particular the major tax advantages offered to manufacturers, helped to promote the industry throughout the 1990s. Meanwhile, government's great efforts in wind resources assessment and project development are also crucial for opening a healthy wind market for its local turbine manufacturers. The government has already set aggressive targets to bring 5,000 MW of new wind power capacity online by 2012 (Joanna et al, 2005). But we should notice that the electricity generated from wind is far lower comparing its huge installed capacity. More attention should be paid to the exact amount of electricity generated, instead of how many turbines have been installed. This should be a crucial issue which needs to be seriously considered when Chinese government is planning their wind development programs.

5.4 Is Policy Always Working Well?—UK Case

5.4.1 Wind Industry Overview

Although UK is believed to have the best wind resources in Europe (IEA, 2004), it only has a total installed wind power capacity of 1,226 MW until the end of 2005, ranked the 5th among European countries and 7th in the world(Figure 5.6). The majority of UK's wind market is occupied by Danish manufacturers such as Seimens and Vestas, followed by German producers.

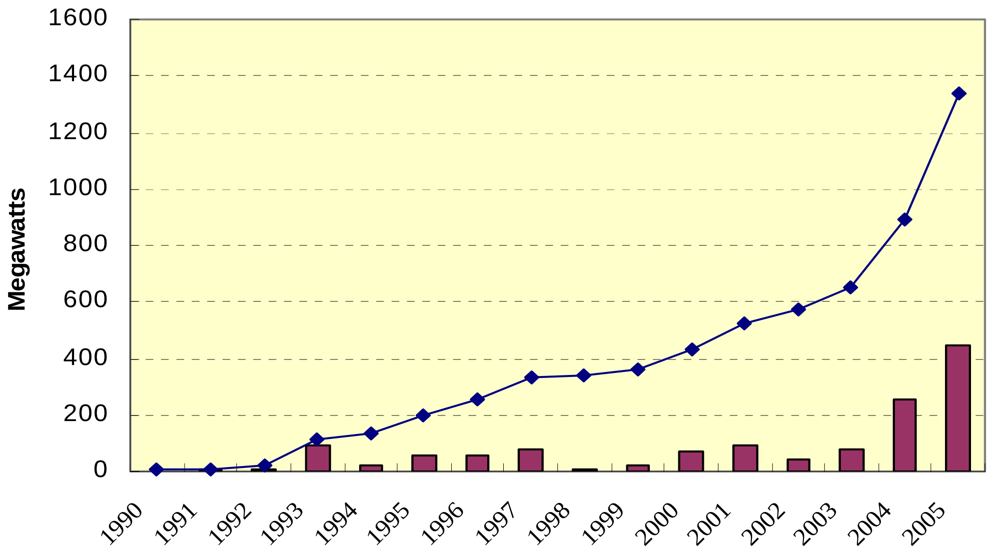

Figure 5.6: Annual & Accumulative Installed Capacity of Wind in UK 1990-2005. Source: BTM, 2006

Until now, there is no any true manufacturer of wind turbines in the UK and only one of wind turbine components. Historically, Britain has also been home to a number of small but innovative wind turbine manufacturers, such as Wind Energy Group (WEG), James Howden and Renewable Energy System (RES). However, the tendering policy applied in UK named as Non Fossil Fuel Obligation (NFFO) and its competitive nature strengthened the comparative advantage of foreign producers, since the prices of their turbines are lower. This caused the downturn in activity and subsequent withdrawal of each company in this sector (Joanna et al, 2005).

DeWind, which was purchased from Germany in 2002, might be called as a UK manufacturer. But it is still manufacturing turbines in Germany and it seems that DeWind may never make it off the ground in the UK. The main reasons is its primary investor, FKI Energy Technology Group, has already announced to withdrawal investment in the wind turbine business, considering the rapid consolidation of wind turbine manufacturers and the increasing influence of major wind power developers as making competition extremely difficult for smaller players (Joanna et al, 2005).

5.4.2 Direct Policies

The UK government has provided R&D support for wind program development since the late 1970s, investing a total of over 200 million dollars from 1977-2003. No other direct incentives have been employed until now (Joanna et al, 2005).

5.4.3 Indirect Policies

As seen in Figure 5.5, the annual installed wind capacity is unstable due to the inconsistent renewable energy policies applied in the UK (Joanna et al, 2005). The NFFO provided periodic tenders for renewable energy generation during the 1990s, but the contracts not sufficiently profitable to draw much manufacturing interest to the UK. The NFFO was created to support the nuclear industry at the time that UK electricity sector was privatized and only provided a small amount of support for renewables. Now the licensed electricity suppliers in the UK must meet a mandated Renewables Obligation (RO), which begins at 3% of their annual supply in 2002-2003, and rises to 10.4% for the period of 2010-2011 and 15% from 2015, until 2027 (Mitchell, Bauknecht and Connor, 2006). Electricity generated from renewables is also exempted from paying the Climate Change Levy, and capital grants are available for offshore wind projects. The Renewables Obligation has increased the rate of deployment of wind energy in the UK and overcome some of the problems with the NFFO. Nevertheless, the wind market in UK has developed much more slowly than that of Germany or Spain, and problems related to planning and siting continue to hinder growth (Joanna et al, 2005).

5.4.4 Conclusions

Although UK has some components manufacturers and human resources in sophisticated technical research, the lack of stable and sizable wind market caused by inconsistent policies has already blocked the development of local manufacturers.

5.5 Conclusions

Followings are the three key findings emerged from case studies:

- ✧ **A stable local wind power market is the precondition for the development of local turbine manufacturing**

We can see clearly from the case of Germany, India and Spain that normally the wind turbine manufacturers start their business in their home country markets. Therefore, a stable home market is crucial to the successful starting and further development of a local manufacturing. This is particularly true for wind turbine industry since it needs an existed platform to test their products and improve technologies before going into the next step of large-scale commercialization. A stable local market will not only provide this essential testing ground, but also make strong signals to investors that they could frame a long-term investment plan under this stable market, especially for R&D input which is fundamental for quick progress of wind turbine technology. It is estimated that a minimum annual demand of 150-200 MW/year for 3 or more years is crucial to developing a nascent local manufacturing industry, while a more capable and aggressive local industry is likely to require a minimum of 500 MW a year (CanWEA, 2004).

	Installed MW 2003	Share 2003 %	Installed MW 2004	Share 2004 %	Installed MW 2005	Share 2005 %
VESTAS (DK)	1,812	25.1%	2,783	33.4%	3,186	27.9%
GE WIND (US)	1,503	20.8%	918	11.0%	2,025	17.7%
ENERCON (GE)	1,218	16.9%	1,288	15.4%	1,505	13.2%
GAMESA (ES)	956	13.2%	1,474	17.7%	1,474	12.9%
SUZLON (Ind)	178	2.5%	322	3.9%	700	6.1%
SIEMENS (DK)	552	7.6%	507	6.1%	629	5.5%
REPOWER (GE)	291	4.0%	276	3.3%	353	3.1%
NORDEX (GE)	242	3.3%	186	2.2%	298	2.6%
ECOT蒕 NIA (ES)	48	0.7%	214	2.6%	239	2.1%
MITSUBISHI (JP)	218	3.0%	214	2.6%	233	2.0%
NEG MICON (DK)	855	11.8%	na	na	na	na
Others	215	3.0%	334	4.0%	567	5.0%
Total	**8,088**	**112%**	**8,513**	**102%**	**11,207**	**98%**

Figure 5.7: Market Shares from 2003—2005. Source: BTM, 2006

All leading turbine manufacturers are from countries with significant domestic wind power development. As seen from Figure 5.7, 9 out of the top 10 turbine suppliers come from the 5 top countries in terms of installed capacity from year 2003 to 2005. Figure 5.8 also illustrates that manufacturers located in these 5 markets represented 91.1% (10,409 MW) of the total turbine manufacturing base in 2005 (11,407MW).

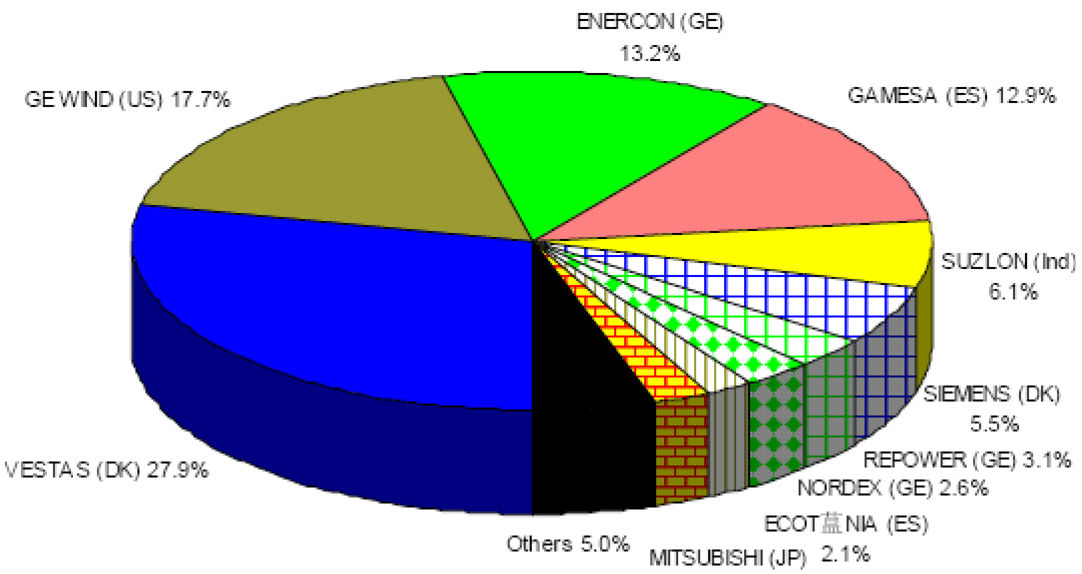

Figure 5.8: Top 10 Suppliers and Their Market Shares in 2005. Source: BTM, 2006

✧ Indirect policies help to create a stable and sizable wind power market

The case studies above illustrate that indirect policies are the key drivers for the forming of stable and sizable local wind power market. However, the effect varied from policy to policy. For example, the market created by UK's NFFO was totally different from the one established under German EFL. Some studies also compared the new policies applied in UK (RO) and Germany (EEG) and concluded that the feed-in tariff system—named EEG in Germany has a number of advantages for renewable generators in terms of reducing their risk, such as price risk, volume risk and balancing risk

(Mitchell et al, 2006). The effect of this reduced risk is an increased ability for renewable generators to finance their investment through the capital market. RO means that developers bear far more risk than is the case in feed-in tariffs system, although the additional cost to customers under EEG system is being argued by many researchers.

- **Direct policies are important for emerging wind power market**

Wind power technology is relatively mature and updated very quickly which make it as an industry with higher entry requirement. Several direct policy options have proven effective, as demonstrated in the case countries to help establishing these emerging markets. For instance, the local content requirement being used in Spain has helped Spanish manufactures like Gamesa grow in experience and begin to expand abroad.

Customs duties that support turbine manufacturing by favoring the import of components over full turbines have been used in India and China with some success.

Export credit assistance or development aid loans tied to the use of domestic technology have been used particularly by Germany, encouraging the dissemination of German technology around the world, particularly the developing world.

Quality certification and standardization programs used in Germany and India are particularly valuable to early development of this industry, since most of the standards are formulated on the real geographic and natural situation of their own countries.

6 FINDINGS FROM SEMI-STRUCTURED INTERVIEWS

This chapter concludes the key findings emerged from 14 semi-structured interviews. According to ‘grounded theory’, all these findings are grouped into conceptual units consisting of technology, policy, mechanism and others key issues for future development. Some findings are consistent with the results concluded from literature review which validate the common views of stakeholders on some key issues, while varying views of different stakeholder on some other issues are also revealed. More importantly, some crucial background information and/or reasons which can’t be seen in literatures are acquired from interviews and summarized in this chapter.

6.1 Technical Barriers

Without exception, all interviewees agree that the under-developed technology of wind turbine design and production is one of the key barriers for the survival and successful development of local manufacturing of China. Generally speaking, the reasons behind include: 1) lack of professional staff; 2) disconnection between R&D and market; and 3) passivity of enterprises.

6.1.1 Lack of Professional Staff

All the interviewees stressed that there are only a few persons who have been trained as professionals for wind turbine manufacturing since it is an emerging industry in China. Data from the interviewee of GoldWind tells us that there are less than 1000 staff working in wind turbine R&D and maintenance by the end of last year, of which only 200 are for R&D. Moreover, wind turbine production is an industry based more on experience than theory. The foreign wind turbine industries have experienced a process from small to large-scale WTG production. Although China now has the ability to design and produce small-scale turbines, it can not satisfy the real need of MW scale turbines from the market. Therefore, the only way to acquire qualified staff is from training and real combat instead of borrowing staff from other industries. Noticing the importance of human resource, GoldWind has already established technical R&D center in Germany and invited professional institutions such as Wind Test for training.

6.1.2 Disconnection between R&D and Production

The national R&D programs of China are all under the uniform management of MOST. Although MOST has input great support for wind turbine R&D, there are still two inevitable disadvantages brought by the above mechanism. They are the difference between actual research and market need, and poor industrialization of research results. Case in America is different. There is no MOST in the States, but a national laboratory. Research institutions, universities and enterprises conduct research jointly in the lab, with flexible financial support either from government and enterprises or only from government. The research content is based on the market need reflected from enterprises and its results could be used by any enterprises if it is government financed.

6.1.3 Passivity of Enterprises

Three of the interviewees stressed that the capital investment of wind turbine industry is higher than other normal industries, due to the complexity of the technology and production. Before going into the market, turbines need to experiment in two typical seasons, summer and winter to test its performance reliability. The developers will only prefer those producers with at least two or three years of experience in the market. So it is very hard for the starters to establish their credit in the market.

6.2 Unstable Policies

When reviewing the development process of China's wind power, most of the interviewees have the same feeling that even until now, the environment for wind power development is unclear and the policies are not stable.

The first driver for wind power development in China was from international pressure. When China was proud of its 20GW annual increased capacity from traditional energy, it never thought of the GHG emissions caused. Wind power became a way to establish environmentally sound national image. The initial mechanism of annually-estimated price attracted no any investors outside the electronic systems. Because the cost could be digested internally, investors from electronic systems did not care whether it is profitable. The objective of the reform within electricity system from 1998 was to establish a competitive market, which pushed the wind power out of the game due to its high cost.

The success in other international wind power market inspired the confidence of Chinese government and increased the attention of investors to Chinese market. However, the always favored feed-in tariff policy was finally replaced by tendering policy, which infirmed the confidence of investors. The worse situation was the unrealistic biddings occurred under this policy and the electricity prices of winners are much lower than the cost.

Two key reasons behind this abnormal phenomenon are:

Firstly, private investors believe that wind power will definitely grow up in the future, so the key issue at present is how to step into this industry once was monopolized. The most effective way to enter and hold some market share is reduce the bidding price as low as possible. In addition, most of the private investors are from real estate industry and have accumulated abundant capitals. They do not care if they could make profit from wind power in short term.

Secondly, the bidding actions of public investors are still somehow related to planned economy, or could be even regarded as a political job. What important for them is to attend the bidding and win it, without consideration of the cost.

In all, no matter it is private investors or public investor, what they are eager to do is to enter into the wind power market and hold the market share as much as possible. As mentioned above, they don not really care whether the project is profitable in the near future. This might not be a serious case for the investors themselves since they both have profound financial back-up. However, it is believed by all the interviewees that it is be harmful to the development or even survival of the entire wind power industry.

6.3 Mechanism Barriers

Although China has been reforming its planned economy to market economy for many years, the working mechanism is still under the structure of planned economy to some extent.

6.3.1 Formulation of Law

The Renewable Energy Law is still general description instead of any detailed instruction. Initially some law experts would like to take this law as an experiment, adding some detailed digits into it, since they believed that it will not influent the whole electricity system because of the tiny ratio of renewables. But the plan failed finally. Even for the operational guidelines which were enforced at the beginning of this year, they are still general regulations without any detailed illustration of bidding procedures. For example, the bidding invitation requires the local content of each wind farm to be 70%. Nobody from the interviewees could tell the exact meaning of local content 70%, although most of them are believed to be the professionals in this field.

6.3.2 Disconnection between Energy and Industry Strategy

Although China has already set 5GW target of wind power to 2010 and also required the 70% local content, no one knows how many turbines could be produced by that time. The energy development plan and wind power industry plan are formulated by different government respectively, without enough information communication to ensure the target could be reached.

6.3.3 Traditional Way of Thinking

The renewable energy management is the responsibility of NDRC, which is also the parent of traditional energy. Therefore, the way of thinking of government official is still related to the traditional energy, and the pricing of renewables is still based on the price of electricity from coal.

6.3.4 Contrived Element

The enaction of policies is decided by some official instead of legal procedures. For example, although feed-in tariff was proposed by researchers based on deep research and international experience, the tendering was finally into effect simply because of the one-sided understanding of some government officials.

6.4 Issues for Future Development

Some key issues for the future development of wind power and manufacturing are also discussed during interviews, and grouped into 6 categories.

6.4.1 The Importance of Local Manufacturing

The lower cost of wind turbines is not the only benefit which could be brought by local manufacturing. The continually increased price of wind turbines sends an important signal to the manufacturing market that the price of turbines is not correlated to the cost. The price of wind turbine went up by 30% in one year due to the rising steel price. But the price of turbine was still rising up after one year, when the steel price went down already. This is largely driven by the huge demand over the whole world, instead of the cost itself. Therefore, when wind power becomes a main source of power in the future, countries without strong local manufacturing like China will have to import turbines abroad, no matter how expensive they are. China will be an energy importer again, the only difference is what it imports is not coal or gas, but wind turbines.

6.4.2 Risk of Wind Power Development

Some key potential risks of wind power investment were emphasized by all interviewees including poor wind source estimation, grid carrying capacity, reliability of turbines and higher capital investment. Most of them are regarded as the crucial element for wind power planning which will be discussed in Chapter 7. Therefore, both policy makers and wind investors should not only emphasize on the speed of wind development, but also pay more attention to the stable and sustainable development. A senior manager from Longyuan, one of the biggest wind investors in China announced at the 2nd Annual China Power & Alternative Energy Summit 2006 that the wind installed capacity of Longyuan itself will reach 3GW to 2010. This is nothing to be proud of since installed capacity is not the only condition for the amount of electricity produced. The real electricity connected to the grid should be the assessment indicators indeed.

6.4.3 Certification System

The importance of certification system is entirely revealed by all interviewees. It will not only help to speed up the maturity of wind turbine manufacturing as a third party, but also establish its sound credit to investors and insurance institutions.

6.4.4 Offshore Wind Power

All interviewees reach the agreement that offshore wind is not a priority for China at present since it is more costly, dangerous and difficult to maintain, but will be in 5 to 10 years time. However, China need to start the research on all issues related to offshore wind, including turbine design, to be well prepared for the robust coming of offshore wind.

6.4.5 Indirect Policy Reform

Stakeholders hold different views about what kind of indirect policy should be utilized in China, RPS, feed-in tariff or tendering. Some believe that feed-in tariff is the best choice since it could provide profitable market for investors, encouraging their confidence while almost no additional financial burden to the customers. Tendering and PRS are also favored by others. They think that the important issue is to keep the market stable, no matter what policy is used.

6.4.6 Training Model

Although all interviewees notice the importance to train professional staff in wind power field, they have bifurcation on training models. Two out of the Chinese universities set up the major of wind power in their courses of Bachelor degree from this year. But some interviewees do not agree with it and believe that occupational training is the most effective method.

6.5 Conclusions

The most crucial impression from interviews is there is no any systematic planning strategy of wind power in China. All stakeholders expressed both their hope and worry for the future development of wind power industry. Investors and producers hope government to provide more detailed and operational support for the development of wind power industry, while researchers remind the investors to be more careful of the potential risks. More attention has been focused on the quantity issues—how much capacity has been installed, rather than quality issues as how much power has been generated. Therefore, how to promote the stable and healthy development of wind power industry becomes the core issue for further consideration.

7 DISCUSSIONS

Based on the findings from literature review, case study and semi-structured interviews, more detailed and critical discussions of some key questions are presented in this chapter. These questions are regarded as the priorities for further policy makings by the author. Some of the questions are followed with detailed suggestions since Chapter 8 will only conclude the strategic recommendations.

7.1 Aims of Wind Power Development

Before going deeply into the detailed discussion, it is necessary to make a clear understating of a general but important question: what are the aims for wind power development in short-medium term and long term perspectives? This is especially important for the policy makers in China.

Wind power is believed to be one of the most clean and broadly distributed renewable energy in the world. The reasons that most countries are developing its wind power are to reduce the GHG emissions, meeting the growing energy demand and safeguard the energy security. Is this the same situation in China? Can wind power really bring all these benefit to China now?

The increase of wind capacity in 2005 in China is definitely impressive. However, even if China's target of 30GW wind power to 2020 could be reached by that time, it will only contribute 3% to the overall 1TW electric installed capacity and 1.2% to the 5,000Twh national electric supply (average 2,000hrs/yr for wind and 5,000hrs/yr for other energy) (Zhu and Shi, 2005). This will be the real position of wind in the whole picture of national energy structure to 2020. Therefore, the substantial contribution to GHG emission reduction and energy demand satisfaction could happen after 2020, which will be regarded as the ultimate aims of wind power development in China. But at present, the most important task of wind power is to build up stable basis and sound platform for the fast and sustainable development of wind power in the near future, including reasonable planning of wind power, developing local wind turbine manufacturing, formulating operational policies and capacity building (Zhu et al, 2005).

7.2 Planning Strategy of Wind Power

Reasonable planning of wind power at national and local level is the precondition for sustainable wind power development which should be considered seriously by policy makers and program planners. Key factors such as wind resource assessment, power grid construction and distribution, real power generation and land use plans should all be taken into account to draw a coordinated and uniform blueprint for medium and long term wind power development.

7.2.1 Wind Resources Assessment

The often cited data of wind resource in China is 250 GW of technical potential for onshore wind and 750GW for offshore, which were estimated by Chinese Academy of Meteorological Sciences in 1995. However, other assessments are not consistent with this data and even with huge difference. For example, data from Chinese Meteorological Administration in 2006 is 300GW and from UNEP is 2000GW for onshore wind (Li, 2005). All these data could give us a concept that China is full of wind resource; however, no one knows what the exact potential is and how it is distributed. Until now, there is no any resource data which could be utilized for wind project planning and distribution (Wang, 2006). More financial and technical input should be allocated in the areas with abundant wind resources, to get a clear picture of how these resources are distributed and what resources are more commercially viable.

7.2.2 Power Grid Construction

Aside the wind resource assessment, grid distribution planning should also be considered. Wind resources in China are widely allocated due to its vast geographic area, the scattered potential wind farms will affect the large scale construction and expansion of power grid (Wang, 2006). Meanwhile, grid construction is a costly project. The average investment of 500KV transmission grid is RMB 350/100Km in China at present. Most of the wind farms are far from the main transmission grid. For example, the TongYu wind farm in Jilin is at least 150 Km away from the nearest 220KV transmission grid. It is estimated that at least RMB 10 billion is needed for grid construction of wind power connection to 2020 (He, 2006).

In order to reduce the potential negative effect to the grid and save the construction cost as well, wind power planners should consider the grid availability during the process of wind farm planning, and the grid companies should also take the national wind power development plan as a reference indicator, when they are making grid construction strategies. Government and the grid companies should conduct more research together on the topics such as grid connection standards, grid reliability and short term power prediction, in order to assure the maximum power generation of wind farms. This is also the pre-condition for establishing stable investment market for wind power industry.

7.2.3 Power Generation

When setting the target for wind power development, policy makers and local government officials should also take the number of power generated from wind as an assessment indicator. The existing way is only taking the installed capacity as the target which resulted in a foaming wind power industry (Wang, 2006). Actually, the concept of 5GW to 2010 is, by the end of 2011, over 10Twh power generated from wind should be connected to the grid. Therefore, the installed capacity and also the wind power connected to the grid should both be included in the target of wind power development.

7.3 Aims and Path for Wind Turbine Manufacturing Development

Further to the awareness of the objectives for wind power development in China, it is also necessary to look at the aims of wind turbine manufacturing development, and figure out the most efficient path.

7.3.1 Strategy for Wind Turbine Manufacturing

Strong information from interviews is almost every interviewee notices the importance of establishing local wind turbine manufacturing. This is also discussed as the question of ‘Made by China’ or ‘Made in China’ (Liu, 2006). The lower cost of wind turbines can also be achieved by establishing local branch of international manufacturers in China, but in that way, China will be a processing and assembling plant again. Only the latter way is the symbol of the growing up of national industry and economy.

However, this point of view is not reflected clearly in the existing policies. Firstly, the 70% local content of wind turbines requirement under wind concession projects is not clearly defined. What is the exact meaning of ‘local’ content in this requirement? Are turbines produced by branches of international manufacturers in China qualified with this condition? No one in the interviews could give an undoubted answer to this question. Secondly, even if we define the ‘local’ content as ‘Made by China’, could the ratio of 70% be satisfied? As mentioned in Chapter 3, Chinese producers only occupied 29.4% market shares of newly installed capacity in 2005 and 22.7% of cumulative capacity. Restricted by design and production capacity, it is almost impossible for Chinese manufacturers to obtain majority of the market shares in the coming few years. Two situations will be occurred if the target of 5GW to 2010 and the requirement of 70% local content are not changed, either the wind market is mostly occupied by international producers or the target will not be reached.

Therefore, it is vital to clarify the concept of 70% local content and carry it out thoroughly in the concession projects. Meanwhile, a more reasonable target of wind power development should be set, taking into account the development situation of local manufacturers properly, if the local manufacturing is exactly what Chinese government is planning to obtain.

7.3.2 Path of Local Manufacturing Development

Technology is the elementary factor for the survival of enterprises. As mentioned in Chapter 3, the most efficient path of establishing local manufacturing is technology importing—absorbing—joint development—self-innovation. Without the latter three steps but only technology importing through joint ventures, it is unlikely to obtain the core technology due to foreign concerns about nurturing the potential competition. The case between Gamesa and Vestas will always be a shadow of international manufacturers.

But the situation changed a little recently. The international wind turbine manufacturing is over heated by more and more potential Chinese investors. The average price of technology transfer from international manufacturers is being run up by the strong demand signals from potential manufacturing investors in China. And the situation of repeated transfer of the same technology is occurring now (Wang, 2006). The cost of technology transfer in 2002 was around RMB one million, but now it is over several billion Euros for 1.5MW turbine. It is calculated by some internal professionals that over RMB100 million will paid to international parties if 100 turbines of 1.5 MW are produced. So now the most feasible alternative for Chinese manufacturers, especially for beginners, is to cooperate directly with foreign turbine designers (Liu, 2006).

Government could also play an important role in avoiding repeated technology transfer. The technology could be imported uniformly by some research centers or industry associations of government and transferred to the local manufacturers with lower price. Meanwhile, cooperative R&D between these centers and enterprises could also be built up to make sure the industrialization of the innovation results.

7.4 Comparisons of Three Potential Indirect Policies

Another hot topic in China's wind power industry now is the application of the three potential policies: RPS, feed-in tariff and tendering. As mentioned in the findings from semi-structured interviews, stakeholders have not reached agreement on which one of them should be utilized. Relatively speaking, the feed-in tariff is more compatible with the present situation in China and the key reasons are:

Renewable Portfolio Standards

One of the key features of RPS is government sets a mandatory national target for the quantity of eligible electricity supplied from RE and nominates percentage for each utility. And most of the countries applying RPS have committed to Kyoto Protocol to reduce GHG emission except for the US. In addition, many more factors such as well-structured competitive market, mature electricity market and effective enforcement etc. are needed for the success of RPS, which make it as a costly policy (More detailed introduction of RPS is available in Appendix VI). China has not taken up any international obligation from Kyoto Protocol. And the most important is the electricity market in China is not mature and competitive enough to implement RPS at this stage.

Tendering

This is the policy utilized in China now named as concession projects. We can judge whether it is suitable for China according to its real performance. As mentioned in Chapter 3, some unreasonable bidding prices were shown in the concession projects. Until now, the price of all winners in from RMB 0.382yuan/kWh to 0.519yuan/kWh, which is all lower than the cost of wind power (Shi, 2006). The price almost becomes the only factor for winning (Shi, 2006). The unreasonable low price will definitely influence the quality of wind projects and the local economy development. Thus, not only the development of wind power market, but also the local turbine manufacturing, as a part of the whole industry chain will be affected. After one year performance of the first concession project in 2008, when the real data of electricity produced, cost of maintenance and project financing are calculated, the financial loss of wind power projects caused by tendering policy will be clear (Shi, 2006).

Feed-in Tariff

The success of feed-in tariff has been validated by many cases such as Germany and Spain. The most concern of feed-in tariff is the higher financial burden brought to customers. But this will be not that much in China. Let us take year 2004 as an example. The power produced from wind in 2004 was 1.1billion kWh, accounting for 0.05% of the total annual electricity consumption. The average additional cost to all customers nationally is less than RMB 0.001yuan/kWh, if the normal cost difference between wind and regular energy RMB 0.25yuan/kWh is referenced (Wang, 2006). It will be true that with the increase of electricity share from wind power, the additional cost on customers will also be higher and even be unacceptable, although the question of what is the exact number could be regarded as unacceptable is still to be discussed and confirmed. But at least at this present, the additional cost could not be the vital condition to prevent the application of feed-in tariff in China. Moreover, the experience from the countries with huge wind development shows that the feed-in tariff breeds the stable market for the development of wind power and manufacturing industry. This is exactly what Chinese wind power industry needs right now.

7.5 Capacity Building

In order to solve the three technical barriers concluded in Chapter 6, capacity building of wind power industry in China should be listed in the calendar. It could be achieved through the following ways:

- ✧ Establishing the cooperative R&D mechanism between government, universities and enterprises;
- ✧ Integrating occupational training, staff exchange and university education;
- ✧ Building-up national technical service center to provide certificate, testing and research service.

All these methods will substantially help the enterprises and the whole industry to train professionals, solving the problem of disconnection between R&D and industrialization, improving the quality of wind turbines and finally increasing the competition ability of local manufacturers in the international market (He, 2006)).

7.6 Conclusions

China is making progress in wind power development, but still there are some essential issues needed to be clarified and clearly understood by China. First of all, the government needs to understand the aim of wind power development at this stage.

These few years are the period of building sound basis for further wind power development. Some basis works related to integrated wind power development planning, such as wind resource assessment and gird construction should be completed during these years. Secondly, the importance of establishing local manufacturing should be realized. More suitable policies to support this industry should be applied and enforced strictly. Last but not the least, Chinese government should input more into the capacity building of China’s wind power industry through various methods.

8 CONCLUSIONS

Based on all the key information and views from previous chapters, this chapter provides a summary of the conclusions of this study and strategic recommendation for the healthy development and deployment of wind turbine industry in China.

8.1 Summary of the Study

This study updates the development situation of wind power in China to the end of year 2005, including the information about wind power market and wind turbine manufacturing industry. Meanwhile, the existing policies to promote the manufacturing industry directly and indirectly are also concluded. According to the basic data provided in chapter 3, we could conclude that the wind power industry in China is now entering into a world with relatively high-speed development.

However, this world should also be regarded as a period with opportunities and risk as well, especially for wind turbine manufacturing industry. Local manufacturing of wind turbines will reduce the cost, promoting the development of local economy and increasing the international exports. But China is also facing many barriers, technically and non-technically. China is poor in the basic research of wind turbine design and production, lack of professional staff and the ability to produce MW scale turbines. From policy side, there is more room for the further improvement of the newly enacted

‘Renewable Energy Law’; some of the key indirect policies are not well designed or performed; and policy makers focus more on the quantitative target such as installed capacity rather than qualitative objectives. In addition, China is lack of completed industry standards for turbine manufacturing until now.

The experience from case study tells us that a stable local wind power market is the precondition for the development of local turbine manufacturing. A stable local market can not only provide a platform for the distribution and testing of locally produced turbines, but also make strong signals to investors that they could frame a long-term investment plan under this stable market. Indirect policies will help to create the stable and sizable wind power market to some extent, and direct policies are important for emerging wind power market and turbine manufacturing, but careful design and strict performance are needed for the success of both of them.

Therefore, China needs to understand the aims of both wind power development and local manufacturing development at this stage, and then formulate the development objectives and strategies which are compatible with the present situation and future development aims. China should utilize the coming 5 years to improve its ability on basis works such as wind resource assessment, grid construction, capacity building and development planning. Last but not the least, China should develop detailed roadmap for the development of wind turbine industry, and apply feed-in tariff as the indirect policy to promote the development of wind turbine industry in the coming few years.

Strategic Recommendations

Following are some detailed strategic recommendations for the further development of wind turbine manufacturing industry in China, which are drawn from this study.

- Improving the Law and its relevant guidelines to provide detailed and operational regulations for the development of wind power and manufacturing industry;
- Developing coherent, medium and long-term roadmap for wind turbine industry;
- Research on the feasibility of applying RPS in China in the future;
- Establishing public technical service platform, including centers of R&D, testing and certificate, to promote the development of wind power industry through information sharing and uniform management procedures;
- Formulating wind resource assessment plans with priorities and compatible power grid construction plans;
- Conducting capacity building projects through inter-government staff exchange, university education and occupational trainings;

REFERENCES

Albrecht, K. (2006) *Renewable Energy Experiences*. [Online] Available from: http://siteresources.worldbank.org/INTENERGY/Resources/Renewable_Energy_ExperienceLatestPPTforWB.ppt [Accessed 29 August 2006]

Anna, J. and Staffan, J. (2002) *Emergence of a Growth Industry: Comparative Analysis of German, Dutch and Swedish Wind Turbine Industries*. [Online] Available from: http://www.druid.dk/conferences/winter2002/gallery/jacobsson.pdf [Accessed 1 June 2006]

BTM Consult ApS. (2006) *International Wind Energy Development, Wind Market Update 2005*. Email from Interviewee.

BTM Consult ApS. (2006) *Wind Market Update 2005-Press Release*. [Online] Available from: http://www.btm.dk [Accessed 1 May 2006]

Canadian Wind Energy Association (CanWEA) (2004) *Manufacturing Commercial Scale Wind Turbines in Canada.* [Online] Available from: http://canwea.ca/downlaods/en/DOCS/Manufacturing_Backgrounder.doc [Accessed 25 July 2006]

China Renewable Energy Scale-UP Program (2005) *National Action Plan for China Wind Power Industry Development*, CRESP Office

China5e (2006) *The Twenty Years for the Industrialization of Wind Turbine in China*. [Online] Available from: http://www.china5e.com/news/newpower/200604/200604040101.html

[Accessed 13 July 2006]

Christian, G. and Felix, M. (2005) *An Analysis of Household Electricity Prices in Germany since Liberalization.* [Online] Available from: http://www.ewi.uni-koeln.de/ewi/content/e266/e563/e2722/e2725/Veroeff_Muesgens_IEWT2005_ger.pdf [Accessed 1 Sep 2006]

Easterby-Smith, M., Thorpe, R. and Lowe, A. (2002) *Management Research: An Introduction* (2nd edn), London, Sage.

EWEA (2005) *Wind Power Market*. [Online] Available from: http://www.ewea.org/index.php?id=196&no_cache=1&sword_list[]=spain&sword_list[]=2005 [Accessed 1 August 2006]

Gamesa (2006) *Introduction of Gamesa Eolica*. [Online] Available from: http://www.gamesa.es/gamesa/index.html [Accessed 1 August 2006]

German Wind Energy Association (BWE) (2006) *Wind Energy in Germany Statistics 2005*. [Online] Available from: http://www.wind-energie.de/fileadmin/dokumente/statistiken/statisiken_englisch/jahreszahlen_2005_eng.pdf [Accessed 31 July 2006]

Global Wind Energy Council (2005) *Wind Force 12*. [Online] Available from: http://www.ewea.org/fileadmin/ewea_documents/documents/publications/WF12/wf12-2005.pdf [Accessed 24 April 2006]

Grummitt, J. (1980) *Interview Skills*. London, Industrial Society

Healey, M.J. and Rawlionson, M.B. (1994) 'Interviewing techniques in business and management research', in Wass, V.J. and Wells, P.E. (eds), Principles and Practice in

Business and Management Research , Aldershot, Dartmouth, pp, 123-146

He, D.X. (2006) Different Choices for the Roadmap of China's Wind Power Technology Development. *Science and Technology in China*. 5, 48-51.

He, D.X. (2006) *Wind Power Depends On Market Growth*. [Online] Available from: http://www.istis.sh.cn/zt/list/pub/flfd/jb/%E8%AF%95%E5%88%8A%E7%AC%AC12%E6%9C%9F.pdf [Accessed 10 August 2006]

International Energy Agency (IEA) (2004) *Wind Energy Annual Report 2003*. [Online] Available from: http://www.ieawind.org/iea_wind_pdf/PDF_2003_IEA_Annual_Report/2003IEA_WindAR.pdf [Access 1 August 2006]

Joanna, L. and Ryan, W. (2005) A *Review of International Experience with Policies to Promote Wind Power Industry Development*. [Online] Available from: http://www.resource-solutions.org/lib/librarypdfs/IntPolicy-Wind_Manufacturing.pdf [Accessed 8 May 2006]

Krohn, S. (1998) *Creating a Local Wind Industry: Experience from Four European Countries*. [Online] Available from: http://www.centrehelios.org/downloads/testimony/1998_EN_Krohn_Windpower_set-aside.pdf [Accessed 29 August 2006]

Lew, D.J. (2000) Alternatives to Coal and Candles: Wind Power in China. *Energy Policy*, 28,271-286.

Li, J.F. (2005) *Wind Force 12 in China*. Chemical Industry Press,Beijing

Liu, W.Q., Lin, G. and Zhang, X.L. (2002) Cost-Competitive Incentives for Wind energy Development in China: Institutional Dynamics and Policy Changes. *Energy Policy*, 30, 753-765.

Liu, Y.L. (2006) *Made in China, or Made by China? Chinese Wind Turbine Manufacturers Struggle to Enter Own Market*. [Online] Available from:
http://www.worldwatch.org/features/chinawatch/stories/20060519-2
[Accessed 19 May 2006]

Mitchell, C., Bauknecht, D. and Connor, P.M. (2006) Effectiveness Through Risk Reduction: A Comparison of the Renewable Obligation in England and Wales and the Feed-in System in Germany. *Energy Policy*, 34(3), 297-305.

National Bureau of Statistics of China (2005) *China Statistical Yearbook 2005*. [Online] Available from:
http://www.stats.gov.cn/tjsj/ndsj/2005/html/C0301e.htm [Accessed 17 May 2006]

NREL (2004) *Fact Sheet on Grid Connected Wind Energy in China*. [Online] Available from:
http://www.nrel.gov/docs/fy04osti/35789.pdf [Accessed 12 July 2006]

Qi, H.S. (2005) *Annual Report of Wind Power Machinery Association*, Wind Power Machinery Association, Unpublished

Rajsekhar, B., Van, H. and Jansen, J.C. (1999) Indian Wind Energy Programme: Performance and Future Direction. *Energy Policy*, 27(11), 669-678.

Robert, P.T. and Susan, B. (1998) *China: A Strategy for International Assistance to Accelerate Renewable Energy Development*. [Online] Available from:
http://www.worldbank.org/astae/388wbdp.pdf [Accessed 25 July 2006]

Robson, C. (1993) *Real World Research: a Resource for Social Science and Practitioner Researcher*. Oxford, Blackwell

Saunders, M., Lewis, P. and Thornhill, A. (2003), *Research Methods for Business Students*, Essex: Pearson Education Limited

Shi, P.F. (2006) Installed Capacity of Wind Farms in China 2005. *China Wind Power*, 5, 7-16.

Shi, P.F. (2006) Risks and Crisis of China's Wind Power Industry. *Science and Technology in China*. 5, 62-63.

Suzlon (2006) *Highlight from FY05-06*. [Online] Available from: http://www.suzlon.com/images/you/Suzlon%20Marks%20FY05-06%20with%20Record%20Growth.pdf [Accessed 1 August 2006]

The China Sustainable Energy Program (2005) *Evaluation of China's Energy Strategy Options*. [Online] Available from: http://www.efchina.org/documents/NEP_LBNL_EN.pdf [Accessed 17 May 2006]

Till, S., Tim, F. and Robert, G. (2003), *Review of Renewable Energy Development in Europe and the US*. Imperial College London

UNESCAP (2004) *Wind Turbine Technology Transfer in Asia*. [Online] Available from: http://www.unescap.org/esd/energy/dialogue/renewable/wind/documents/WindTurbine_Technology_Transfer_in_Asia.pdf [Accessed 1 May 2006]

Victor, K.M. (2001) *The Use of Wind Energy in India—Lesson Learned*. [Online] Available from: http://web.mit.edu/10.391J/www/proceedings/Mallet2001.pdf [Accessed 1 Sep 2006]

Wang, G.L. (2006) Quick or Slow--The Development of China's Wind Power? *Science and Technology in China*. 5, 60-61.

Wang, G.L. (2006) The Struggling Way for the Development of Chinese Manufacturers. *Science and Technology in China*. 5, 64-66.

Wang, Z.Y. (2006) Semi-structured Interviews with Center for Renewable Energy Development under NDRC.

Wang, Z.Y., Zhao, Y.Q. and Gao, H. (2006) Wind Power Industry in China. *Science and Technology in China*. 5. 52-55.

Wiser, R., Hamrin, J., and Wingate, M. (2002) *Renewable Energy Policy Options for China: A Comparison of Renewable Portfolio Standard, Feed-in Tariffs and Tendering Policies*. [Online] Available from: http://www.resource-solutions.org/lib/librarypdfs/IntPolicy-Feed-in_LawsandRPS.pdf [Accessed 29 May 2006]

Woebbeking, M. and Nath, C. (2004) *Type and Project Certification*. [Online] Available from: http://www.germanlloyd.org/mba/wind/publicattpcglwind2003.pdf [Accessed 31 July 2006]

Zhu, J.S. and Shi, P.F. (2005) How to Enhance the Development of China's Wind Power Industry. *China Wind Power*, 4, 20-22.

Appendix I: List of Interviewees

Name	Position	Organization	Stakeholders' Interest
Andrew Garrad	Director	Garrad Hassan and Partners Ltd	Wind Energy Consultancy
Anonymous	Officer	Suzlon Energy LTD. Beijing Office	Wind Turbine Manufacturing
Cai Zhaowen	Director	Production Department of Longyuan Electric Group	Wind Energy Investment
Dai Yande	Deputy Director-General	Energy Research Institute of NDRC	National-level Energy Policy Research
David Quarton	Director	Garrad Hassan and Partners Ltd	Wind Energy Consultancy
Eric Martinot	Visiting Faculty	Tsinghua-BP Clean Energy Research and Education Center	Policy Research of Clean Energy
Li Junfeng	Secretary-General	China Renewable Energy Industry Association	Policy Making for RE Industry Development
Miao Hong	Consultant	CRESP Project World Bank Beijing Office	Renewable Energy Development
Qi Hesheng	Senior Engineer	Wind Power Machinery Association	Technical Research of Wind Power
Ren Dongming	Associated Professor	Center for Renewable Energy Development under NDRC	National-level RE Policy Research
Shi Pengfei	Deputy Director-General	China Wind Energy Association	Wind Energy Industry Research
Wang Jin	Engineer & Director	Goldwind Science & Technology Co., Ltd	Wind Turbine Manufacturer
Wang Yang	Chief Technical Officer	Garrad Hassan and Partners Ltd	Wind Energy Consultancy
Wang Zhongying	Senior Energy Economist	Center for Renewable Energy Development under NDRC	Roadmap Design for Wind Energy
Total	**14**	**11**	

Appendix II: Questions List of Semi-structured Interviews

Question I: Please briefly introduce the key businesses of your company/organization which are related to renewable energy, especially to wind energy?

Question II: Is the local manufacturing of wind turbine a feasible way for China to make the investment more cost-effective?Any positive or negative effects might bring?

Question III: As a latecomer, what barriers China might face during the booming process of local manufacturing of wind turbine?

Question IV: There are different models of local manufacturing such as wind turbine assembly, component manufacture and whole turbine manufacture. Which of them, in your opinion, is/are more suitable for China?

Question V: What is the importance of quality certificate system to the sustainable development of local wind turbine industry?

Question VI: The stable market will provide a sound environment for the booming of local manufacturing. What impact do you think the newly enforced tendering process of wind project might bring to the manufacturers?

Question VII: At present, is off-shore wind the priority for development in China?

Question VIII(a): As a private company, what kind of policies do you believe the policy makers should formulate to promote the local manufacturing of wind turbine?

Question VIII(b): What kinds of direct/indirect policy incentives have already been applied to promote the local manufacturing? Any further steps?

Appendix III: Cumulative Wind Installed Capacity by Province

(In the order of installed capacity)

No.	Province Name	Quantity of Wind Turbines	Installed Capacity(KW)
01	Xinjiang Autonomous Region	296	181,410
02	Inner Mongolia Autonomous Region	260	165,740
03	Guangdong Province	271	140,540
04	Liaoning Province	203	127,460
05	Ningxia Autonomous Region	133	112,950
06	Jilin Province	143	109,360
07	Hebei Province	143	108,250
08	Shandong Province	100	83,850
09	Fujian Province	75	58,750
10	Heilongjiang Province	70	57,350
11	Gansu Province	74	52,200
12	Zhejiang Province	59	34,150
13	Shanghai Municipality	18	24,400
14	Hainan Province	18	8,700
15	Hongkong	1	800
Nationwide (Excluding Taiwan Province)		**1,864**	**1,265,910**

Appendix IV: The Wind Turbines Installed within 2005

Province	Wind Farm	Manufacturers	Unit (KW)	Quantity	Installed Capacity
Hebei	Weichang Hongsongwa	Goldwind	600	42	25,200
		Goldwind	750	6	4,500
	Shangyi Damanjing	GE Wind	1,500	23	34,500
	Zhangbei Baiduluo	GE Wind	1,500	6	9,000
	Sub-total			77	73,200
Inner Mongolia	Hexigtenqi Saihanba	Vestas	850	36	30,600
	Sub-total			36	30,600
Liaoning	Gaizhou Xianrendao	Shenyang University of Technology	1,000	1	1,000
	Sub-total			1	1,000
Jinlin	Taobei Qingshan	Goldwind	750	6	4,500
		Gamesa	850	58	49,300
	Taonan Datong	Gamesa	850	19	16,150
	Changling 52	Gamesa	850	11	9,350
	Sub-total			94	79,300
Heilong-jiang	Muling Shiweizi	Nordex	1,300	3	3,900
		Hafei	1,000	1	1,000
	Yichun Daqingshan	Vestas	850	19	16,150
	Sub-total			23	21,050
Shanghai	Nanhui Binhai Park	GE Wind	1,500	10	15,000
	Chongming Dongwang	GE Wind	1,500	3	4,500
	Sub-total			13	19,500

Shandong	Qixia Tangshanpen	Goldwind	750	10	7,500
	Changdao Liancheng	Windey	750	1	750
		Gamesa	850	32	27,200
	Changdao Xiaoheishan	Windey	750	6	4,500
	Rongcheng Dongchudao	DFSTW	1,500	4	6,000
		Nordex	1,500	3	4,500
	Sub-total			56	50,450
Fujian	Nanridao Houshanzai	Gamesa	850	19	16,150
	Zhangpu Liuao	Gamesa	850	36	30,600
	Sub-total			55	46,750
Guangdong	Huilai Shibeishan	Goldwind	600	87	52,200
	Shenzhen Dameisha	Windey	250	8	2,000
	Sub-total			95	54,200
Ningxia	Qingtongxia Shaogang	Bestas	850	31	26,350
		Gamesa	850	36	30,600
	Qingtongxia Jiangding	Goldwind	750	1	750
	Sub-total			68	57,700
Xinjiang	Dabancheng	Goldwind	1,200	1	1,200
			600	11	6,600
		ABO	660	1	660
	Urumqi Tuoli	Goldwind	750	40	30,000
		GE Wind	1,500	20	30,000
	Sub-total			73	68,460
Hongkong	Lamma	Nordex	800	1	800
	Sub-total			1	800
Total (excluding Taiwan Province)				**592**	**503,010**

Appendix V: Cumulative Market Share of All Manufacturers to Year 2005

(Domestic Manufacturers Are Highlighted)

No.	Manufacturers	Installed Capacity (kW)	Percentage of Total Capacity
01	Gamesa	271,550	21.5%
02	Goldwind	222,150	17.5%
03	Vestas	173,050	13.7%
04	NEG Micon	151,950	12.0%
05	GE Wind	109,500	8.6%
06	Nordex	98,050	7.7%
07	Micon	49,000	3.9%
08	Xi’an Nordex	29,400	2.3%
09	Nordtank	25,540	2.0%
10	MADE	18,480	1.5%
11	Nedwind	17,500	1.4%
12	Zond	16,500	1.3%
13	Windey	13,750	1.1%
14	Bonus	12,350	1.0%
15	Bazan-Bonus	12,000	0.9%
16	AN Bonus	9,600	0.8%
17	DFSTW	6,000	0.5%
18	Yituo-MADE	5,280	0.4%
19	Tacke	4,500	0.4%
20	Dewind	3,600	0.3%
21	HSM	3,000	0.2%
22	Wandian	2,400	0.2%
23	Others	2,310	0.2%
24	Yituo	1,500	0.1%
25	Jacobs	1,500	0.1%
26	Shenxin	1,200	0.1%
27	HEEW	1,200	0.1%
28	SUT	1,000	0.1%
29	Hafei	1,000	0.1%
30	AWT	550	0.0%
31	USW	500	0.0%
Total		**1,265,910**	**100%**

Appendix VI: Introduction of Three Key Indirect Policies[2]

Feed-in Tariff

Description

A feed-in tariff is a price-based policy that specifies the price for grid owners or operators to buy from renewable energy sources. Feed-in tariff offer renewable energy developers a guaranteed power sales price which is called feed-in tariff, coupled with a purchase obligation (a guaranteed market) by electric utilities. Standardized interconnection requirements for renewable generators are also a common and important component of the feed-in tariff. The regulators may amend the power sales price periodically to reflect the falling renewable energy costs or other market conditions. But they should ensure that the price level and duration of the sales contract is sufficiently attractive to ensure reasonable pay back for renewable energy investments.

Factors for Success

Germany, Denmark and Spain have all implemented successful feed-in tariff. Such feed-in tariff provides generators stable and attractive prices for power sales, and provides standardized interconnection requirements. In fact, the birth of America's modern renewable energy industry can be traced back to a form of feed-in tariff most prominently developed in California and some other States. The experience from the above countries indicated that a successful feed-in tariff should include design features that can eliminate risk for potential renewable investors. These measures can be in the forms of long-term contracts (15-20 years), guaranteed buyers (must-take or default contract terms), and a price that offers a reasonable rate of return for renewable energy

[2] Source of this Appendix is RW6.

producers. Other features of a well-designed feed-in policy are that it should be simple, allows a variety of renewable energy types to participate, has low administrative costs, and flexible enough to capture changing market and cost efficiencies as they evolve(The China Sustainable Energy Program, 2003).

Renewable Portfolio Standards

Description

Both feed-in tariff and renewable portfolio standard (RPS) are government-mandated policies designed to create a market for renewable energy development. However, unlike the feed-in tariff, the RPS is a quantity-based policy that requires a quantitative target of renewable energy to be included in the electricity mix by a specific date. An RPS also specifies operators' responsibilities for obtaining that renewable energy and stipulates penalties for non-compliance. Under an RPS, a country or state requires all utilities or retail suppliers to purchase a certain amount of renewable energy. As currently implemented, RPS policies tend to be silent on price and leave that to be determined by the market.

Factors for Success

There are several design factors that seem to dictate the success of an RPS in spurring new renewable development. Some of the key factors include appropriate target levels, renewable targets that are long lasting and increase over time, strong and effective enforcement with appropriate penalty levels, and output-based generation targets. It is also important to have credit-worthy buyers in place to allow long-term contracts and renewable energy financing. Finally, the creation of a certificate-based trading platform ("green certificate trading") to assist liable parties in finding eligible renewable generation helps lower the administrative costs of compliance and helps parties meet their compliance targets.

Tendering Policies

Description

Tendering policy is defined as one that uses government-overseen competitive processes to meet a planning target through long-term power purchase agreements with renewable generators. Tendering policies are a variation of feed-in tariff and RPS, the key difference is that the price and the eligible projects are selected through a competitive bidding process. Like feed-in tariff, tendering policies guarantee to purchase the output of a qualifying renewable energy facility at a specified price for a specified period of time. The difference between these two policies is how the price is set, and which renewable energy generators can participate. While the feed-in tariff sets a price and guarantees to purchase the renewable energy output from any eligible facility at that price, a tendering policy uses competitive bidding to select projects that offer the best price. These projects are then awarded power purchase agreements for their output. As with feed-in tariff, this guaranteed power purchase agreement helps reduce investor risk and helps the project secure financing.

Factors for Success

The key success of tendering policies is the ability to reduce costs over time for renewable energy development. In the UK example, the Department of Trade and Industry selected the lowest price projects in each technology band, which resulted in stiff competition. This was successful in driving down the per-kWh price of renewable electricity bid within each technology band. For example, the average price of large wind dropped from around 18 cents/kWh to 4.5 cents/kWh over five years. In the last year of NFFO, large wind and landfill gas were price competitive with the average power pool purchase price. However, the tendering policy can only be implemented successfully with the conditions of mature technology and competition market.