

行政院及所屬各機出國報告

(出國類別：洽公)

赴歐洲洽商台電麥寮案風機
返國報告

服務機關：漢翔公司

出國人職稱：組長/處長/組長/處長/管理師

姓名：黃榮次/李龍鑫/羅明賓/羅清溪/張玉女

出國地區：德國/丹麥/西班牙

出國期間：95.08.12-95.08.25

報告日期：95.09.07

壹、摘要

本公司承包台電「麥寮風力發電機組新建工程」，原規劃之風機廠商西班牙 Gamesa 公司，因國際能源價格飛漲，造成風機搶購熱潮，致本公司擬採購之風機必須排至 2009 年才能交貨，無法滿足台電合約需求，將面臨違約罰款等重大損失。

為加速麥寮案風機採購之進行，特規劃前往歐洲，直接與 Gamesa 公司協調風機提前交貨之可能性，並確認風機交期及價格。同時另前往德國、丹麥及西班牙等國訪問其他風機製造商，瞭解相關機組之可能交期、價格及 ICP 意願等市場情況，考量建立第二商源，以期降低麥寮案執行風險，維護公司最大利益。

貳、目次

壹、摘要

貳、目次

參、拜會廠家及小組提報摘要

肆、本文(會議內容)與風機廠家會議重點與摘要

肆(一) Nordex

肆(二) Repower

肆(三) Fuhrlander

肆(四) Vestas

肆(五) Gamesa

伍、結論與心得

參、拜會廠家及小組提報摘要

European Wind Turbine Manufacturers Visiting Schedule

7/28/06

Date	Company	Airport / Location	Contact / Address	Model /Spec	Topics
2006/8/14 (Monday)	Nordex	Hamburg, Germany 德國 漢堡	Mr. Karsten Brueggemann International Sales Nordex Energy GmbH Bombarch 2, 22848 Nordstedt, Germany Phone: +49 (40) 50008 176	NS0 2500KW	1. Wind Turbine Spec & Work Scope of Mai-Liao project 2. Price, delivery date, & Terms conditions 3. Manufacturing situation 4. ICP intention 5. Future Cooperation In Taiwan market
2006/8/15 (Tuesday)	Repower	Hamburg, Germany 德國 漢堡	Mrs Franca Frommer Teamassistentin Unternehmensentwicklung REpower Systems AG Alsterkrugchaussee 378	MM82 2000KW	1. Wind Turbine Spec & Work Scope of Mai-Liao project 2. Price, delivery date, & Terms conditions 3. Manufacturing situation 4. ICP intention 5. Future Cooperation In Taiwan market
2006/8/17 (Thursday)	Fuhlander	Frankfort, Germany 德國 法蘭克福	Dr. Jan Roes / Carina Demuth Projektmanagement / Sales Führländer Aktiengesellschaft Auf der Höhe 4 56477 Weigandshain Tel.: 02964 / 99 86-0 Fax: 02964 / 99 86-33	FL2500-80 2500KW	1. Wind Turbine Spec & Work Scope of Mai-Liao project 2. Price, delivery date, & Terms conditions 3. Manufacturing situation 4. ICP intention 5. Future Cooperation In Taiwan market
2006/8/21 (Monday)	Vestas	Bilund, Denmark 丹麥 比靈斯	Mr. Jeff Cheong Head of Sales Vestas Australian Wind Technology Pty Ltd Ph: +61 3 8098 7345	V80-2.0 2000KW	1. Wind Turbine Spec & Work Scope of Mai-Liao project 2. Price, delivery date, & Terms conditions 3. Manufacturing situation 4. OEM Opportunity 5. Future Cooperation In Taiwan market Note: 1. Vestas is the largest company in wind turbine manufacturing.
2006/8/23 (Wednesday)	Gamesa	Madrid, Spain 西班牙 馬德里	Mr. Pedro E. Artigao Gamesa Eolica Asia-Pacific Business Director Tore Picasso, 9th Floor	G80-2000 2000KW	1. Price, delivery date, & Terms conditions 2. Manufacturing situation 3. OEM Opportunity 4. Future Cooperation In Taiwan market. Note: 1. To Verify manufacturing capacity. 2. Current production status.

小組提報摘要：

此次訪歐，小組均向各風機廠家要求

- 風機規範及必須符合 IEC Class Ia/b
- 時程(2007年7月底前)
- ICP(五項選二項)
- 最高 22% Down payment(原則上廠商可接受)
- 試車成功後，兩年保固需求(原則上廠商可接受)
- 每天 4 萬歐元的延遲罰款(廠商認為罰則偏高，很難接受)

肆、本文

肆(一) 與 Nordex 會議：

一、小組成員自我介紹，並以簡報檔提報漢翔公司能量及簡介，同時介紹台灣在風力發電目前興建計畫及未來之規劃建置能量等。

二、說明參察案的風機規格、時程及 ICP 要求

三、Nordex 公司及實績簡介：

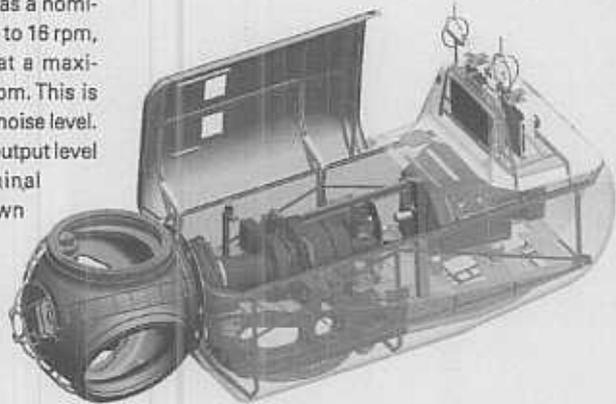
- 2006 Installation of Germany's 1st offshore turbine a N90/2500
- 2005 **Launch N90/2500 kW**
- 2003 Installation of the 2,000 Nordex turbine / 1. Offshore turbine installed
- 2001 Commencement of industrial rotor blade production
- 2002 IPO
- 2000 Transfer of wind power activities to the new Nordex AG
Completion of the world's first series 2.5 megawatt wind turbine
- 1999 Installation of the 1,000th Nordex turbine
- 1995 **Construction of the world's first series megawatt wind turbine**
- 1992 Establishment of production operations in Germany
- 1987 **Production of the world's largest series wind turbine (250 kW)**
- 1985 operation of Nordex in Denmark

四、Nordex 建議機型 N90。

TECHNICAL SPECIFICATIONS.

The higher speed at which the HS version of the N90/2500 rotates at wind speeds of between 8 and 13 m/s means that it produces a higher energy yield than the LS version. A further major difference between the HS and LS versions, apart from suitability for different locations (strong wind/light

wind), is the noise level. While the HS has a nominal speed of up to 16 rpm, the LS is run at a maximum of 14.9 rpm. This is reflected in the noise level. The reference output level at 95 % nominal output is shown below:



N90/2500 LS			N90/2500 HS	
reduced-noise operation at 95 % red. nominal output			at 95 % red. nominal output	at 95 % red. nominal output
101,5 dB(A)	102,5 dB(A)	103,5 dB(A)*	104,5 dB(A)	108 dB(A)
1,600 kW	2,000 kW	ca. 2,200 kW	2,500 kW	2,600 kW

*calculated

五、與 Nordex 討論結果

- Nordex 對本案準備最積極充分
- Nordex 同意協助塔架在國內製造及認證
- 控制介面 SCADA 待雙方工程人員進一步協商
- 如果簽約，Nordex 同意自費提供常駐技師一名協助本案
- Nordex 同意以 N60/S70/N77 機型配合國內 ICP 要求
- Nordex 願意給本公司在台唯一代理權，共同開發台灣風電市場

六、詳細會議記錄如後。

Minutes of Meeting

Subject: AIDC- Nordex Cooperation Discussion for Taiwan market

Date: 14.08.2006

Location: Bornbarch 7, Conference Room, Germany

Participants:	Name	Company/Function
	Judith Y.N Chang	AIDC, Legal Specialist
	Gary Lo	AIDC, Director Material Department
	Long-Shin (Stanford) Lee	AIDC, Power Energy Business Director
	Y. T. Huang	Ministry of Economic Affairs, Director
	Robin Lo	AIDC, Senior Manager Power and Energy Business Department
	Tony Adam	Nordex – Expert Markets
	Karsten Bruggemann	Nordex - Sales Manager

Reported by: K. Bruggemann

Phone: -176

Fax: -491

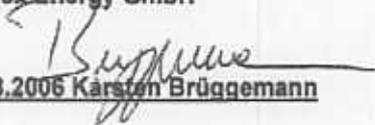
Reporting Date: 14.08.06

Distribution: Nordex Internal

Item	Description	Action No.
1	<p>Meeting Purpose</p> <p>AIDC was awarded the procurement for wind turbine generators from Taiwan Power Company for the Yulin Mai-Liao Wind Farm Project and visited Nordex to evaluate the purchase of 15 turbines and potential long-term business cooperation.</p>	
2	<p>AIDC Introduction</p> <p>AIDC was presented by Dr. Lee. They have just completed one project with 6 x 2.0 MW turbines. Now they are procuring the above mentioned Wind Farm Project and regard this project as an entry into a potential long-term cooperation with a selected turbine manufacturer.</p>	
3	<p>Nordex Introduction</p> <p>Nordex was presented by K. Bruggemann with special emphasis on the Asian market and the recommended products. For the Taiwanese market the N60 or N90 2500 HS was proposed. AIDC raised the issue whether the N80 would also be suitable especially because of its IEC1a certification. From side of Nordex it was clarified that IEC1b is in terms of the survival wind speed exactly the same. The difference is only on turbulence. Nordex will prepare a statement on this issue for AIDC to forward to TPC.</p>	1

Action No.	Description	Who	When
1	Statement on IEC 1a/ 1b to forward to AIDC	Karsten Brüggemann	22.08.2006
2	Site Evaluation for Mai Liao	Karsten Brüggemann	22.09.2006
3	Revised Quotation	Karsten Brüggemann	22.08.2006
4	German partner of Formosa HI	Stanford	22.08.2006
5	Draft Distributor Agreement	Karsten	22.08.2006

Nordex Energy GmbH


14.08.2006 Karsten Brüggemann

AIDC


Stanford Lee

肆(二) 與 Repower 會議：

一、Repower 簡介

- 1991 - 1998 Foundation of the predecessor firms
- 2000 Takeover of the HSW-location Husum
- 2000 Foundation of the REpower Systems AG
- 2001 Successful IPO
- 2002 MD-technology Bestseller in Germany
- 2002 First turbine in France installed
- 2003 10 % market-share in Germany
- 2003 First installations In Japan
- 2004 REpower overtakes GE in Germany
- 2004 First projects in P and I, partner in China
- 2005 First Projects in UK and AUS, Partner in PAREVA becomes shareholder

二、Repower 建議機型



MM82

Technical data

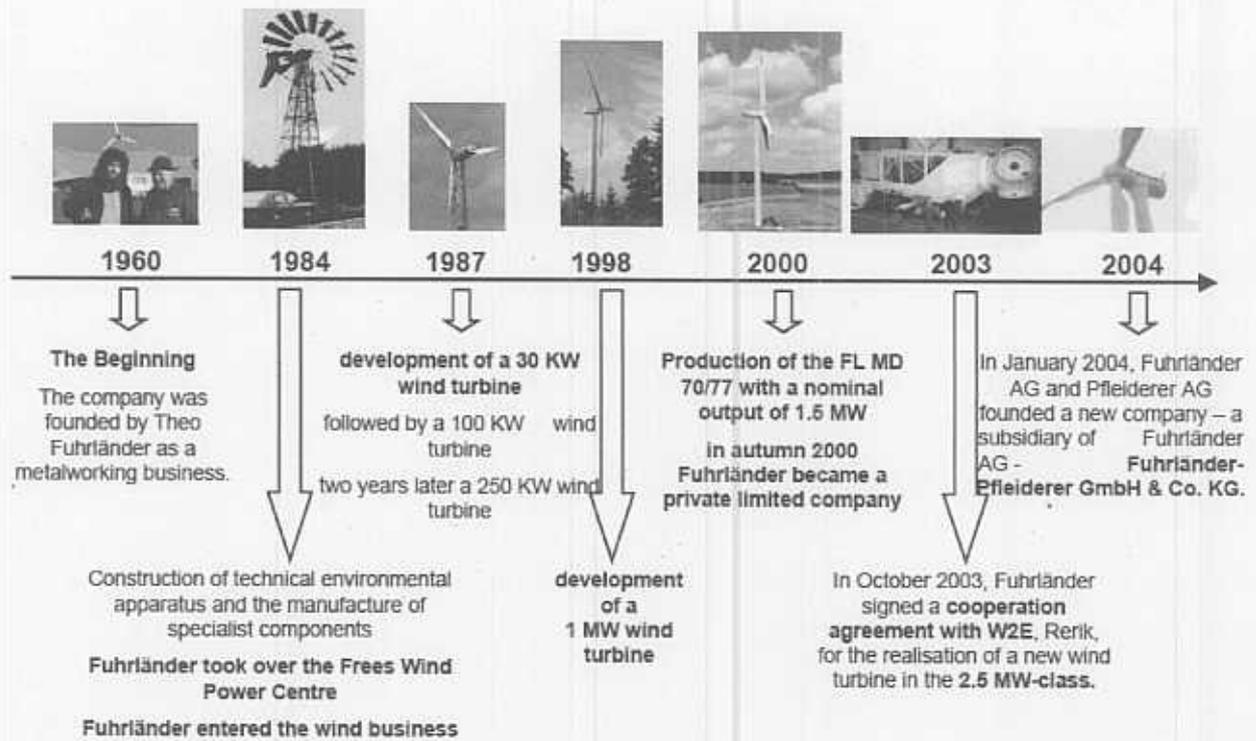
Drive data	
Rated power	2,000 kW
Cut-in speed	3.5 m/s
Rated wind speed	13.0 m/s
Cut-out speed	25.0 m/s
Wind zone	up to CRB 3
Type class	up to IEC Ia
Rotor	
Diameter	82.0 m
Rotor area	5,261 m ²
Rotor speed	8.3 - 17.7 rpm (+16.0%)
Blade	
Length	40.0 m
Type	GFC shell construction
or	GFC/GFC shell construction
Yaw system	
Type	Externally geared low-point bearing
Drive system	Gear motor
Stabilization	Disc brake
Gear system	
Type	Helical planetary stage with two spur gear stages
or optional	Helical planetary step-up gear with one spur gear stage
Transmission ratio	i = approx. 105.4
Electrical system	
Generator type	Double-fed asynchronous generator, 4-pole
Rated power	2,000 kW
Rated voltage	690 V
Rated speed	900 - 1,800 rpm (+16.3%)
Generator protection class	IP 34
Converter type	Pulse width-modulated (IGBT)
Power control	
Principle	Electrical blade angle adjustment - pitch and speed control
Tower	
Type	Steel tube
Hub height	59/80/100 m
Foundation	
	Reinforced concrete foundation with foundation tower, adjusted on site conditions
Utility features	
	■ Individually adjustable blades (electrically controlled) - fail-safe system
	■ Extensive redundant temperature and speed sensing system
	■ Fully integrated lightning protection
	■ Shielded cables and power rails protecting people and machinery
	■ Rotor holding brake with soft-brake function

三、 會議摘要

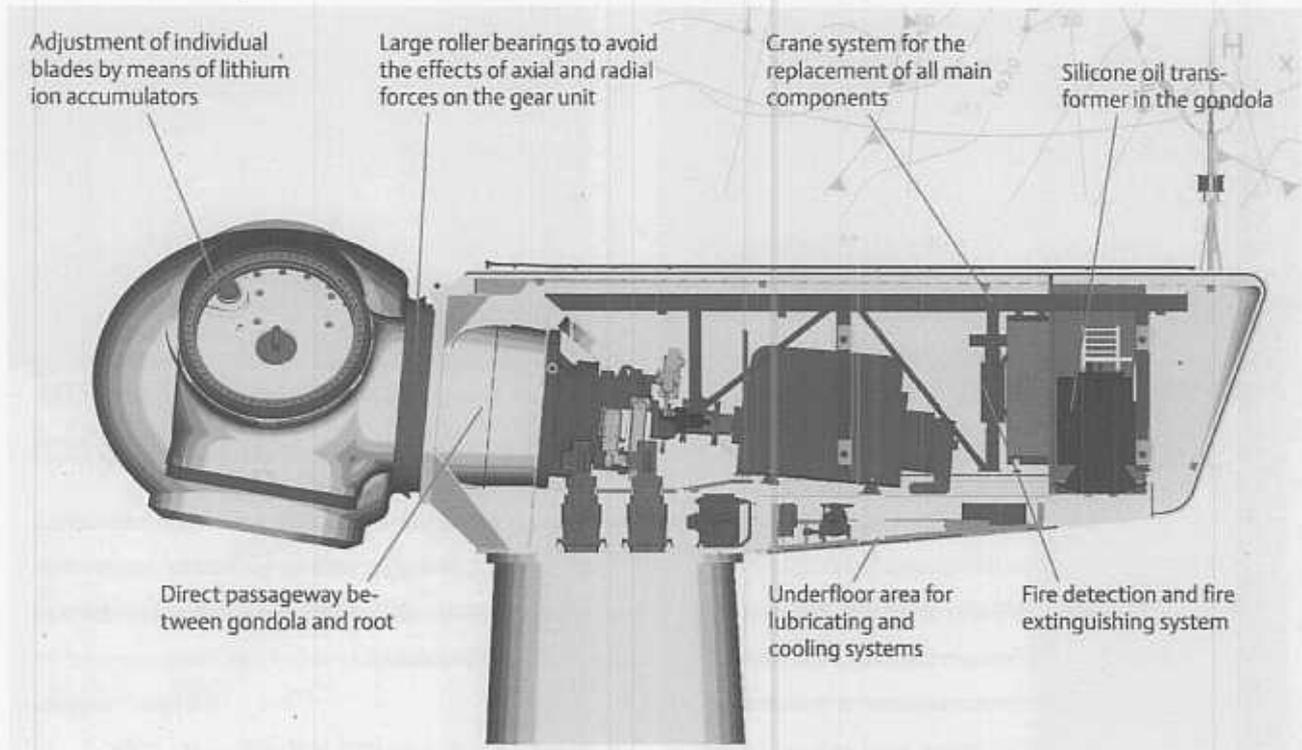
- Repower 含塔架初步報價 xxx 萬歐元
- Repower 同意協助塔架在國內製造及認證，每具可減 xx 萬歐元，
- 2007 年交期必須視 60Hz 的齒輪箱供應商產能是否來得及配合
- Repower 進入新市場必須經董事會同意，於 8/22 日召開內部董事會後，告知我方因 60Hz 的唯一齒輪箱供應商(winergy)2007 年產能均已銷售給美國簽約專案，因此確定無法滿足本公司麥寮案交期上的需要，但 Repower 董事會對與本公司合作開發台灣市場仍有高度興趣。
- Repower 已正式函告不報價。

肆(三)與 Fuhrlander 會議：

-- Fuhrlander 簡介



二、 Fuhrlander 建議之機型 FL2500



三、會議摘要

- 對台灣風電市場有高度之興趣
 - 對 ICP、技術轉移態度開放且積極
 - F 公司與 W2E 合作所開發的 FL2500 風機，採用許多操作上所得到的實務經驗的新設計，尤其是移除轉子與齒輪箱之間的傳動長軸，讓轉子直接與齒輪箱連接，再以軸承支撐中間之結構，此舉可以大幅減重、降低震動及運轉應力，提高齒輪箱之壽命。
 - 小組亦告知 F 公司一個參考價格，希望 F 公司能慎重考慮
 - F 公司同意重新考慮報價。
- 、詳細會議記錄如後

Meeting Minutes 16:45 on August 17 2006

AIDC has clearly expressed the Mai-Liao project scope of work, ICP and other requirements. AIDC also addresses the willingness to cooperate with Fuhrlaender.

Fuhrlaender has also expressed the interest of this project. Fuhrlaender is also willing to offer the possibility of out sourcing and purchasing parts from Taiwan.

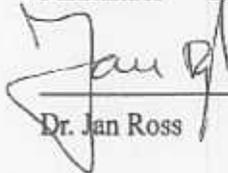
A presentation from W2E regarding the 2500 KW machine which Fuhrlaender recommended is done by W2E CEO Christoph Klewitz.

Fuhrlaender understand that AIDC requires:

1. 22 % advanced payment and the rest of the payment is based on the milestone.
2. Two-year warranty after the commission for wind turbine
3. The liquidated damage for the project is around 40,000 Euro per day

However, Fuhrlaender has to further evaluate the delivery schedule, payment schedule, ICP proposal and other offers to meet AIDC's project requirements. Fuhrlaender will come back with proposal by August 25 2006 to meet AIDC request.

Fuhrlaender Sale director



Dr. Jan Ross

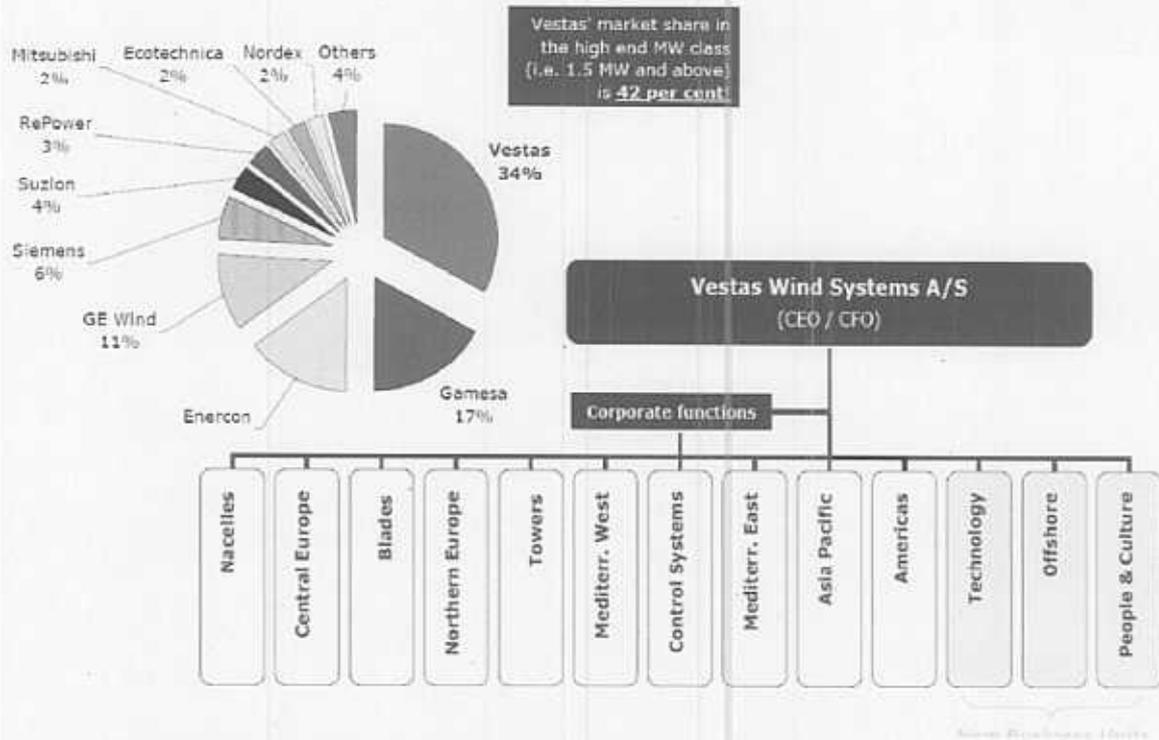
AIDC Director



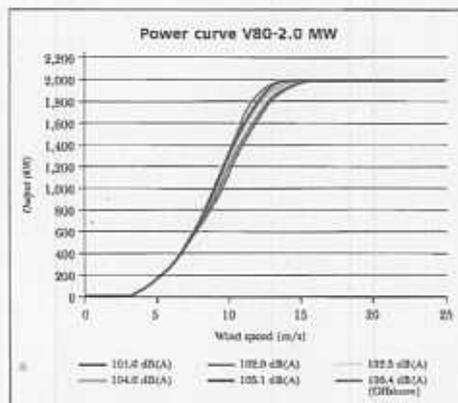
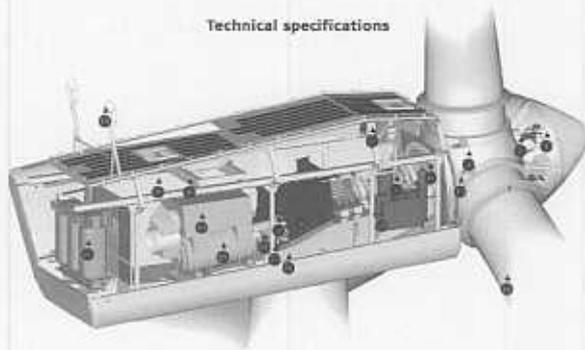
Dr. Stanford Lee

肆(四) 與 Vestas 會議：

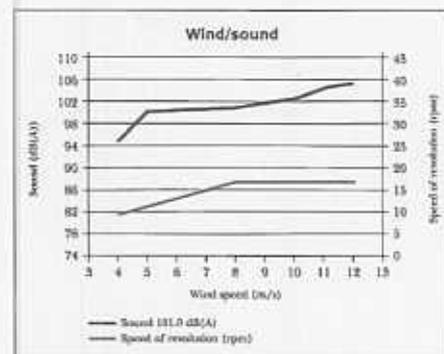
一、Vestas 簡介：Vestas 是目前市佔率在高的領導廠商。



二、Vestas 建議之機型 V80-2.0



The figure above illustrates the relationship between wind and sound levels, and that between wind and speeds of revolution for turbines equipped with OptiSpeed®. It clearly shows the sound level advantages of lower speeds of revolution because the beneficial effect on sound levels of lower speeds of revolution is approximately 7 dB(A) lower at 4 m/s than at 8 m/s. For other sound levels, the benefit can be as much as 10 dB(A). Please note that a decrease of 3 dB(A) is considered to represent a halving of the sound level.



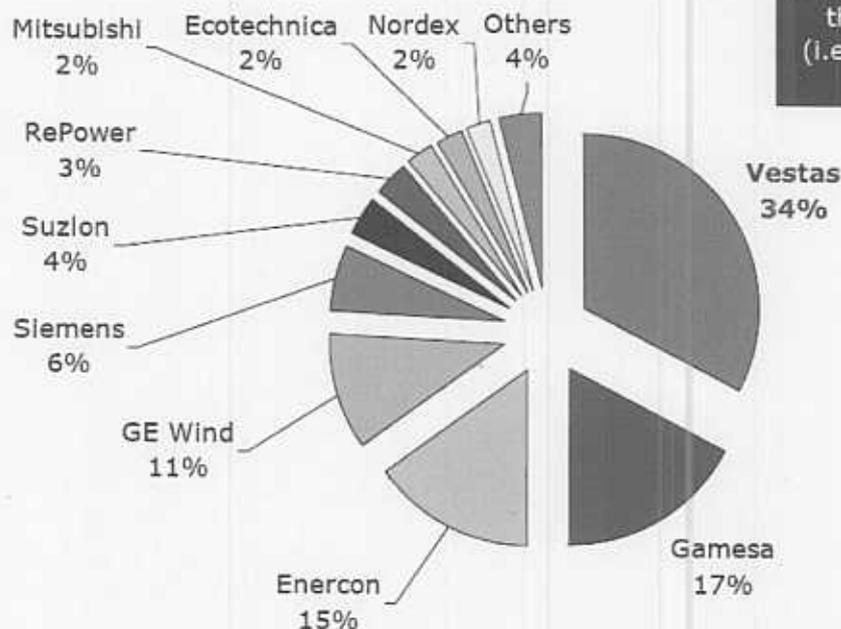
The sound output level can be adjusted by varying the revolution speed of the turbine as illustrated in the figure above. In practice, this means that, for example, the sound level recorded at a distance of 340 m (hub height 78 m) can be reduced from 44.5 to 40.4 dB(A) – i.e. by more than half the recorded level.

三、會議摘要

- 對台灣風電市場有興趣(台電彰工案風機組採用 VestasV80-2.0)
- 但全盤不同意台灣對 ICP、技術轉移的做法，也不會配合，且姿態相當高。
- 目前含塔架報價每具 20X 萬歐元，且塔架與風機不分開銷售(經協商爭取塔架由國內廠商製造，但仍未獲同意)。2007 年第四季尚有風機餘額，但言明若不加價及趕快簽約，將優先提供給價格較好的日本市場
- 澳洲電力公司 ROARING Thinking Energy 一次下單就高達四十幾具(ROARING 所訂購之 Vestas 機組，組裝完畢待運之照片見下圖)。為貼近市場，目前 Vestas 已將銷售總部從丹麥移往澳洲，並在澳洲設有葉片製造廠，可見經濟批量在談判上的力量。

肆(五) 與 Gamesa 會議：

一、Gamesa 簡介：Gamesa 是僅次於 Vestas 目前市佔率第二之風機領導廠商。



Source: BTM Consult, 2005

二、Gamesa 建議之機型 G80-2000

Rotor	
Hubline	80 m
Hub air	1,227 m ²
Rated speed	6.2 - 19.5 rpm
Rated torque	1045 kNm (1045 tonf.m)
Weight (incl. hub)	Approx. 33 T
Hub steel mass	Approx. 2.8 T

Blades	
Number of blades	3
Length	59 m
Weight	NACA 63.023 + FFA-W3
Material	Glass fibre reinforced with carbon fibre
Hub blade weight	5,300 kg

Tubular Tower		
Blade span	Height	Weight
3 blades	87 m	127 T
4 blades	87 m	149 T
4 blades	78 m	101 T
4 blades	100 m	182 T

Gearbox	
Type	2 planetary gear / 2 helical stages
Size	50 kW / 1,100 L / 62 kW / 1,100 L
Rating	100 kW (with oil cooler)
Oil cooler	2.2 MW

Generator 2.0 MW	
Type	Double fed machine
Rated power	1.8 MW
Voltage	690 V ac
Frequency	50 Hz / 60 Hz
Rated speed	9.55 / 11.93 rpm
Number of poles	4
Rated torque	203.1 kNm (203.1 tonf.m) / 203.1 kNm (203.1 tonf.m)
Rated rotor current	1,500 A @ 690 V
Power factor (cosφ)	0.95 CAP / 0.95 IND at rated load and 1.00 cosφ at 1.10 cosφ
Power factor (cosφ)	0.95 CAP / 0.95 IND throughout the entire range

Mechanical design

Drive train with main shaft supported by two spherical bearings that transmit the side loads directly to the frame by means of the bearing housing. This prevents the gearbox from receiving additional loads, reducing maintenance and facilitating its service.

Brake

Aerodynamic primary brake by means of full feathering blades. In addition, a hydraulically-actuated mechanical disc brake for emergencies is mounted on the gearbox high speed shaft.

Lightning protection

The Gamesa G80-2.0 MW wind turbine generator uses the "total lightning protection" system, in accordance with standard IEC 61024-1. This system conducts the lightning from both sides of the blade tip down to the root joint and from there across the nacelle and tower structure to the grounding system located in the foundations. As a result, the blade and sensitive electrical components are protected from damage.

Control System

The Generator is a doubly fed machine (DFM), whose speed and power is controlled through IGBT converters and PWM (Pulse Width Modulation) electronic control.

- Benefits:
 - Active and reactive power control.
 - Low harmonic content and minimal losses.
 - Increased efficiency and production.
 - Prolonged working life of the turbine.

Gamesa SGIPE

Wind farm control system, developed by Gamesa Eólica, that allows real-time operation and remote control of wind turbines, meteorological forecast and electrical substation via satellite-terrestrial network. Modular design with control tools for active and reactive energy, noise, vibrations and wake effects. TCP/IP architecture with a Web interface.

SMP-8C Predictive Maintenance System

Predictive Maintenance System for the early detection of potential deterioration or malfunctions in the wind turbine's main components.

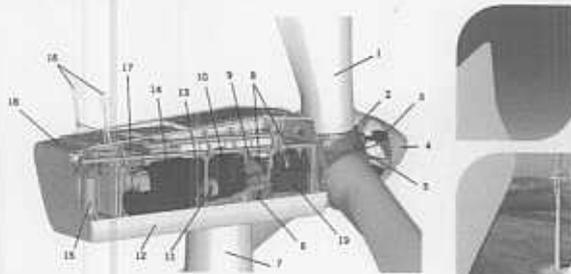
- Benefits:
 - Reduction in major corrective measures.
 - Increase in the machine's availability and working life.
 - Preferential terms in negotiations with insurance companies.

Noise control

Aerodynamic blade tip and mechanical component design, reactive noise eliminators. In addition, Gamesa Eólica has developed the Gamesa NKS™ noise control system, which permits programming the noise emissions according to criteria with an 80%, low or wind direction. This achieves the goals of local regulation compliance as well as maximum production. Low noise curves: 103, 102, 101 dB.

Grid connection

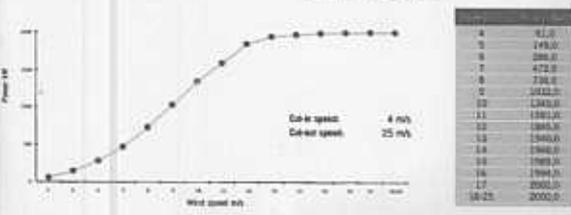
Gamesa Eólica's doubly fed wind turbines and Active Converter and low speed converter technologies ensure the compliance with the most demanding grid connection requirements. Low voltage ride-through capability and dynamic regulation of active and reactive power.



- | | | | |
|-----------------------------|--|-----------------------------------|------------------------------|
| 1. Blade | 6. Active gear control | 11. Gearbox | 15. Transformer |
| 2. Wake lining | 7. Tower | 12. Main drive shaft | 16. Anemometer and wind vane |
| 3. Hydraulic pitch actuator | 8. Nuts (nut with low bearing housing) | 13. Remote support frame | 17. Top controller |
| 4. Hub cover | 9. Shock absorbers | 14. Intermediate high speed shaft | 18. Blade pitch |
| 5. Hub | | 14. Doubly fed generator | 19. Pitching act |

Power Curve Gamesa G80-2.0 MW (for an air density of 1,225 kg/m³)

Power curve calculation based on NACA 63.023 and FFA-W3 airfoils. Calculation parameters: 50 Hz grid frequency, tip angle pitch regulated, 10% turbulence intensity and a variable rotor speed ranging from 6.0 - 19.0 rpm.



三、會議摘要

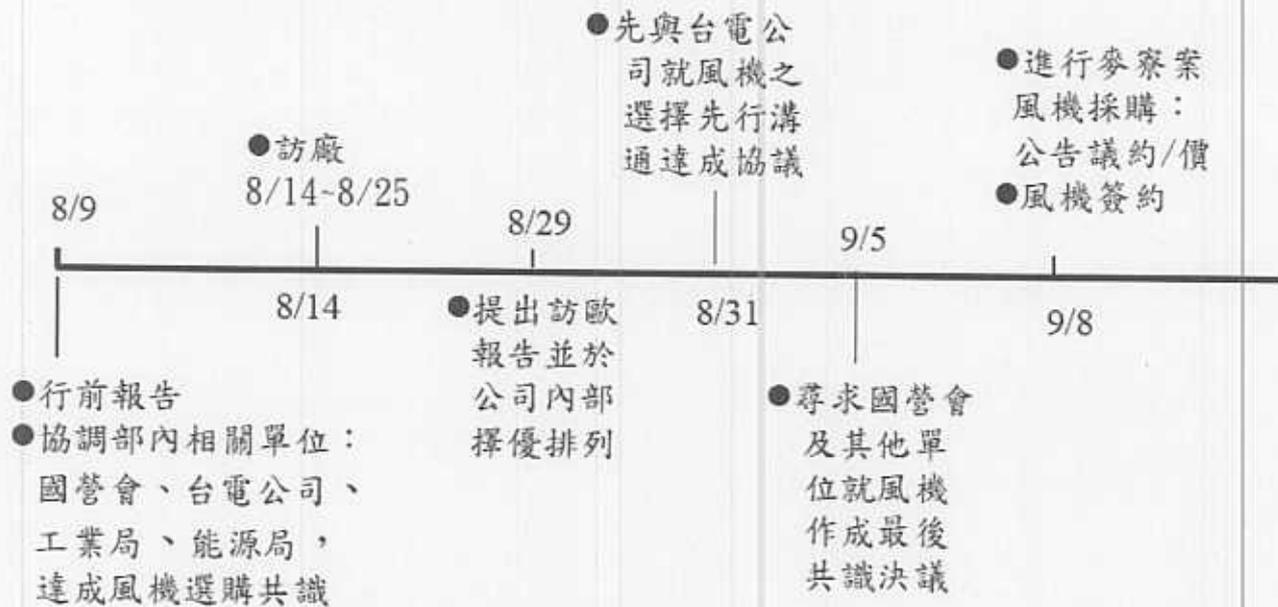
- 台電香山案已採用 Gamesa G80-2000 風機
- 對本公司深具好感，也願意與本公司合作開發台灣風電市場
- 同意與本公司及其他台灣之廠商合作共同解決其產能瓶頸問題
- 對本公司面臨台電麥寮案的問題，同意積極解決，但坦承此非目前談判層級人員之權限，因此
- 建議公司高層能利用 Gamesa CEO 於 9/13 日前往天津主持風機生產廠開幕機會，商談解決交運地及交期問題，同時建立雙方高層溝通機制，加強未來雙方合作機會。
- 經濟部駐西班牙經濟組組長陳銘師組長與 Gamesa 管理階層熟悉，且積極從中協調，助益甚多。
- Gamesa 是本次唯一同意訪歐小組參觀葉片製程的公司

五、結論與心得：

一、歐洲風機廠商拜訪結果綜整表。

漢翔公司歐洲風機廠商拜訪結果綜整表						
編號	廠家 (國別)	機型(KW) IEC Class	交期	是否同意 國內自製 塔架?	是否願意 配合 工合 (ICP)?	其他優惠措 施
1	Nordex (德國)	N90 (2500KW) IEC Class Ib	2007年第四 季	同意	部分同意	願意給本公司 在台獨家 代理權，與 本公司合作 開拓台灣市 場
2	Fuhrlander (德國)	FL2500 (2500KW) IEC Class Ia	分三批交運 第一批:2007 年第四季 第二批:2008 年 第三批:2008 年	同意	願意配合	有意願與本 公司合作開 拓台灣市場
3	Repower (德國)	MM88 (2000KW) IEC Class Ia	不報價			
4	Vestas (丹麥)	V80-2.0 (2000KW) IEC Class Ia	2007年第四 季	經協商爭 取塔架由 國內廠商 製造，但仍 未獲同意	完全不同 意	
5	Gamesa (西班牙)	G80 (2000KW)	2008年底或 2009年初	同意	願意在台 灣製造部	有意願與本 公司合作開

後續計畫及作為。



三、心得

本次訪歐，發覺德國風機廠商對本公司及台灣風力發電市場相當陌生，但經過小組介紹後，均對公司從航太轉而投入風力產業及市場均持高度肯定、信心及合作意願。德國風機廠商對技術移轉及 ICP 配合度較高，可能是有持續不斷研發創新的關係。德國各風機廠均致力於大型風機的研發如：Nordex 2.5M，Repower 5M 及 Fuhrlander FL2.5M 機組。Vestas 對技術移轉及 ICP 配合度較低，可能是受 2001 年 Gamesa 技轉之後成為其競爭對手有關，目前 Vestas 主力產品為 2.0 及 3.0M 之機組。Gamesa 對本公司態度較開放及友善，且熟悉台電需求及履約。但 Gamesa 如堅持從天津出貨，則 Gamesa 風機無法列入考慮。

四、各公司在中國大陸均有合資公司或設廠

Nordex:

- 西安 N43(JV)
- 銀川 S70/N77(JV)
- 保定 N60 Blade

Repower:

- 2002: REpower licenses the REpower 48/750 to Goldwind 金風 and Zhejiang Windey 浙江 in Hangzhou:
- 2004: REpower licenses the MD 70/77 to Dongfang 東風蒸汽渦輪 Steam Turbine Works in Deyang，包頭(JV)與 Vestas 為同一家

Fuhrlander: 授權大鹿島公司製造 FL1000

Vestas: 對大陸市場較保守，但仍在保定設廠，並於波蘭及澳洲設有葉片廠

Gamesa: 天津生產 G47/G52/G58 風機

五、建議事項：以目前台電標案之合約價金及限定不得從大陸出口等規定，未來在熱絡的風機市場環境中，要買到歐美地區製造風機之可能性愈來愈低，將延誤推動風力發電期程。台電公司應及早規劃因應。