出國報告（出國類別：其他）

德國布萊梅風力發電交流訪問團出國報告

服務機關：經濟部能源局
姓名職稱：蘇主任秘書金勝
出國地區：德國
出國期間：106 年 5 月 15 日至 5 月 21 日
報告期間：106 年 7 月 14 日

行政院及所屬各機關出國報告提要

出國報告名稱：德國布萊梅風力發電交流訪問團

頁數 118 含附件：■是□否

出國人員姓名/服務機關/單位/職稱/電話

蘇金勝/經濟部能源局/主任秘書/02-27757702

出國類別：□1 考察 □2 進修 □3 研究 □4 實習 ■5 其他

出國期間：106 年 5 月 15 日~ 5 月 21 日

報告期間：106 年 7 月 14 日

出國地區：德國

分類號/關鍵詞：離岸風力發電、港口建設、港口運維(Offshore Wind Power, Port Construction, Port Maintenance)

內容摘要：

在本(能源)局與德國在台協會促成下，我國於 105 年 12 月 21 日與德國簽署「臺德能源轉型合作意向共同宣言」，宣示雙方深化能源領域合作之願景。

在上開基礎下，本局接受德國布萊梅邦政府之邀請，籌組「德國布萊梅風力發電交流訪問團」，以離岸風力為主題，由本局蘇主任秘書率國內相關單位與廠商，包括行政院原子能委員會、核能研究所船舶暨海洋產業研發中心海洋產業處、台灣綜合研究院研究二所、財團法人工業技術研究院、臺灣港務股份有限公司臺中港務分公司、台灣電力股份有限公司綜合研究所能源研究室、再生能源處、歐風能源股份有限公司、台灣綠色電力股份有限公司、世紀鋼鐵、德商美最時貿易股份有限公司離岸風力發電部門、德勤財務顧問股份有限公司(勤業眾信集團)等 12 個單位參訪布萊梅之離岸風場、港口基礎建設及運維產業，進行產業媒合交流，並強化我國機關間合作與溝通管道，以利加速推動離岸風電發展。

目　錄

壹、出國行程紀要

一、出國目的

我國於 105 年 12 月 21 日與德國簽署「臺德能源轉型合作意向共同宣言」，宣示雙方深化能源領域合作之願景。在上開基礎下，本(能源)局接受德國布萊梅邦政府之邀請，籌組「德國布萊梅風力發電交流訪問團」，以離岸風力為主題，由本局蘇主任秘書率國內相關單位與廠商，參訪布萊梅之離岸風場、港口基礎建設及運維產業，進行產業媒合交流，並強化我國機關間合作與溝通管道，以利加速推動離岸風電政策。

二、行程紀要

本次出訪由本局蘇主任秘書金勝率團，團員組成除本局外，尚包括行政院原子能委員會、核能研究所船舶暨海洋產業研發中心海洋產業處、台灣綜合研究院研究二所、財團法人工業技術研究院、臺灣港務股份有限公司臺中港務分公司、台灣電力股份有限公司綜合研究所能源研究室、再生能源處、歐風能源股份有限公司、台灣綠色電力股份有限公司、世紀鋼鐵、德商美最時貿易股份有限公司離岸風力發電部門、德勤財務顧問股份有限公司(勤業眾信集團)等 12 個單位。本次訪問除參加「臺德離岸離岸風電交流座談會」進行討論與經驗交流外，並透過布萊梅政府安排，拜會布萊梅市政廳 (Bremen Town Hall)、布萊梅投資機構 (Bremen Invest)、布萊梅商會 (Bremen Chamber of Commerce)及參訪 Fraunhofer 風能暨能源系統機構 (IWES)-葉片測試場、動態機艙測試實驗室 (DyNaLab)、SENVION 風力機製造公司、Nordergründe 離岸風場、布萊梅港港務公司 (Bremenports GmbH & Co. KG)、布萊梅港區及 Eurogate 碼頭物流公司、及 Falck 海事安全訓練中心等，讓團員實地瞭解德國布萊梅政府推

動風力發電執行策略與推動經驗。本次出國行程規劃及團員名單如表 1 及表 2 所示。

表 1　德國布萊梅風力發電交流訪問團行程

日期	活動主題
106.05.15(一)	啟程
106.05.16(二)	1.抵達布萊梅 2.拜會布萊梅市政廳 (Bremen Town Hall) 3.拜會布萊梅投資機構 (Bremen Invest) 4. 拜會布萊梅商會 (Bremen Chamber of Commerce)
106.05.17(三)	1.參訪 Fraunhofer 風能暨能源系統機構 (IWES) ー 葉片測試場、動態機艙測試實驗室 (DyNaLab) 2.參加「臺德離岸風電交流座談會」
106.05.18(四)	1.參訪 SENVION 風力機製造公司 2.參訪 Nordergründe 離岸風場
106.05.19(五)	1.拜會布萊梅港港務公司 (Bremenports GmbH & Co. KG) 2.參訪布萊梅港區及 Eurogate 碼頭物流公司 3.參訪 Falck 海事安全訓練中心
106.05.20(六)~05.21(日)	返程

表 2 德國布萊梅風力發電交流訪問團團員名單

單位	職稱	姓名
經濟部能源局	主任秘書	蘇金勝
工業技術研究院綠能與環境研究所	副所長	王人謙
	經理	呂威賢
船舶暨海洋產業研發中心海洋產業處	處長	周顯光
行政院原子能委員會核能研究所	專案主持人	黃金城
台灣綜合研究院研究二所	所長	陳建緯
臺灣港務股份有限公司臺中港務分公司	資深事務員	陳慧穎
台灣電力股份有限公司綜合研究所能源研究室、再生能源處	研究室主任	鍾年勉
	副處長	林明成
歐風能源股份有限公司	專案助理	白兆梅
台灣綠色電力股份有限公司	總經理	李建勳
	秘書	吳曉玲
世紀鋼鐵	執行長	李建成
	顧問	林明弘
	特助	賴俊成
德商美最時貿易股份有限公司離岸風力發電部門	協理	古曰肅
德勤財務顧問股份有限公司(勤業眾信集團)	協理	朱韻儒

*共 17 位團員

貳、參與活動及工作內容

一、拜訪布萊梅市政廳 (Bremen Town Hall)

(一)時間：5 月 16 日(星期二)上午

(二)會談/接待人員

Senator Martin Günthner, Minister of Economic Affairs, Labour and Ports

Christian Gutschmidt, Director International Affairs at the Ministry of Economic Affairs, Labour and Ports

(三)會談/參訪紀要

1.參議員 Martin Günthner 曾於 2016 年 10 月率團訪臺，此次代表德國聯邦布萊梅政府接待本訪問團。持續能源供應和過渡轉型是二十一世紀世界各地面臨的主要挑戰之一，德國主打“Energiewende”(德語)，意為能源轉型計畫，目標是發展再生能源，以取代化石燃料及核燃料，過渡到可持續發展經濟。

2.在日本福島事故發生後，臺灣與德國對於增加再生能源的目標一致，希望帶來綠能供應及能源獨立的優勢。隨著德國新型風電場發展的競標制，經過了過去幾年的穩定學習曲線，目前可以在沒有或幾乎沒有補貼的情況下，提供離岸風電。德方表示從長遠來看，離岸風電不僅是環保永續的，在價格上也很有競爭力。

3.布萊梅是國際貿易非常活躍的城市，在風能方面亦為領導者之一。在 1990 年代初，布萊梅安裝第一台陸域風力發電機，2002 年開發了世界上第一台海上 MW 級的風力發電機的原型機。德方表達期許我方藉由此行能深入瞭解布萊梅提供的價值鏈範圍，促進雙邊合作的機會。

圖 1 本團與德參議員 Martin Günthner 等人於布萊梅市政廳前合影

二、拜會布萊梅投資機構 (Bremen Invest)

(一)時間：5 月 16 日(星期二)下午

(二)會談/接待人員

Matthias Hempen, Director Asia

Dieter Voss, Cluster Manager Wind Energy

(三)會談/參訪紀要

1.布萊梅港座落於北海之濱，為德國第一大出口港，且為全球第 25 大貨櫃碼頭，為全球企業進入歐洲市場的重要門戶，已扮演超過 1200 年貿易樞紐的角色。布萊梅市市民約有 67 萬 1,000 人，但區域人口高達 270 萬人，就業人口人均 GDP 7 萬 5,236 歐元，為德國第十大綜合性工業城市，以大學和研究機構為基礎，設有航太及離岸風電的高科技研究中心，具有高競爭力的人力資源。

2.布萊梅主要的產業聚落包括物流工業(Ports, transport, warehouse, logistics)、國際貿易、汽車工業、食品工業、航太工業、海事工業及風電產業等。

(1)散裝貨櫃：物流產業為布萊梅及布萊梅港重要的經濟支柱，亦提供當地大量的工作機會。布萊梅港口水深超過 15 公尺，2016 年貨櫃運量約 550 萬 TEU，每日透過空運、海運、鐵路運送至歐洲內陸，與臺灣每週有定期航線。

(2)汽車進出口：布萊梅港是歐洲最大的汽車港，擁有完善的汽車轉運與倉儲設備及連結製造廠及歐洲內陸的交通網絡。德國、東歐及北歐的進出口汽車大部分在此中轉。2016 汽車運量超過 200 萬台，主要出口至美國、東亞及中東，進口主要來自日本、韓國及美國。

(3)汽車製造：布萊梅擁有 600 多家汽車零件供應商，且為 Mercedes-Benz 全世界最大的汽車生產地，Mercedes-Benz 在地員工約 1 萬 2,000 人，每年生產超過 32 萬 4,000 台汽車。除了小轎車外，布萊梅港還轉運挖掘機、起重機和重型機械設備等。

(4)離岸風電：布萊梅港是德國最重要的離岸風電發展基地，擁有離岸風電的專用港口及完整的產業鏈，工業區內有 Areva、Repower、WeserWind 等離岸風力的上、下游企業。另外，當地的造船和航海技術，也能做為離岸風電產業研發、維運的後盾。

圖 2　Bremen Invest 簡報

三、拜會布萊梅商會 (Bremen Chamber of Commerce)

(一)時間：5 月 16 日(星期二)下午

(二)會談/接待人員：Torsten Grunewald

(三)會談/參訪紀要

1.布萊梅商會的主要任務為檢討基礎建設於規劃過程中的經濟需求，同時也為經濟結構轉型階段的企業，提供廣泛的諮詢服務，特別是新創企業。另外，對於企業接班人問題的協助、租稅優惠及補貼信息，還有與政治機構的對話。

2.商會定期發布經濟報告，為布萊梅經濟活動，提供代表性的概況分析。商會亦會進行相關遊說活動，制衡國家官僚體系，為經濟提供更多的機動空間，同時提供信息通信技術(ICT)及勞動保護領域各種信息和諮詢服務。

3.商會另一項重要功能為擔任公共採購機構與工商業之間的仲介角色，為聯邦布萊梅州提供合同諮詢，向聯邦布萊梅省的企業提供有關公共採購合同的建議。當公共機構查詢公共工程等時，商會提供他們合適的公司名單。

4.商會亦協助跨境業務，在布萊梅以出口導向型外貿的情況下，協助企業進入國外市場，並安排與全球銷售合作夥伴和供應商的聯繫，也為來自非歐盟成員國的投資者和商業領袖提供實際幫助，獲得居留許可，並與負責外國人的地方當局密切合作。

5.就涉及國際業務的融資和法律問題提供意見，就海關和外貿立法問題提供諮詢意見。

四、參訪 Fraunhofer 風能暨能源系統機構 (IWES)

(一)時間：5 月 17 日(星期三)上午

(二)會談/接待人員：Dr. Antje Wagenknecht

(三)會談/參訪紀要

Fraunhofer Institutes 為德國亦是目前歐洲最大的應用研究機構，致力於學術研究與產業應用間之橋樑。研究範圍係針對人類生活上的各種需要，包括健康、安全、通訊、流通、能源及環境等方面，有 60 多個研究所。IWES 是風力發電系統相關技術的主要研究單位，位於德國布萊梅港區(Bremerhaven)，超過 170 家企業及研究單位聚集在此處，建構完整的離岸風能產業鏈。本次參訪風能研究部門(Wind Energy and Energy System Technology)。

1. 風力機葉片測試場 (Rotor Blade Test Site)：進行葉片之靜態及動態測試，包括極限及疲勞負荷。
2. 多自由度風力機傳動鏈(power-train)測試平台(DyNaLab)：可測試最多達 10 MW 機組。傳動鏈是影響風力機可靠度及發電成本最關鍵次系統，DyNaLab 可模擬風力機實際承受之各種可能負載狀況，以縮短研發修改及測試驗證之時間與成本，並提供風力機組傳動鏈於實驗室之完整試驗，降低風力機於安裝後之故障風險，大幅提升機組可靠度及可用率。

Rotor

Qualification of composite materials and components
- 70- and 90-meter testing facility certification approval
- Accredited testing of specimens and components

Industrialized manufacturing
- Experimental tests in the "BladeMaker" demonstration center
- Validation testing of manufacturing processes and materials
- CNC-controlled production cell with 2 cooperating 6-axis gantries

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Fraunhofer IWES

圖 3　**IWES** 葉片測試場能量

Drive trains and grid connection

DyNaLab with 10 MW drive performance / peak 15 MW
- Nominal torque: > 8.6 MNm
- Rotor load application unit for dynamic bending moments, thrust and radial forces
- Artificial grid: 44 MVA installed inverter power
- Technical reliability of mechatronical systems
- Planning and implementation of system tests, accelerated lifetime tests
- Model validation

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Fraunhofer IWES

圖 4　**IWES** 多自由度傳動鏈測試平台(DyNaLab)

五、參加「臺德離岸風電交流座談會」 (B2B 產業媒合)

(一)時間：5 月 17 日(星期三)下午

(二)德方單位

Foreign Trade Promotion and International Affairs, Bremen;

WAB (the Wind Energy Agency);

Green Giraffe (renewable energy finance specialist);

Bremenports;

BIS (Bremerhaven economic development company);

DOC (Deutsche offshore consult);

OWEN BREMEN;

fk-wind (Institute of wind energy);

IMS Nord;

ONP;

SIEM offshore contractors;

STELLWIND;

Flack safety services;

wpd offshore。

(三)會談紀要

1.本座談會由本人與布萊梅經濟官員共同主持。會議開始首先說明我國離岸風機推動之緣起、必要性及具體推動作法，並強調政府推動離岸風機之決心，期待透過離岸風機的推動，達成我國再生能源推廣目標，並有效帶動整體產業鏈與技術升級。續由工研院報告「Status of Offshore Wind Development in Taiwan」相關細節。德方對於我國離岸風機推動之目標與決心有深刻體認，且表示德國當時的情

形與推動過程更為嚴峻，我國目前的目標與推動進程規劃完整，在預定時間內若按部就班具體執行，定能達到設定的目標。

2.德國由「固定電價制」改變為「競標制」之緣起

(1)德國離岸風電原採用固定躉購電價，提供產業長期穩定的發展環境，惟隨著產業鏈成熟與完整，德國政府決定於 2021~2025 年之過渡階段(Transition Period)採用競標制度。2017 年 4 月舉辦第一次，預定 2018 年 4 月舉辦第二次，每次各釋出 1.55 GW 之裝置容量，合計 3.1 GW。得標廠商須於 2021~2025 年間完工商轉。2017 年 4 月第一次競標結果，由德國廠商 EnBW 與丹麥 Dong Energy 2 家廠商共 4 個風場得標，其中 3 個風場無政府補貼金額，完全由自由市場售電。德方專家表示「零補助」之主要原因為，得標業者均以未來 10~15 MW 風力機組進行規劃，成本應可降低，並預期未來自由市場電價將會提高。德國於 2026~2030 年將採政府主導之競標模式 (Centralized Model)，規劃朝向荷蘭、丹麥模式，亦即由政府先規劃開發區域，並完成調查作業與併網設施，後再開放業者競標。

(2)德方以自身設置經驗提出建議，未來應多注意離岸風電建置中的關鍵風險問題，尤其臺灣具氣候及環境之特殊性，相關風險可能來自於水下環境條件與狀況、海象及相關氣候、工作船舶的選用與配合度、港埠至作業現場與陸地物流狀況、基礎設施建構的時程，都可能成為未來進行離岸風電開發時遭遇的議題。

(3)德方相關單位對於我國港口基礎建設之進度表示關心，並詢問是否能有效滿足離岸風機安裝及製造之基本條件。台中港務公司表示開發規劃已完成，目前正進行招標作業，未來將提供更高規格的基礎設施，加大承載重為 50 噸/平方公尺。

圖 5 本團說明我國離岸風電政策與願景

圖 6 本團簡報臺灣離岸風電推動現況與策略

六、拜訪 SENVION 風力機製造公司

(一)時間：5 月 18 日(星期四)上午

(二)會談/接待人員：SENVION 市場部經理及生產線工程師等

(三)會談/參訪紀要

1.位於布萊梅港區的 SENVION 風機公司前身為 REPower，是全球投入離岸風力機組之先驅，也是最早開發出 5 MW 機組的公司，近年來因整併，由印度 Suzlon 風機公司投資經營。德國 2010 完成之第一座 Alpha Ventus 離岸示範風場，即採用 6 部 REPower 5 MW 機組。目前該公司積極投入浮動式風力機(Floating Wind Turbine)之研發。SENVION 風機市場相當大，除歐洲外，南美洲巴西、智利及阿根廷亦為其主要市場。

2.本次參觀其機艙製造工廠，此行獲得許可於遠方拍攝其裝配線，包括風機轉子驅動軸上的各關鍵零組件如輪轂、剎車、軸承、轉向器及齒輪箱與發電機及其他附屬配件等風機機艙內各關鍵零組件，從組裝到測試之作業流程。

圖 7 布萊梅港 SENVION 公司

圖 8 遠方拍攝 SENVION 公司風機機艙內關鍵零組件裝配線現場

七、近岸風場 Nordergrunde (wpd group)

(一)時間：5 月 18 日(星期四)下午

(二)會談/接待人員：Achim Berge Olsen, Managing Director

(三)會談/參訪紀要

1.該風場位於德北威希河河口附近，處於 12 海浬領海範圍內，離岸約 15 公里，本次搭乘德國 wpd 公司安排之工作船，參訪名聞遐邇的 Nearshore Wind Farm Nordergrunde。

2.wpd 公司介紹該專案 2003 年取得規劃許可，2008 年遭環保團體抗爭與法院訴訟，2011 年才與邦政府及環保組織達成協議。專案分風機(WTG)、基礎(FOU)、場區海纜(IAC)、離岸變電站(OSS)、基礎與風機之運輸與安裝(INS)等 5 家 EPC 負責施工及安裝。原定 2016 年建造完成，目前風機、海纜、基礎均已安裝完成，惟因離岸變電站發包採 Multi-contracting，且履約不順，故將延至 2017 年第 3 季安裝完成，第 4 季才能正式運轉。規格臚列如下：

(1)總裝置容量 111MW。

(2)總投資金額約 4 億 1,100 萬歐元。

(3)保證躉購電價每度電 19.4 歐分，為期 8 年。

(4)開發商 wpd 約占 1/3 股權，並由銀行提供專案融資。

(5)水深小於 10.3 公尺。

(6)年平均風速約 9.3 公尺/秒。

(7)18 架 Senvion 6MW 機組，設計使用年限 25 年。

(8)Senvion 提供 10 年維修服務、單樁基礎。

(9)電網營運商負責電網與離岸變電站之連接。

圖 9 出發前往 Nearshore Wind Farm Nordergrunde

圖 10 Nearshore Wind Farm Nordergrunde 遠眺圖

八、拜會布萊梅港港務公司 (Bremenports GmbH & Co. KG)

(一)時間：5 月 19 日(星期五)上午

(二)會談/接待人員

Robert Howe, Geschäftsfüchrer Managing Director

Stefan Färber, Abteliungsleiter Interne Dienste Head of Internal Services

Christian Hein, Abteilungsleiter Hafenentwicklung Head of Port Development

Uwe Will, Senatsrat a.D.

(三)會談/參訪紀要

Bremenports GmbH & Co. KG 為布萊梅港管理公司，屬於布萊梅邦政府 100%控股公司。該公司提供港口規劃，具備建設基礎設施運營和維護工程與開發能力。布萊梅港之經營型態為一地主港角色，布萊梅港務公司負責碼頭及後線土地之基礎建設、維護鐵路和疏浚，至於碼頭場域內所需要之重件吊裝機具、運輸車輛或倉儲建築物，則由承租業者視個案需要自行興建經營。布萊梅港務公司房東的角色，僅收取土地租金及港灣費用，維持港埠開支。布萊梅港務公司主要管理 3 大區域，摘要說明如下：

1.Bremerhaven(外港)

(1)貨櫃碼頭：每年約 550 萬 TEU 吞吐量

(2)汽車碼頭：每年約 230 萬輛汽車

(3)客運碼頭：作為郵輪母港，每年約 7 萬名旅客

(4)修造船區：目前有 3 家公司進行修船業務

2.Bremerhaven (漁港)

(1)離岸風力專區：風機設備製造及測試區

(2)食品加工區

(3)修造船區

3.Bremen

(1)離岸風電專用碼頭，位於外港，碼頭長度 500 公尺，後線土地約 25 公頃。

(2)離岸風電產業園區，位於漁港，包含水下基礎、葉片、機艙組裝及測試區，該區重件碼頭長度為 280 公尺，水深 7.10 -8.10 公尺，土地承載力 7 噸/每平方公尺。機艙於碼頭邊裝船，利用重鋼板增加承載力。水下基礎於生產廠房至碼頭邊緣安裝軌道，以軌道裝船載運至外港。在外港水下基礎專用碼頭長度 900 公尺，承載力 10 噸/每平方公尺，直接以軌道自船上卸至陸地上。

(3)由於布萊梅港海床屬泥質土壤，安裝船下樁時容易造成真空現象，為因應各種安裝船規格與下樁條件，布萊梅港務公司採取措施如下：

A.海床：目前可因應 6 種安裝船型，spud can 面積約 80~160 平方公尺、承載力約 65~188 噸/每平方尺，可採直靠方式，離碼頭岸壁需 24 公尺之安全距離。

B.大象腳(Elephant's foot)：因部分安裝船並無 spud can，布萊梅港公司特別於海床面設置 4 隻「大象腳」，以混凝土板(直徑 11 公尺、厚度 1.25 公尺)及鋼環(直徑 9 公尺、5.5 高度)，並在鋼環裡放入碎石料，供安裝船下樁。

(4)布萊梅港離岸風電產業聚落目前座落於漁港區，風力機設備於廠房生產後裝船至外港重件碼頭，面臨布萊梅港產業製造區與外港重件碼頭，須經過裝卸 2 次搬運，無

法將風機設備直接載運出港問題，布萊梅港刻正執行 OTB 計畫(Offshore Terminal Bremerhaven)，規劃取得 260 公頃土地，作為風力發電機組生產和物流區，以解決港口基礎設施和運輸需求。

圖 11 布萊梅哈芬港離岸風力產業聚落

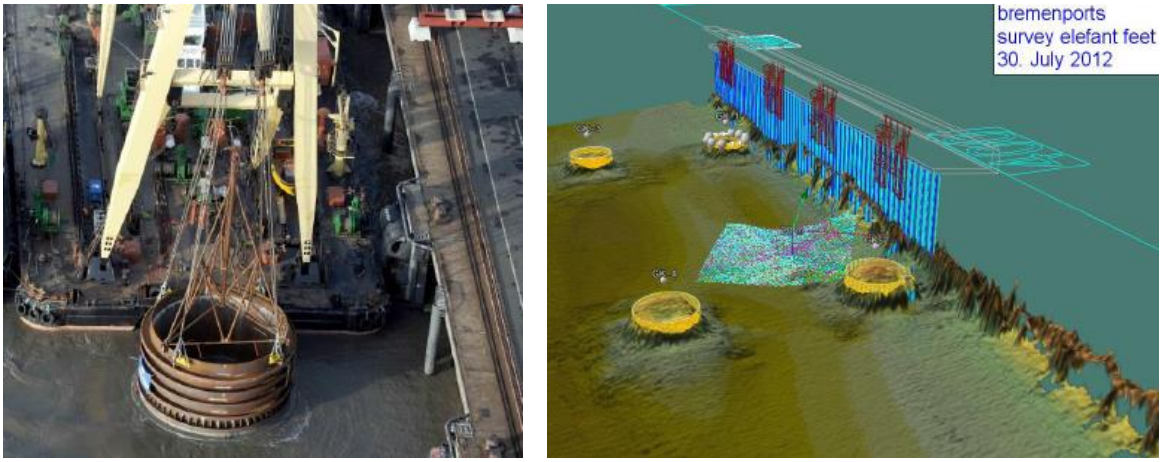

圖 12 大象腳(Elephant's foot)

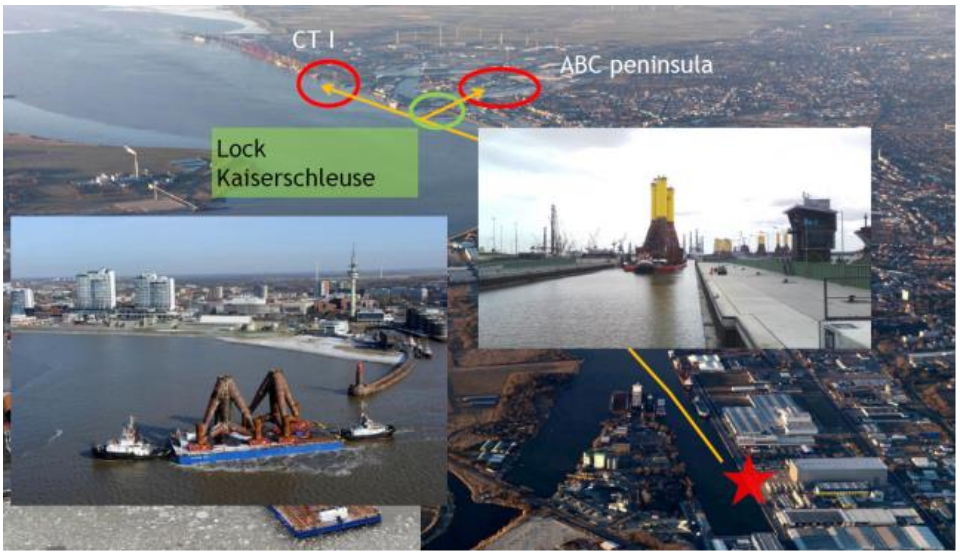

圖 23 水下基礎載運

圖 34 布萊梅港 OTB 計畫示意圖

九、參訪布萊梅港區及 **Eurogate** 碼頭物流公司

(一)時間：5 月 19 日(星期五)上午

(二)會談/接待人員：Nina Distler

(三)會談/參訪紀要

1. EUROGATE 係由 EUROKAI 及 BLG LOGISTIC 於 1999 年共同合資組成的公司，主要成立的原意是作為貨櫃碼頭操作的營運公司，並負責德國及義大利各地重要貨櫃集散港口的營運。但隨著離岸發電的發展及當地產業的需要，EUROGATE 也開始負責離岸風電專用碼頭的建置與營運。
2. 以布萊梅港為例，最初規劃為具有 4,680 公尺碼頭線的貨櫃專用碼頭，惟在當地政府介入協調下，貨櫃業者同意將 500 公尺的碼頭線及後線讓出，作為離岸風電專用碼頭，並進行碼頭承載力及海床的改善工程。如今專用碼頭已具有 25 公頃的面積，提供離岸風電相關業者從事風機零組件、海底基礎及相關工程設備的裝載需求。有需求的業者再分別向 EUROGATE 承租使用場所及工作時間。在 EUROGATE 的管理下，原來貨櫃業者擔心的港口擁塞及影響貨櫃裝載等問題並未發生，成功為貨櫃碼頭及風電專用碼頭共存樹立典範。
3. 本團參訪當日在碼頭上有風機零組件的堆置及暫存，正待運送船隻抵港後運送上船。當日亦有 GEOSEA 的 THOR 自升式平台船靠岸，進行離岸風力機組的葉片更換作業。布萊梅港係利用碼頭橋式機，協助進行貨物的上船作業，同時運用橋式機軌道承載力較強的特性，將重件分散重量於軌道附近，以降低加強碼頭承載力所需的成本支出。

4. 目前布萊梅港面臨發展瓶頸，除德國其他碼頭加入競爭外，由於布萊梅港容易淤積，在離岸風力機組逐漸大型化的趨勢下，航道吃水已日漸不足，因此，布萊梅已在規劃打造另一個更大型的風電專區，惟由於當地部分民眾擔心對環境造成影響，並已向法院提起訴訟，目前開發計畫處於暫停狀態。

圖 154 布萊梅港鳥瞰圖(圖片來源：EUROGATE)

圖 16 布萊梅港風電碼頭規劃圖(圖片來源：EUROGATE)

圖 57　GEOSEA THOR 停靠布萊梅港進行作業

圖 68 風機塔架置於碼頭後線等待出口作業

十、參訪 Falck 海事安全訓練中心

(一)時間：5 月 19 日(星期五)下午

(二)會談/接待人員：中心經理 Neilsen 及訓練教師等

(三)會談/參訪紀要

Falck 機構的海事安全訓練中心位於布萊梅港區附近，布萊梅中心於 2011 年 7 月成立，是 Falck 德國境內的唯一訓練中心。2016 年培訓人數超過 1 萬人，與海事相關的訓練課程包括 STCW、OPITO 與 GWO。Neilsen 先生認為 OPITO 雖然是過去數十年海事工程慣常的標準，但其為因應油氣產業所創設的本質，在離岸風電業尚有不完全適宜的部分，GWO 訓練標準雖然每年仍有小幅修改，但大致內容已底定，也為幾家主導業者認可採用，未來由 GWO 主導應是不爭的事實。

圖 19　中心經理 Neilsen 先生介紹訓練器材

圖 20　訪問團於 Falck 訓練中心外合影留念

參、結論與建議

一、布萊梅與布萊梅港在風力發電業擁有約 120 家公司，代表該行業的整個價值鏈。我方可考慮促成臺中市政府與布萊梅邦政府簽署離岸風電產業合作意向書，我方標準檢驗局或工研院與 Fraunhofer 公司的合作，台電公司或台中港勤公司與 EUROGATE 碼頭營運公司的合作。

二、台中港的離岸風電碼頭是臺灣離岸風電場開發關鍵，可參考布萊梅如何從一個漁港成功轉型成國際貿易大港，且成功建置離岸風力發電完整的產業鏈，未來在規劃設計上須更周全考量，並納入相關單位之專業意見。

三、離岸風場採用的風機大型化是必然趨勢，近年來甚至有加速的現象。SENVION 將在 2017 年 6 月歐洲離岸風能研討會(WindEurope)發表世界上最大的 10MW 離岸風機，可見風機廠家的競爭非常激烈且技術愈臻成熟。風機大型化的趨勢，藉由風機系統設計的技術精進，與日俱增，有加速與驚人的發展，值得關注。

四、建議台電公司未來在訂定承攬商履約資格與採購發包策略時，考量施工界面管理等環節。另外，因白海豚保育是國內環保團體極為關切事項，可借鏡德國遭受環保組織抗爭經驗，建議在基礎施工時，採用氣泡牆隔離施工噪音之方法，避免抗爭的發生。

五、參訪 Fraunhofer 風能暨能源系統機構(IWES)，瞭解其對風場開發商可提供的服務包括全尺寸靜力與與破壞力力學實驗的葉片轉子測試中心、離岸試驗場可進行離岸風機真實承受的累積性負荷量測(有別於實驗室中的材料負荷)、氣候實驗艙可進行力學與環境同時影響的模擬測試等，有助於台電公司未來在規劃及推動離岸風電開發時，可訂定符合臺灣特殊環境使用條件之風機規格，更兼具務實及前瞻思維。

六、台電公司示範風場工程規範，雖規定機型須符合 IEC 61400-1 Class IB 等級以上及 IEC 61400-3 規定之要求，但加入考量颱風情況之加嚴條件，即提供經國際合格認證機構審查核可之設計驗證資料，符合 50 年迴歸期其輪轂高度 10 分鐘平均極端風速 Vref 須不低於 54 公尺/秒，且 3 秒鐘平均極端風速 Ve50 須不低於 73 公尺/秒，以確保風力發電機組安全運轉。

七、本次台電公司參團成員對於布萊梅港經驗深有所感，將積極與台中港務公司洽租 5A、5B 碼頭及 4C 後線事宜，台中港務公司積極辦理碼頭設施改善工作，應可如期於 2019 年上半年陸續完成，可滿足離岸風電安裝水上設備(上塔架 T-Section、中塔架 M-section、下塔架 B-section、輪轂 Hub、機艙 Nacelle)之施工期程需求。

八、自 2002 年德國政府頒布離岸風電發展白皮書起，布萊梅港開始轉型成為離岸風電專用港口之路。經過 10 幾年的努力，從全歐最大的漁港，一一解決裝載、航行等問題，讓廠商直接把製造好的產品運出海，並可供應運輸、物流、建築、能源等需求，且可與研究中心、學校合作，屬第三類港埠設施型態。

九、目前台中港 5A、5B 碼頭已開始改善工程，應足以應付離岸風電施工需要，進行風機重件組裝、後線暫儲與船舶裝、卸載之需求，至於碼頭場域內之重件吊裝機具、運輸車輛或倉儲建築物，建議由開發商視個案需要自行建置。預估可供每年 30 部 8MW 級以下各式風機預組裝之用，為我國離岸風電開發重要里程碑。

十、建議台中港可參考布萊梅港務公司之經驗，致力於港口基礎建設及維護，對於港口營運及物流服務提供，則由民間專業機構操作。以長期發展而言，開發商選擇距離風場最近的港口為設置風場降低成本之關鍵因素，港口為海、陸運輸之樞紐，是風機生產與船舶及其他運輸工具的銜接點，除具備基本重件碼頭，更應具發達的交通網路及廣大的腹地，並擁有足以擴充之產能。因此在政策上，需同時兼顧產業需求、確保基礎建設、船機設備之投入與使

用效益，避免投資浪費與資產閒置，逐步引導風電產業在地化。

十一、我國即將展開大規模的海上風場開發，未來勢必有大批工作人員於海域中進行工程作業，因此及早訂定海事工程施工安全標準是防範工安問題發生及保障勞工安全必要的措施。離岸風電業已逐漸形成共識，將以 GWO 安全訓練為基本要求，情況就如同全世界跨國航行的商船船員必須接受 STCW 訓練課程，取得結業證書一樣。建議統籌產、官、研能量組成聯合工作小組，積極協助台電公司、港勤中心及工研院綠能所，金工中心與船舶中心，共同設立符合國際標準的海事安全訓練中心，未來可就近於國內進行人員訓練及發證的工作。

附件 1 我方簡報

工業技術研究院
Industrial Technology Research Institute

Status of Offshore Wind Development in Taiwan

Wei-Hsien Lu
Manager, GEL, ITRI
May 17, 2017

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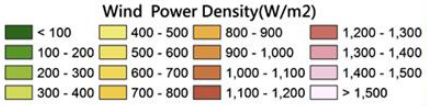
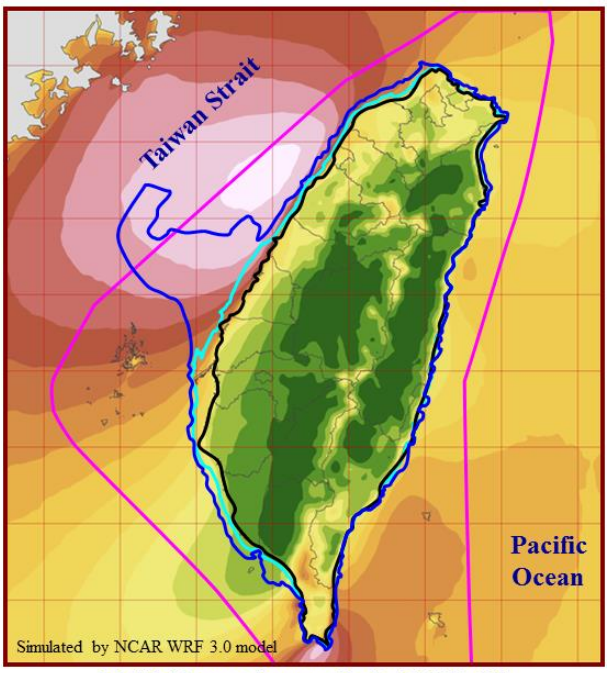
Taiwan Offshore Wind Potential

- **Shallow Water** (5-20 m)
  - **Area:** 1,779.2 km²
  - **Potential:** 9 GW
  - **Feasible:** 1.2 GW
- **Deep Water** (20-50 m)
  - **Area:** 6,547 km²
  - **Potential:** 48 GW
  - **Feasible:** 5 GW
- **Deeper Water** (> 50 m)
  - **Potential:** 90 GW
  - **Feasible:** 9 GW





Ref. "Wind Resource Assessment Handbook," ITRI, 2011

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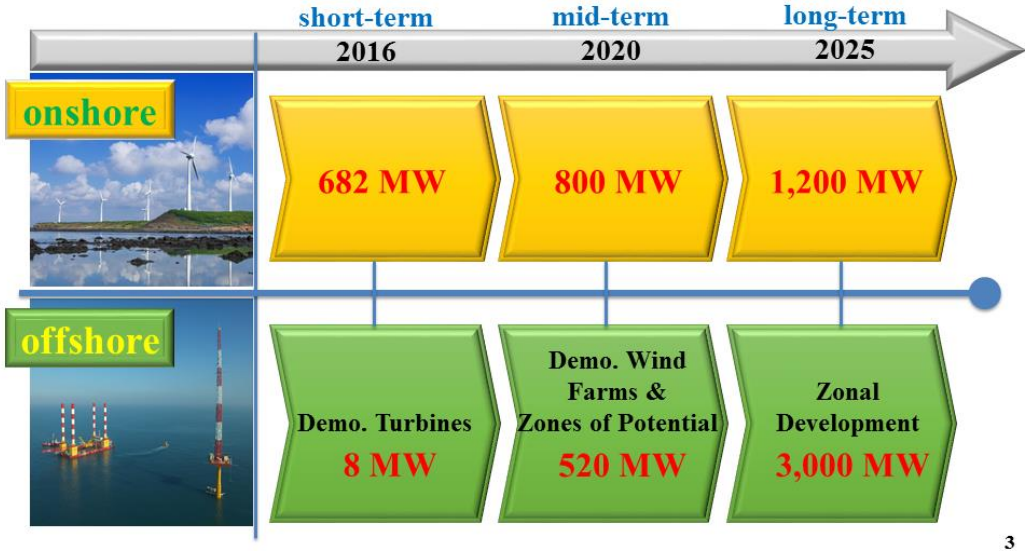
Targets of Wind Power Development

- **Promote <u>onshore development</u> and <u>sustainable environment for offshore development</u> first.**



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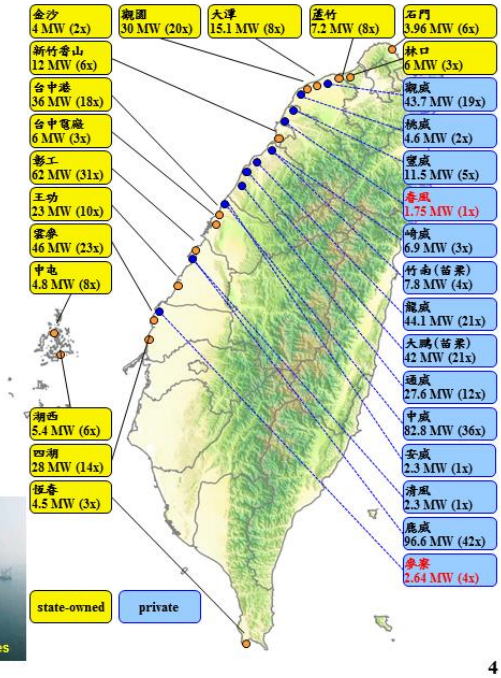
Current Status of Wind Development

Onshore (by the end of 2016)

- **State-owned:** 169 WTs / 294 MW
- **Private:** 177 WTs / 388 MW
- **Total:** **346 WTs / 682 MW** (14.4 % of all RE)
- **2016 Production:** ≈ 1,445 GWh (11.4 % of all RE)

Offshore

- **2 demonstration turbines have just been commissioned on 28th April, 2017**



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Strategies for Offshore Wind

DIP Incentives for Pioneers → **ZAP** Transition Period → **ZD** Self-sustaining Industry

[Phase 1] Offshore Demonstration Incentive Program (示範獎勵辦法)

- **4 Demonstration Turbines by 2017, 3 Demonstration Wind Farms by 2020**
- **Government provides subsidy for both equipment & developing processes**

[Phase 2] Directions of Zone Application for Planning (場址作業要點)

- **36 Zones of Potential revealed for preparation in advance of Zonal Development**
- **Applicants must acquire EIA approval by 2017 and Preparation Permit by 2019**

[Phase 3] Offshore Zonal Development (區塊開發)

- **Zones will be released in stages by the government** (similar to Round 3 of UK)
- **Commercial scale for cost reduction**
- **SEA has been approved by EPA**

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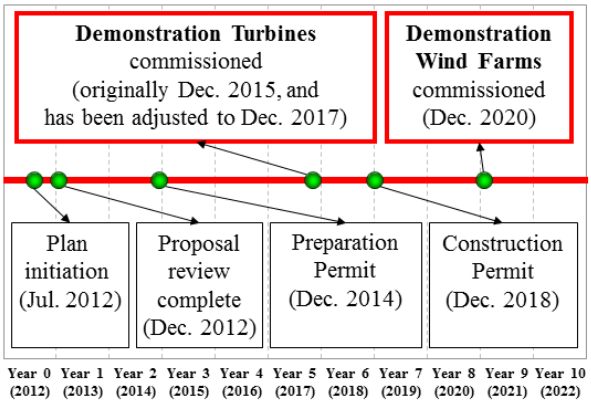
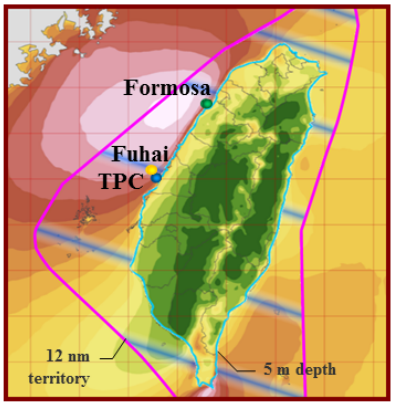
Demonstration Incentive Program

[Phase 1] DIP

■ Demonstration Projects of Offshore Wind

- **3 Winners** (Fuhai, Formosa & TPC) **officially announced on 9th January 2013**
- **MOEA provides subsidies for both turbines & wind farms to encourage pioneers**
- **To confirm feasibility in terms of administration, technology and finance**





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Specifications & Requirement of DIP

[Phase 1] DIP

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Awarded Demonstration Projects

[Phase 1] DIP

★ **Formosa** (海洋) @Miaoli
- **Capacity:** 128 MW (32 turbines)
- **Distance from Shore:** 2-6 km
- **Water Depth:** 15-35 m

★ **Fuhai** (福海) @Changhua
- **Capacity:** 120 MW (30 turbines)
- **Distance from Shore:** 8-12 km
- **Water Depth:** 20-45 m

★ **TPC** (台電) @Changhua
- **Capacity:** 108-110 MW (18-30 turbines)
- **Distance from Shore:** 7-9 km
- **Water Depth:** 15-26 m

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Zone Application for Planning

[Phase 2] ZAP

Siting for Zones of Potential (ZoP, 潛力場址)

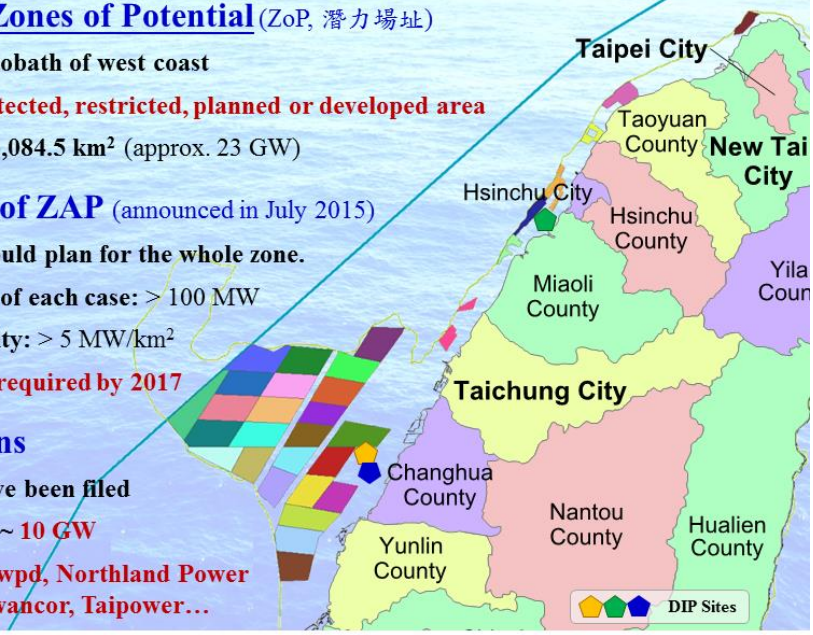
- Within 50 m isobath of west coast
- Excluding protected, restricted, planned or developed area
- 36 ZoP: total 3,084.5 km^2 (approx. 23 GW)

Directions of ZAP (announced in July 2015)

- Applicants should plan for the whole zone.
- Total capacity of each case: > 100 MW
- Capacity density: > 5 MW/km^2
- EIA approval required by 2017

Applications

- 22 projects have been filed
- Total capacity ~ 10 GW
- Dong Energy, wpd, Northland Power China steel, Swancor, Taipower…



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Zonal Development

[Phase 3] ZD

Purpose

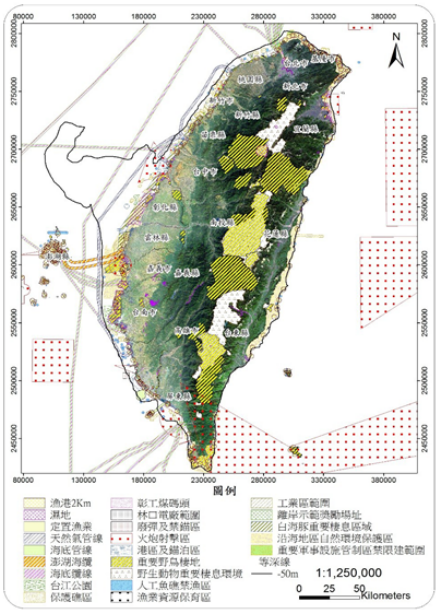
- Marine Spatial Planning
- Optimal Resource Utilization
- Domestic Industry Development

Goal

- Zones will be released in stages
- 500 MW - 2 GW for each stage
- To reach 3 GW target by 2025

Strategic Environmental Assessment

- SEA Report reviewed and approved by EPA on 28th December, 2016
- 36 ZoP will be reduced or adjusted based on the results of inter-ministerial negotiations and SEA consultation.



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Invest in Taiwan

■ Hub in Asia Pacific & Global Logistics

- **Located at the heart of the Asia-Pacific region**
- **Good and inexpensive utilities and telecommunication services**
- **Best partners for multinational companies operating in the Asia-Pacific region**

■ Sound Legal Framework

- **Foreign investment regulations ensure protection for foreign investment**
- **All accounting systems in Taiwan conform to international standards**

■ High Economic Freedom

- **Ranked 14th among 186 countries by the "2016 Index of Economic Freedom"** (published by the Heritage Foundation and the Wall Street Journal)
- **Comprehensive income tax treaties or agreements with 30 countries for avoidance of double taxation**
- **No restrictions on the industries for foreign investments** (except for investment with national security concerns or investment from China)

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Feed-in Tariff System

Renewable Energy Development Act (REDA, 再生能源發展條例)

- **Taiwan promulgated the Renewable Energy Development Act in July, 2009 to systematically promote renewable energy.**
- **The core strategy of the Act is Feed-in Tariff system.**
- **PPA (power purchase agreement) of renewable energy is guaranteed for 20 years.**
- **A Committee is formed to review the formula and tariffs annually.**
- **Tariffs shall not be lower than the average cost of domestic fossil-fueled power.**

Feed-in Tariffs of wind power in Taiwan

- **Onshore:** NT$ 2.8776 (€8.4¢) / kWh for 20 years
- **Offshore:**
  - **Option #1:** NT$ 6.0437 (€17.7¢) / kWh for 20 years
  - **Option #2:** NT$ 7.4034 (€21.6¢) / kWh for the first 10 years
    NT$ 3.5948 (€10.5¢) / kWh for the next 10 years

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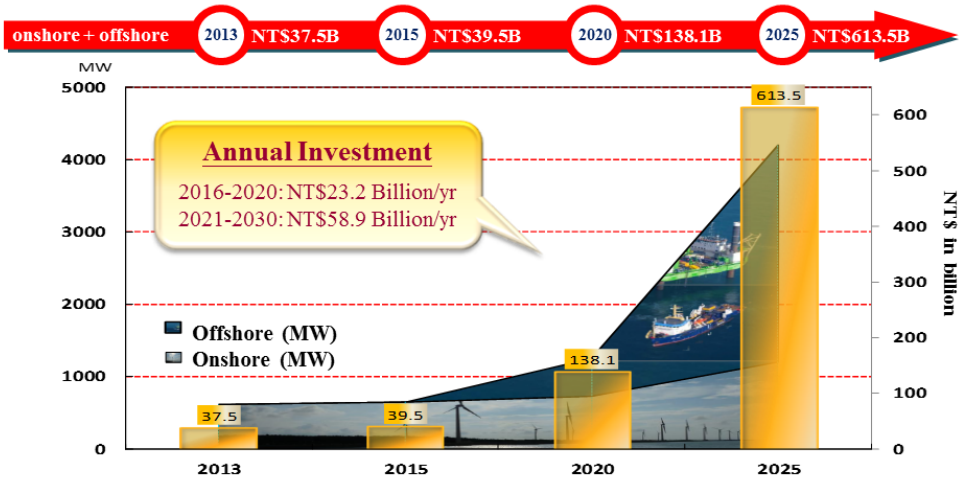
Market Estimates

- **Offshore 3,000 MW by 2025 → NT$ 544B (€16B) investment***
- **Policy → Developers → Service Providers → Manufacturers**



*onshore: NT$56,700/kW (€1,668/kW); offshore: NT$181,600/kW (€5,341/kW)

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Major Challenges

■ Asian Environment

- Turbine design resistant to typhoons
- Foundation design resistant to earthquakes

■ Environmental Impact

- Migrating birds & marine mammals
- Local fishery, navigation safety and radar interference

■ Infrastructure & Supporting Measures

- Ports and industrial park
- Grid connection
- Financing and insurance

■ Project Implementation

- Construction vessels and offshore expertise
- Contract strategies & project management
- Risk assessment and mitigation




Pictures from: Vergnet, YCPS, bis, Centrica

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Summary

■ Develop Offshore Wind in 3 Phases

- **[Phase 1] DIP** (2012~): Incentives for Pioneers
- **[Phase 2] ZAP** (2015~): "Zones of Potential" for commercial projects
- **[Phase 3] ZD** (2017~): Pipeline for a sustainable domestic market

■ Taiwan: the Best Entrance into Asian Offshore Wind Market

- **Resource:** best offshore wind resource in the world
- **Policy:** stable environment and clear targets
- **Supply Chain:** design, manufacturing, construction, O&M
- **Environment:** sound legal framework & high economic freedom
- **Vision:** competitive, innovative, and profitable industry of offshore wind

Welcome to Taiwan and we will be your best partners to explore the Asia-Pacific offshore wind market

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工業技術研究院 Industrial Technology Research Institute

Contact Us

- **InvesTaiwan Service Center; Tel: +886-2-23112031; http://investtaiwan.nat.gov.tw/eng/main.jsp**
- **MOEA One-stop Service of Wind Power; Tel: +886-2-87723415; http://www.twtpo.org.tw/eng/Home/**
- **Renewable Energy Project Office; Tel: +886-2-87720089; http://www.re.org.tw/Eng/Index**
- **Green Energy Industry Promotion Office; Tel: +886-2-87722252; http://www.taiwangreenenergy.org.tw**
- **Bureau of Energy, MOEA; Tel: +886-2-27721370; http://web3.moeaboe.gov.tw/ECW/english/home/English.aspx**

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Government's Efforts

➢ Inter-ministerial Coordination & Collaboration

■ Grid Connection

- Encourage Taipower to establish "Plan of Power Transmission Infrastructure Dedicated for Renewable Energy"
- Collaborate with local government to facilitate construction of offshore/onshore substations and subsea cables

■ Fishery Coordination

- Fishery Agency announced the standards of compensation for offshore wind
- Include all relevant stakeholders to discuss the mechanism of community fund

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Government's Efforts (cont.)

■ Infrastructure

- Establish development plans for dedicated wharves and ports of construction, manufacture and O&M
- Collaborate with local government to secure land of wind industry park
- Encourage state-owned companies to design and build Turbine Installation Vessels

■ Industrial Establishment

- Encourage technology transfer and cooperation to develop Taiwan-made offshore wind turbines
- Develop domestic capabilities to accumulate practical experiences, and export Taiwan services to global offshore wind market

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Government's Efforts (cont.)

➢ Dedicated Offices to Facilitate Development

■ Office of Energy and Carbon Reduction, Executive Yuan

- Facilitate inter-ministerial coordination & collaboration
- Remove administrational barriers of regulatory processes
- Ensure smooth procedures of application review for offshore wind

■ MOEA One-stop Office of Wind Power

- Clarify and simplify procedures of offshore wind application
- Monitor review progress of relevant ministries
- Identify obstacles or assistance required for each application

附件 2　Bremen Invest 簡報

The German Federal State of Bremen

State of Bremen - The dynamic region in Europe

Key facts about Bremen

- City-state population: 671,000
- Regional population: 2,700,000
- Ranked 10th among Germany's dynamic industrial cities
- GDP per employed worker: 75,237 euros
- High-tech competence center for the German aerospace industry
- High-tech competence center for the German Off-Shore Wind Industry
- No 1 export harbour in Germany
- World ranking among container ports: 25
- NO 1 car export harbour, > 2 million cars
- Highest density of students in higher education institutions in Germany

Source: Chamber of Commerce, Bremen Statistical Office, BLG Logistics-Group, WFB Bremen Economic Development Corp., Bremenports

Bremen, the dynamic region

- Ports, transport, warehouse, logistics
- International trade
- Automotive
- Food and Beverages
- **Aviation and Aerospace**
- **Maritime Industry**
- **Wind Industry**

Container terminal Bremerhaven

- World ranking among container ports: 25
- Water depth up to 15m
- Almost 5.5 million TEU p.a. turnover in 2016
- Daily transportation to the hinterland by air, sea, rail or road
- Weekly liner services between Bremerhaven – Taiwan

Car terminal Bremerhaven

- Handling volume in 2016: More than 2 million cars
- Export to USA, East Asia, Middle East
- Import from Japan, Korea, USA
- Blocktrains to European centers
- Multi-storey facilities
- Blocktrains between manufacturing plants and terminal

BREMEN BREMERHAVEN

Bremeninvest

Mercedes-Benz plant Bremen

BREMEN BREMERHAVEN

Bremeninvest

Automotive metropolis

Automotive metropolis

Location key advantages for the automotive industry

- Worldwide no. 1 Mercedes-Benz production plant
- Annual production volume above 324,000 units
- **C-Class competence center** since 2014
- Exclusive industrial site for automotive industry
- **Electric car EQ** assembly by 2019
- More than 600 automotive components suppliers
- Europe's no. 1 car terminal (harbour)
- Consolidation and supply to overseas assembly line
- Automotive R&D institutes
- Mercedes workforce in Bremen 12,000

Automotive metropolis companies

Mercedes-Benz
MAGNA CAR TOP SYSTEMS
SCHEDL
COLER Kraftfahrzeugtechnik
LEAR CORPORATION
ZF
ADIENT
ADIENT
ArcelorMittal
LOREL
YAZAKI
HANSA FLEX
HELLA

BREMEN BREMERHAVEN

Bremeninvest

Premium products „Made in Bremen“

BREMEN BREMERHAVEN

Bremeninvest

Premium products

BECK'S · Milka · café HAG · JACOBS · Vitakraft · NORDSEE · HACHEZ · FRoSTA · Melitta®

BREMEN BREMERHAVEN

Bremeninvest

Aerospace Bremen overview 2017

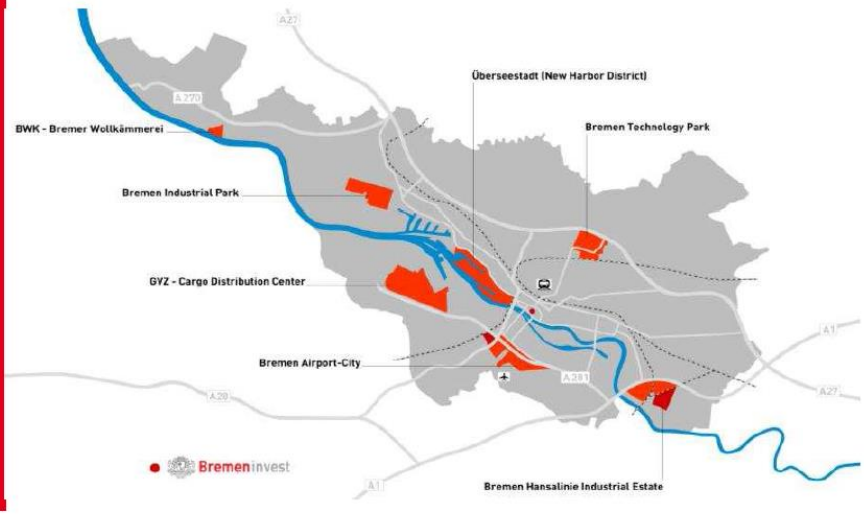
- ca. 140 Enterprises
- ca. 12,000 Employees
- ca. 4 Bn € Turnover p.a.
- Full Order Books of OEMs > 2020
- 20 Institutes

BREMEN BREMERHAVEN

Bremeninvest

Wind

Industrial sites in Bremen



Logistics Park Bremen (GVZ)

Industrial site Hansalinie / Auto components & Light industries

1 Mercedes-Benz Werk Bremen
2 Con-Cover by Friedola®Tech GmbH
3 Schulz System Technik
4 Johnson Controls Headliner GmbH
4 Magna Car Top Systems GmbH
5 Schedl Automotive System Service GmbH
6 M. Preymesser GmbH & Co. KG
7 Mercedes-Benz (Rohbaulinie)
8 Mercedes-Benz , Niederlassung Nutzfahrzeuge
9 Pfenning Logistics
10 Lear Corporation GmbH
11 Mercedes-Benz, Lorei Teillager
12 Mercedes-Benz/Lorei GmbH,Leergutmanagement
13 DB Schenker/Mercedes-Benz I-Park
14 Brose Fahrzeugteile GmbH & Co
15 Mercedes Benz/Rhenus Rohbau-Teillager

Bremeninvest representatives

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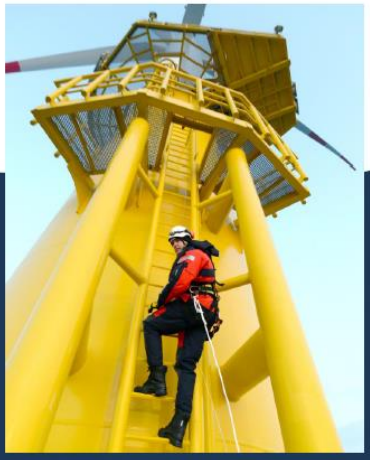
附件 3　WAB 簡報



WAB - Wind Power Network
Welcomes Taiwanese Delegation

May 2017

WAB has been **Successfully** Active in the Wind Energy Industry for **more than 15 Years**

Facts and Figures

Established in	February 2002
Number of members	More than 350
Form of organization	Registered association
Offices	Berlin and Bremerhaven
Subsidiaries	germanwind GmbH Offshore-Windenergie Messe und Veranstaltungs GmbH
Financed through	Membership fees and partial sponsorship by the State of Bremen
Core areas of activity	Business networking, permanent working groups across companies and national representation of the offshore and onshore wind industry

Executive Board: **Elected Representatives** from Member Businesses

The Executive Board of WAB

Irina Lucke
EWE Offshore Service & Solutions GmbH
Chairwoman

Dr. Klaus Meier
wpd AG
Deputy Chairman

Jens Assheuer
WindMW GmbH

Norbert Giese
Senvion SE

Thomas Haukje
Nordwest Assekuranzmakler GmbH & Co. KG

Jean Huby
Ocean Breeze Energy GmbH & Co. KG

Dr. Knud Rehfeldt
Deutsche WindGuard GmbH

Thorsten Rönner
BVT Bremen GmbH

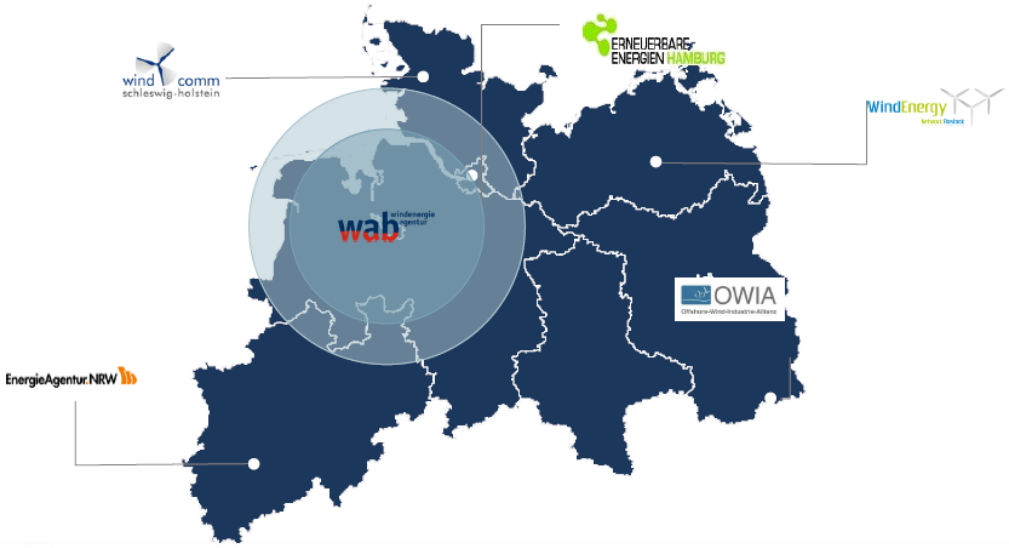
Thorsten Schwarz
GE Grid GmbH

Dr. Antje Wagenknecht
Fraunhofer IWES

Representing more **than 350 Businesses and Institutes** in the Wind Energy Industry

A Selection of WAB's Members

WAB: The **Number One Industry Network** for Wind Energy in Germany's North-West Region and **Central Contact** for Germany's Offshore Wind Industry



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Regularly Press Releases and **Publications** on Offshore Wind Energy

Newsletter	Offshore magazine	Offshore map	Reports
• Every two months • German and English versions • News and developments in the offshore wind industry	• Offshore Wind Industry • Current status of national and international use of wind energy	• WAB's map of projects in Germany and Europe • Offshore wind farm projects in planning and in operation	• Studies • Industry reports • Press conferences

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International **WINDFORCE** Conferences

7

OWIA - Joint Forces for **Offshore Wind Energy**

Offshore Wind Industry Alliance:
Building a strong Networks linking the North and Baltic Sea

8

WAB as Sponsor of **OWIA** is **Strongly Committed** to **Ensure** the **Important** Role of Offshore Wind Power within **Germany's National Energy Policy**

Campaigning for Offshore Wind Energy

- Initiative for the Offshore Wind Energy Industry
- Campaign focuses on:
  - Energy Policy
  - Industrial Policy
  - Consumer Policy
  - Climate and Nature Protection

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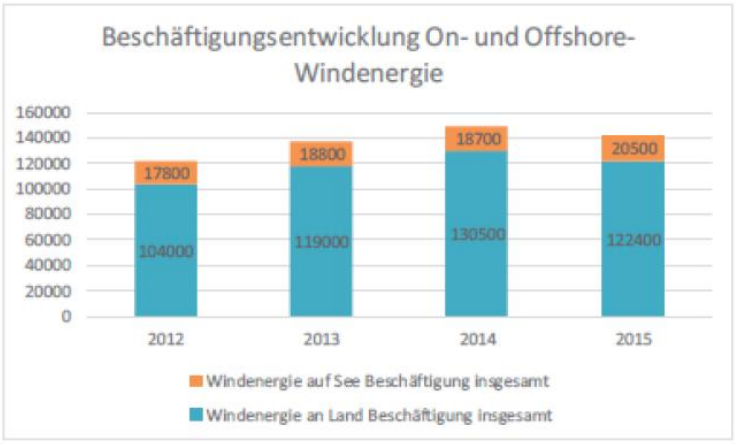
Development of **Employment** within the **Innovation-Driven Future Industries** in Germany



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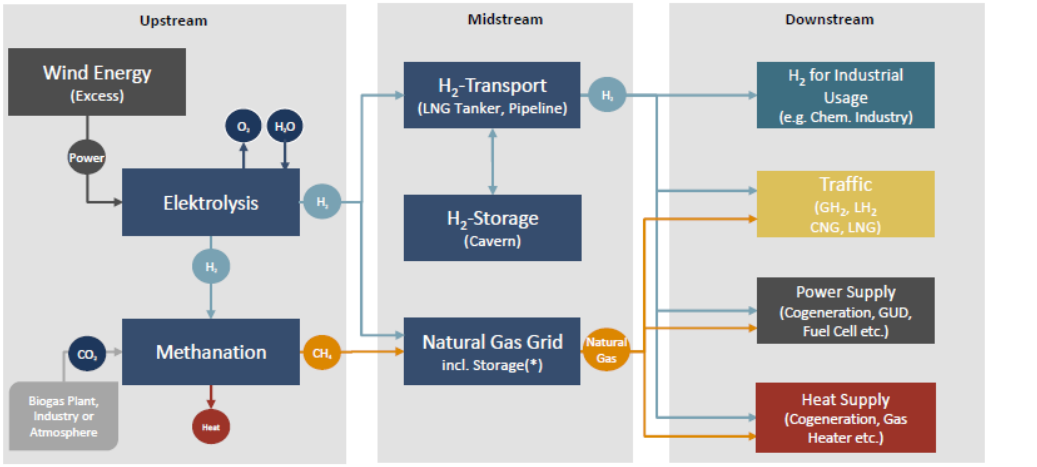
Wind-to-Gas (W2G) Includes Several Utilisation Paths and **Enables Linkage of Sectors** (Power, Heat, Traffic, Industry)

Overview of the W2G utilisation path



* Alternative Transport: LNG Tanker

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附件 4　SENVION 簡報

Introduction to Senvion Offshore

prepared for Taiwanese Wind Energy Delegation

May 18th, 2017

SENVION
wind energy solutions

Agenda

SENVION
wind energy solutions

9.00 a.m.: Presentation

1. Senvion in facts & figures
2. German offshore framework conditions
3. Senvion's approach for successful offshore projects
4. Q&A

9.45 a.m.: Visit of nacelle production facility

11.00 a.m.: Lunch snack

11.30 a.m.: Transfer to harbour

1. Senvion in facts & figures

Senvion was founded in 2001 by a merger of various companies

SENVION
wind energy solutions

Senvion History

pro+pro
product + project development

DENKER & WULF AG

Jacobs
ENERGIE GmbH

bwu

HSW
Windenergie GmbH

REpower
Systems

SENVION
wind energy solutions

Company snapshot

- Headquartered in Hamburg, Germany
- 4th largest player in Europe: ~10.6% market share[1] in 2016
- Pioneer in offshore area
- Renamed to Senvion in Jan. 2014

[1] BNEF, Global wind turbines manufacturing market trends, 22 February 2017

4

Senvion is a leading global player in wind energy

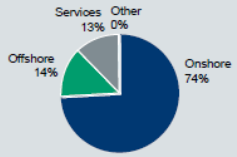
SENVION wind energy solutions

Key facts	Revenues (CY 16)	Adj. EBITDA / margin (CY 16)	Installed base (YE 16)	Order book (YE 16)
	€2,210m	€206m / 9.3%	15.5GW	€5.3bn[1]

Revenue breakdown

By business (End-16)

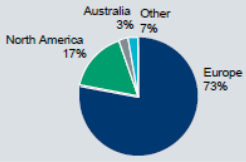
Total: €2,210m



Installed base breakdown[2]

By region (End-16)

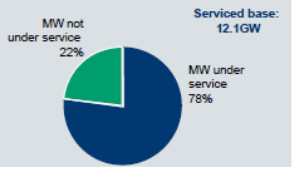
Total installed base: 15.5GW
More than 6,700 turbines installed worldwide



Service coverage

By serviced fleet (End-16)

Total installed base: 15.5GW



Product portfolio snapshot[3]

Onshore

MM series: MM100, MM92, MM82

2.XM series: 2.4M114, 2.4M110, 2.3M124, 2.3M120

3.XM series: 3.6M140, 3.4M140, 3.4M114, 3.4M122, 3.4M104, 3.6M114

- First mover and technological leader in 3MW class
- Strong player in all wind classes
- Released industry-leading low wind turbine – 3.4M140
- Expanded portfolio via acquisition of Kenersys assets in India

Offshore

6.XM series: 6.2M152, 6.2M126

- First mover in 5MW+ class
- Largest operating fleet in 5MW+ class
- Largest commercially proven turbine by power rating
- 10MW+ turbine study announced

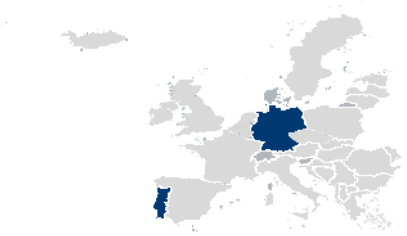
Notes:
1. Includes net firm orders, signed contracts and service order book
2. Europe: Germany, France, UK, Italy, Belgium, Poland, Portugal; North America: Canada, USA; Other: Netherlands, China, Japan, Austria, Hungary, Czech Republic, Spain, Sweden, India, Greece, Russia, Korea, Switzerland, Romania, Turkey
3. Selected products

Source: Company information

Senvion continuously improves production footprint to serve key and emerging markets

SENVION wind energy solutions

From Germany focused…

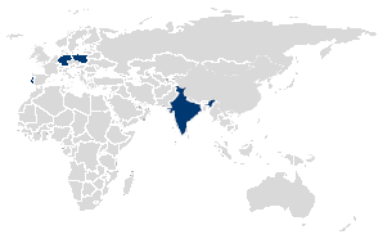


Nacelle	Blades
Bremerhaven	Bremerhaven
Husum	Vagos
Trampe	
Oliveira de Frades	

3.6 GW Nacelle capacity

CY16 installations – 1.7 GW

…to globally streamlined footprint



Nacelle	Blades
Bremerhaven	Vagos
Oliveira de Frades	Ustron, Warszovice
Baramati	

2.7 GW Nacelle capacity

Sufficient capacity for growth

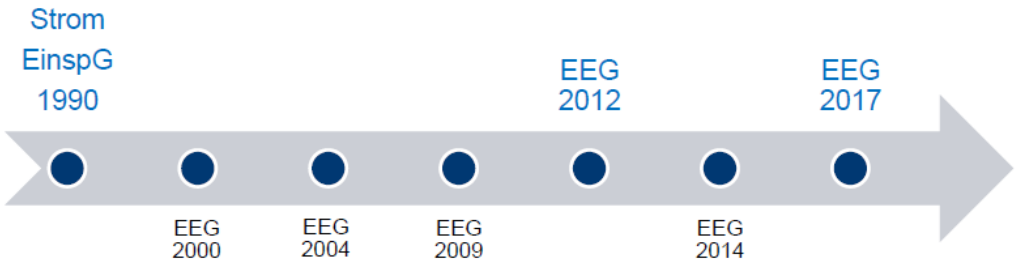
Key benefits

- Reducing complexity by consolidating global production facilities
- Generating synergy effects and benefitting from scale
- Realizing shorter production cycle times
- Leveraging capacities in low cost countries

2. German offshore framework conditions

With a solid industrial basis, the policy goals were switched from promotion to market integration

SENVION
wind energy solutions



- Stable expansion targets
- Solid remuneration of renewable energy
- R&D investments for enhanced technology

8

Offshore wind auctions and expansion policies will shape the industry in future years

SENVION wind energy solutions

Previous framework

If BSH-permit is granted and grid-connection confirmed, the project owner executes windfarm project and receives EEG tariffs/subsidies

Transitional period

- Commissioning 2021 - 2025
- 2 auctions, April 1st 2017 & 2018
- 2 x 1550 MW
- Max. 12 ct/KWh
- "Existing projects" (6,500 MW) eligible for participation

Surprising results in 1st auction round

- 1,490 MW awarded, average price:
  0,44 €ct/kWh
  3 projects: 0 ct/kWh

Centralised Model

- Commissioning 2026 onwards
- Yearly auctions, starting 2021
- 700 - 900 MW
- Lowest bid last transitional period auction
- Projects pre-developed by governmental authorities;
  step-in right for existing projects without award in transitional period

9

3. Our approach for successful offshore projects

WTG are most decisive for an offshore windfarm's commercial success

SENVION wind energy solutions

Approx. 40% of windfarm CAPEX are spent for WTG

Rotor
12 % Rotor (hub, blades, pitch system)

Nacelle
20 % Nacelle (drivetrain, converter, transformer)

Tower
8 % Tower (steel, switchgear & electrical systems)

➔ Proven WTG technology required for reliable energy yield at lowest LCOE

Source: EWEA / The Crown Estate

11

Our offshore WTG is based on proven and reliable technology

SENVION wind energy solutions

- First generation 18th December 2014
- Test run completed at 99.6% availability

Certification status and timeline

- 2014-11-06: Type Certificate (prototype)
- 2016/Q2: IEC Type Certificate
- 2016/Q4: Update of Type Certificate to 6.33 MW rated power

Senvion's next generation offshore WTG will set a new market standard…

SENVION wind energy solutions

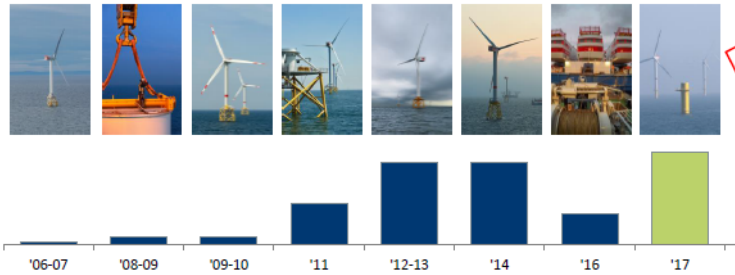
… but it's too big to show on this slide

13

Senvion features a 10 year track record in 5/6MW offshore projects

SENVION wind energy solutions

	Beatrice	Thornton Bank I	Alpha ventus	Ormonde	Thornton Bank II/III	Nordsee Ost	Norder-gründe	Nordsee One	TBA	TWB II	TBA
Capacity	2x 5M (10 MW)	6x 5M (30 MW)	6x 5M (30 MW)	30x 5M (150 MW)	48x 6.2M126 (295 MW)	48x 6.2M126 (295 MW)	18x 6.2M126 (111MW)	54x 6.2M126 (332 MW)	6.2M152 & 3.XM series	32x 6.2M152 (203 MW)	6.2M152 & next gen.
Depth & distance	45m 23km	17-23m 30km	26-29m 56km	17-21m 9km	12-28m 26km	22-25m 57km	3-11m 18km	26-34m 47km	–		–
Customer	SSE	C-Power	e.on EWE Vattenfall	Vattenfall	C-Power	RWE	wpd	Northland Power / RWE	–	Trianel EWE	–
Country									–		–
Comments				Winner of the Renewable UK prize for Best Large Project '12	Before schedule delivery		Successfully delivered in 2016	Currently under construction	Floating & nearshore project		



Fleet size of 158 turbines and 923 MW installed offshore
Contracts signed for 86 WTGs and 535 MW

14

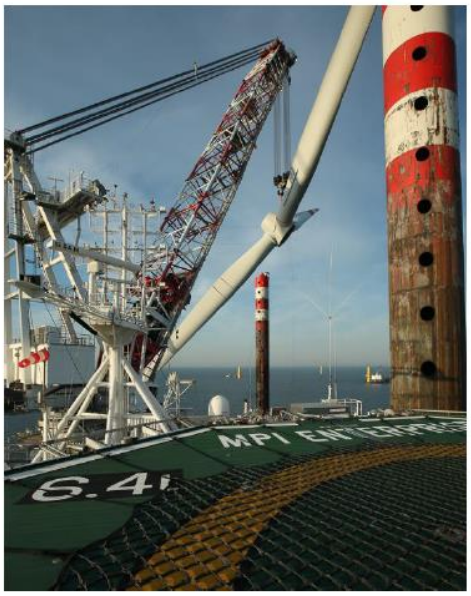
Nordergründe: reduced LCOE + improved overall economics

SENVION wind energy solutions

- **Location:** approx. 34 km north of Wilhelmshaven
- **Water depths:** 3 – 11 m
- **Typ of turbine:** Senvion 6.2M126
- **Total output:** 111 MW with 18 turbines
- **Production:** approx. 400 GWh per year
- **Operator:** OWP Nordergründe GmbH

Nordergründe, Germany

- **Nordergründe** is a great example of how Levelized Cost of Energy can be reduced. **Cooperation with the client** and the other contractors lead to **creative solutions** to improve the overall economics of this wind farm consisting of 18 x 6.2M126 turbines.



15

Nordsee One: successful reduction of interfaces

SENVION wind energy solutions

- **Location:** 40 km north of the island of Juist in the North Sea
- **Water depths:** 26 – 34 m
- **Typ of turbine:** Senvion 6.2M126
- **Total output:** 332 MW with 54 turbines
- **Production:** 1,200 GWh per year
- **Operator:** Nordsee One GmbH

Nordsee One, Germany

- **Senvion** manages and takes **responsibility for the whole value chain** of the wind turbine generator package: from engineering to commissioning. This includes all transports, harbor logistics and construction vessels for this scope. The reduction of interfaces was a major supporting element of the project finance for this €bln1,5 wind farm.

16

Senvion is deeply involved in latest technological developments

Floating foundations are another step to globally available, standardized and economic wind energy

Project description

- Part of French government's calls for proposal of 4 offshore floating foundations projects
- 4 x 6.2M152 WTG planned on Ideol designed concrete floating foundations, commissioning in 2020
- Site located in the Mediterranean Sea 16km offshore, water depths of 55m

Senvion scope of work

- Co-Engineering regarding the floater and WTG design
- Modification and provision of wind turbines 6.2M152 as well as O&M
- Harbour installation works, offshore commissioning (in cooperation)

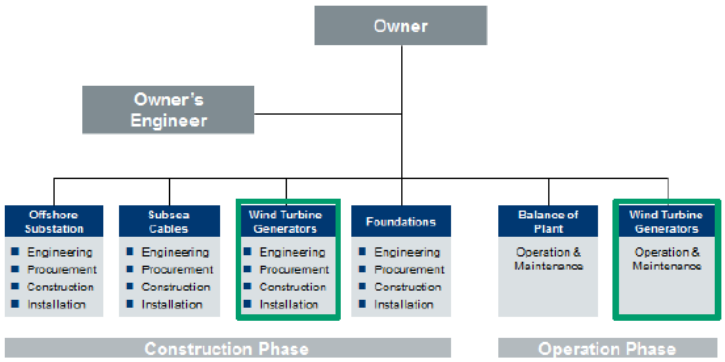
17

Senvion offers tailor-made solutions to customers

The structuring of offshore windfarm projects evolved from multi-contracting to 3 - 4 main work packages, allowing

- risk allocation fitting to contractors competences,
- limited interface management at owners and a
- reduction of contingency budgets and cost overruns.

➔ **Senvion's role developed from WTG supplier to EPCI contractor.**

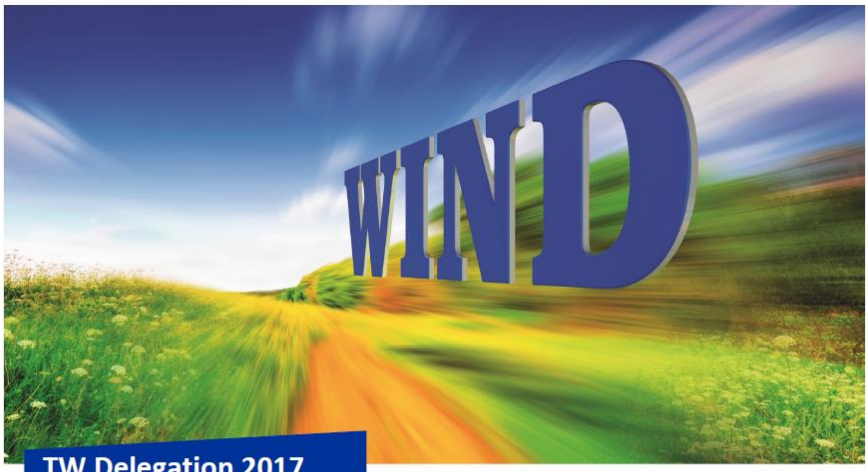


18

4. Q&A

SENVION
wind energy solutions

附件 5　WPD 簡報



TW Delegation 2017
台灣代表團 2017
wpd offshore Solutions
達德離岸全方位整合
18.05.2017

wpd
think energy

Agenda
議程

wpd
think energy

- Introduction to wpd Group
  達德能源集團
- Introduction to wpd Taiwan Energy
  達德能源集團台灣分公司
- Nearshore Wind Farm Nordergründe
  近岸風場 Nordergründe

wpd group – facts
達德能源集團—簡介

4,100 MW installed capacity 裝置容量

2,080 wind turbines erected 已安裝風機數量

1,800 members of staff 集團員工人數

Project pipeline of **7,500 MW** wind onshore 陸域風場規劃容量

Project pipeline of **5,600 MW** wind offshore 離岸風場規劃容量

Project pipeline of **300 MW** photovoltaic 太陽光電規劃容量

In **18** countries 國家數量

wpd group – structure
達德能源集團—組織架構

Broad coverage of the wind value chain
涵蓋整個風電價值鏈

Deutsche Windtechnik AG	wpd AG	wpd windmanager GmbH & C. KG
Maintenance and repair of wind turbines, O&M services 風機維運服務	Developer & Independent Renewable Power Producer (IRPP) 開發商及 獨立再生能源發電廠	Commercial & technical management of wind farms 風場商務及技術管理

wpd AG – structure
wpd AG – 組織架構

Business model
營運模式

Greenfield Development 素地開發	Structuring & financing 架構與融資	Tendering & Construction 招標與興建	Sale / IRPP 銷售/獨立發電	Wind farm management 風場管理
•Site evaluation 場址評估 •Project planning 專案規劃 •Permission process 許可申請 •EIA investigation 環評調查 •Technical planning 技術規劃	•Commercial & legal structuring 商務及法務架構 •Financing of project development 專案開發融資 •Calculations/ financial modelling 計算／財務模型 •Project finance (syndication of debt facilities) 專案融資	•Negotiations with contractors 與承包商協商 •Project management (time schedule, quality, costs) 專案管理 (時程、品質及成本)	•Sale of projects through tender processes 透過招標程序銷售專案 •Sale of projects to strategic or financial buyers 將專案售與策略夥伴/財務夥伴 •IRPP (own capacity 1,370 MW) 獨立發電 (持有1,370MW)	•Commercial management (bookkeeping, insurance, banks, etc.) 商務管理 (帳務、保險及銀行等) •Technical management (O&M management, manufacturers, service providers) 技術管理 (維運、生產、服務提供)

wpd AG offices

Germany 德國
Bremen
Bietigheim-Bissingen
Bad Kreuznach
Düsseldorf
Hamburg
Kassel
Leipzig
Munich
Osnabrück
Potsdam
Rostock
Schleswig

Croatia 克羅埃西亞
Dubrovnik

Denmark 丹麥
Aarhus

Finland 芬蘭
Espoo

France 法國
Boulogne-Billancourt
Dijon
Limoges
Nantes
Paris

Italy 義大利
Rome

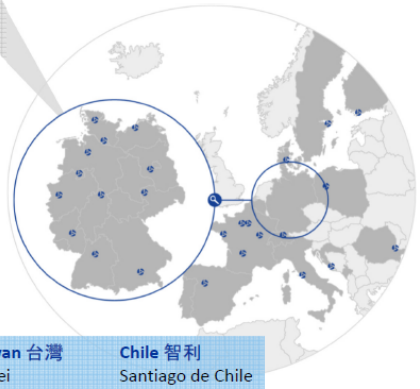
Poland 波蘭
Poznań

Romania 羅馬尼亞
Galați

Spain 西班牙
Valladolid

Sweden 瑞典
Stockholm

Switzerland 瑞士
Zurich



Taiwan 台灣
Taipei

Canada 加拿大
Mississauga

Chile 智利
Santiago de Chile

USA 美國
Portland, Oregon

wpd: partner for institutional investors and major utilities wpd: 機構投資人及主要電廠的夥伴

CEZ GROUP

CEZ Group 捷克CEZ能源集團

Sale of portfolio of 8 German onshore wind farms (85.25 MW, 35 WTG)
售予8座德國陸域風場 (85.25 MW, 35部風機)

INNERGEX

INNERGEX Renewable Energy Inc.
加拿大 INNERGEX 再生能源公司

Sale of portfolio of 8 French onshore wind farms (131 MW, 62 WTG)
售予 8 座法國陸域風場 (131 MW, 62 部風機)

HANSAINVEST

HansaInvest / Signal Iduna
德國資產管理公司
Sale of portfolio of 8 German onshore wind farms (102.1 MW, 38 WTG)
售予 8 座德國陸域風場 (102.1 MW, 38 部風機)

EnBW

EnBW 巴登-符騰堡州能源集團

Sale of 4 fully consented German offshore projects (approx. 1,250 MW), Co-operation agreement covering the further project development
售予 4 座德國已取得許可之離岸風場 (約1,250 MW) 及未來進一步合作

wpd: partner for institutional investors and major utilities wpd: 機構投資人及主要電廠的夥伴

swisspower

Swisspower 瑞士電力

Sale of portfolio of 4 German onshore wind farms (29.3 MW, 11 WTG)
售予 4 座德國陸域風場 (29.3 MW, 11 部風機)

Munich RE MEAG

MunichRE / MEAG
慕尼黑再保 / 慕尼黑資產管理公司

Sale of portfolio of 11 German onshore wind farms (72.7 MW, 40 WTG)
售予 11 座德國陸域風場 (72.7 MW, 40 部風機)

SWM HSE mainova

Stadtwerke München / HSE / Mainova
慕尼黑公用事業
Sale of 2 German onshore wind portfolios (50 + 163 MW)
售予 2 座德國陸域風場 (50 + 163 MW)

Allianz

Allianz Capital Partners
安聯

Sale of one German onshore wind farm (14 MW)
售予 1 座德國陸域風場

Publikumsfonds
Closed end funds 閉鎖基金

Closed funds with 5,000 investors
5000位投資人的閉鎖基金

wpd: partner for institutional investors and major utilities wpd: 機構投資人及主要電廠的夥伴

talanx.

Talanx 德國保險公司

Sale of portfolio of 3 German onshore wind farms (57.5 MW, 19 WTG)
售予 3 座德國陸域風場 (57.5 MW, 19 部風機)

Gothaer John Laing

Gothaer Life Insurance, John Laing Group Plc

Acquisition of a 40% and 30% stake in the Nordergründe offshore project
分別收購Nordergründe 離岸風場40%及30%股權

ewz SIEMENS cdc infrastructure Marguerite Industriens Pension pka aip

Marguerite / Siemens / PKA / Industriens Pension / CDC / ewz
(Total investment volume: 1.3 bn Euro 總投資金額13億歐元)

- Equity financing of the Butendiek offshore wind farm (288 MW) Butendiek離岸風場的股權投資
- Construction and operational management by wpd 工程及營運管理由 wpd 負責
- wpd invests part of the project's equity 本案部分股權由 wpd 投資
- Debt financing arranged by KfW IPEX, Unicredit and Bremer Landesbank incl. commitments of EIB, KfW Förderbank, EKF and further six commercial banks 由歐洲投資銀行等六家銀行聯貸

wpd offshore – facts
達德離岸風場—簡介

8 座離岸風場計畫已核准
offshore wind projects fully consented

提供採購及工程管理服務 **3** 座離岸風場
Procurement and construction management for projects

10 座離岸風場 projects **(4,605 MW)** 正在開發中 under development

位於 in **6** 個國家 countries

200 位專案團隊成員
project team members

wpd offshore
wpd 離岸風場

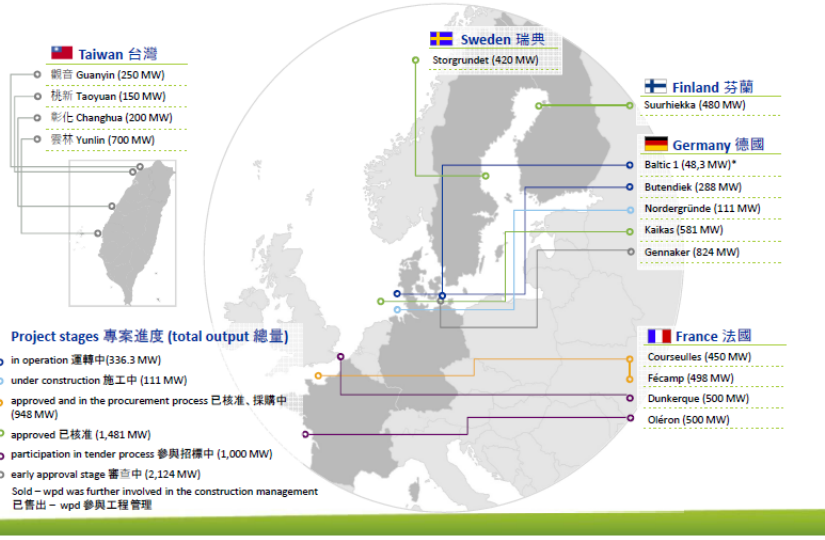
Strategy 策略

- Development of a diversified European offshore-wind-farm-portfolio 開發多元的歐洲離岸風電場址
- Extensive expertise in project and construction management as well as logistics and O&M services
  在專案、工程管理、後勤及運維等多面向的專業
- Ownership and operation at later stage together with investment partners 後期與投資夥伴的所有權及營運管理

Team 團隊

200 project team members, combining the record of developing 21 offshore wind farms with the construction experience of 3 offshore wind projects
200位專案團隊成員經驗，包含21座離岸風場的開發及3座離岸風場的工程

project development 專案開發
wpd projects wind offshore 離岸風場專案



reference 參考實績: Butendiek
project overview 專案簡介

- Total capacity of 總裝置容量 288 MW
- Total investment volume Euro 1.3 bn 總投資金額13億歐元
- Project debt finance by 12 financial institutions
  由12個機構提供專案融資
- Equity investors 投資者包括: wpd, Marguerite Fund, Siemens Financial Services, PKA, Industriens Pension, CDC, ewz
- Located 32 km west of island of Sylt 位於 Sylt 嶼西方32公里處
- Low water depth 水深約 (17 - 22 m)

Turbines 風機: 80 x Siemens SWT 3.6-120
Foundation 基礎: Ballast Nedam Offshore
OSS 海上變電站: Cofely Fabricom GdF Suez
Cabling 海纜: Visser Smit Marine Contracting

reference 參考實績: Butendiek
project overview 專案簡介

- EPCI-contracts (incl. design, manufacturing, transport & installation) EPCI合約，包括設計、生產、運輸及安裝
- Proven technology (Siemens turbines with 10 year full service maintenance contract; monopile foundations) 經驗證的技術 (西門子風機含10年完整維修合約；單樁基礎)
- Start of construction 工程開始: Q2 2014
- The project has been completed on schedule and within budget. In August 2015, Butendiek was brought into operation. 本案如時於預算內完工，2015年8月運轉
- wpd manages the project during procurement, construction and operational phase 本案自採購、建造至營運期間由wpd管理

on time and in budget
如時如預算完工

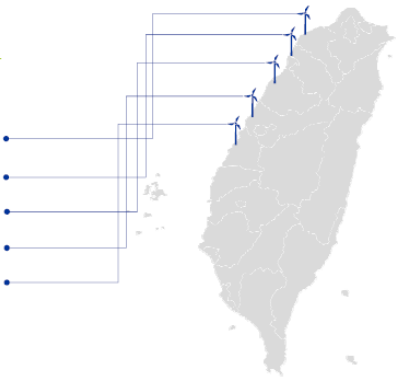
wpd Taiwan

- Office Location: Taipei
  辦公室地點：台北
- Employees: ca. 70
  員工人數：約70人
- Founded in 2000 as InfraVest in Taipei
  於 2000年創立於台北（英華威）
- Part of wpd group since beginning of 2016
  自2016年初成為達德能源集團的一部分
- Business fields onshore wind, offshore wind, photovoltaic
  事業領域為陸域風電、離岸風電、太陽光電
- The first private wind power company in Taiwan
  為台灣第一間民營風電公司
- Market share onshore wind 50%
  陸域風電之市佔率為50%

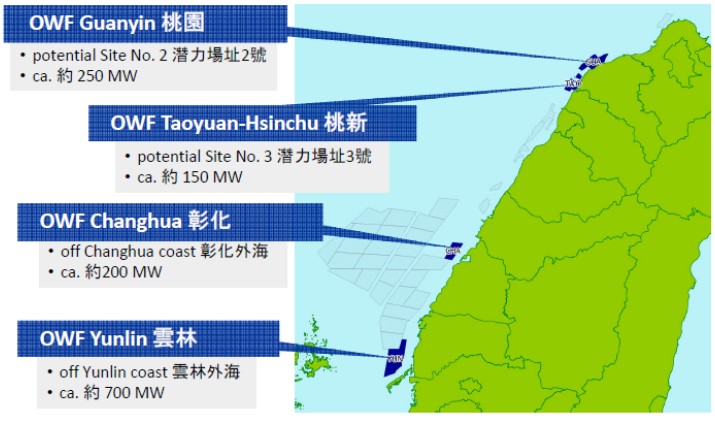
Projects
專案

in operation since 2007
自2007年開始營運

City 城市	Installed capacity 裝置容量
Taoyuan 桃園	48.3 MW
Hsinchu 新竹	11.5 MW
Miaoli 苗栗	113.7 MW
Taichung 台中	85.1 MW
Changhua 彰化	96.6 MW
Total 總容量	355.2 MW



wpd offshore developments in Taiwan
達德於台灣開發之離岸風場

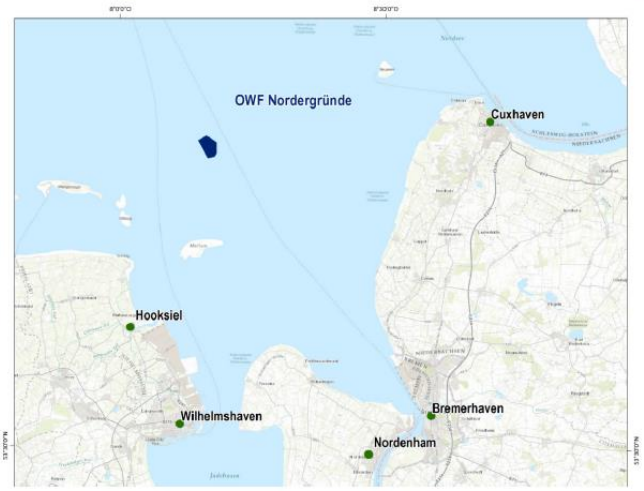


Nearshore Wind Farm Nordergründe
近岸風場 Nordergründe

SITE 地點	Within German 12 nm-zone 德國12海浬內 Distance to coast 離岸距離: 15 km Water depth 水深: < 10.3 m

Size 大小:	111 MW
Construction 建造時間:	2016
Technology 技術:	proven (Senvion 6M Turbine with 10 year full service maintenance contract, monopiles) 經認證與採用的技術 (Senvion的6M風機, 10年維修服務, 單樁基礎)
Design lifetime 設計壽命:	25 years
Approval 許可:	approval for construction and commercial operation confirmed 建造與營運之許可已經確認
Grid 電網:	grid connection to offshore substation provided by grid operator 電網營運商負責電網與離岸變電站之連接
Financing 融資:	financial closed complete 財務狀況已確認
Management 管理:	wpd is an experienced partner, own equity commitment 達德集團有豐富的管理經驗, 同時是部分風場產權的持有人

Nearshore Wind Farm Nordergründe
近岸風場 Nordergründe



Nearshore Wind Farm Nordergründe
近岸風場 Nordergründe

Approval steps 批准步驟

- December 2003: Regional planning approval according to "Landesraumordnungsprogramm Niedersachsen"(considering Nordergründe as spatially tolerable).
  2003年12月 : 得到區域規劃許可 (Nordergründe 的位置是可接受的)
- November 15, 2007: Preliminary Approval according to § 9 BImSchG
  2007年11月15日 : 得到初步許可
- October 31, 2008: Approval according to § 4 BImSchG, appealed
  2008年10月31日 : 許可遭到上訴
- March 3, 2011: Dispute resolution agreement with government of Lower Saxony and conservation organizations
  2011年3月3日 : 達成與下薩克森邦政府及環保組織的協議

September 2013: wpd acquired all project rights from Energiekontor AG
2013年9月:達德自Energiekontor AG取得此專案的所有權利

Total investment volume 總投資金額: Euro 411 mio
Debt finance 專案融資: EIB + KfW IPEX Bank
Secured feed-in tariff 保證躉購電價: 19.4 €ct./kWh for 8 years 每度19.4歐分，為期8年
Strong wind resource 強勁的風資源 (9.3 m/s; 378.1 GWh (P50))

Nearshore Wind Farm Nordergründe
近岸風場 Nordergründe
Involved Contractors 承包商

First offshore wind farm with regional contractors
第一個與當地承包商合作之風場

Work package 工作包	Scope 範圍	Contractor 承包商	References 參考資料	
Turbine 風機 (WTG)	Engineering, Procurement and Construction (**EPC**) of 18 x 6.2M126 Offshore WTG (6.15 MW each) 18隻6.2M126風機(單機容量6.15 MW)之EPC (工程、採購、建造)統包	SENVION wind energy solutions	**Top 3 in Offshore (>800 MW)** OWF Nordsee Ost (48 WTG) OWF Thornton Bank (48 WTG) OWF Ormonde (30 WTG)	
Foundations 基礎 (FOU)	EPC of 18 x FOU 18座基礎之EPC **-> monopile 單樁& -> transition piece 轉接段**	AMBAU	OWF Meerwind (80 FOU) OWF Thornton Bank (43 FOU) OWF Alpha Ventus (2 FOU)	

Nearshore Wind Farm Nordergründe
近岸風場 Nordergründe
Involved Contractors 承包商

First offshore wind farm with regional contractors
第一個與當地承包商合作之風場

Work package 工作包	Scope 範圍	Contractor 承包商	References 參考資料	
Internal Cabling (IAC) 場區海纜	**EPC + Installation** of the internal wind farm cables EPC統包加安裝	NSW	OWF Rodsand OWF Alpha Ventus Project Cascade	
Offshore Substation (OSS) 離岸變電站	**EPC of the OSS** including installation of OSS topside 此EPC統包包含了變電站頂面之安裝	**Multi-contracting**		
Installation (INS) 安裝	**Transport & Installation** of FOU and WTG 基礎與風機之運輸與安裝	BiLFINGER	Vessel "MPI Enterprise": OWF Nordsee Ost (295 MW) OWF Gwynt y Mor (576 MW)	

Nearshore Wind Farm Nordergründe
近岸風場Nordergründe
Current Status 現狀

- Wind turbines, cables, foundations have been installed
  風機、電纜、基礎已安裝完成
- Installation of substation scheduled for: the 3rd quater of 2017
  變電站預計於2017年第三季安裝完成
- Commissioning completion and starting of operation: the 4th quater of 2017
  試運轉與正式運轉預計於2017年第四季達成

Contact
聯絡人

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Director Projects Taiwan
wpd offshore solutions GmbH
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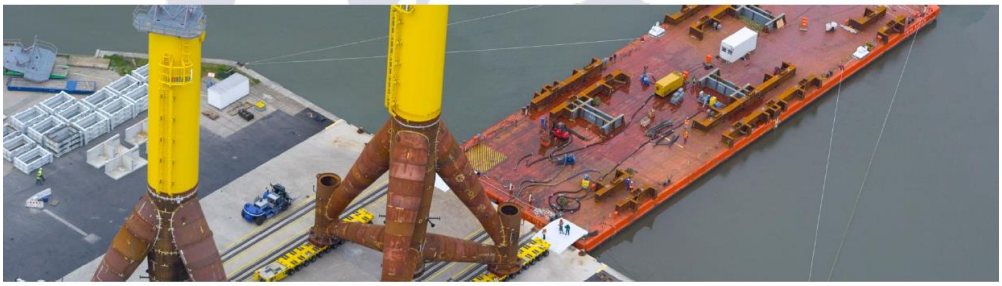
Phone number: +49 (421) 168 66 - 5839

附件 6　Bremen Ports 簡報

bremenports
World port in good hands

Professional port management and infrastructure for the maritime offshore industry

bremenports - World port in good hands



Robert Howe
CEO

Uwe Will
International

Christian Hein
Port Development

bremenports
World port in good hands

Professional port management and infrastructure for the maritime offshore industry

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(1) The universal ports of Bremen and Bremerhaven
(2) Port Infrastructure for the Offshore Industry
(3) International consultancy experience for your benefit

Taiwan-German Offshore Wind Energy Summit - Bremerhaven 19 May 2017

The universal ports of Bremen and Bremerhaven

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: World port in good hands

Bremerhaven

Oversea-port/Kaiser-ports

- Container (5.5 mill TEU p.a.)
- Automobile (2.03 mill cars p.a.)
- Cruise traffic
- Shipyards

Bremerhaven

Fishing-port

- Offshore-Wind
- Food-processing industry
- Shipyards

Bremen

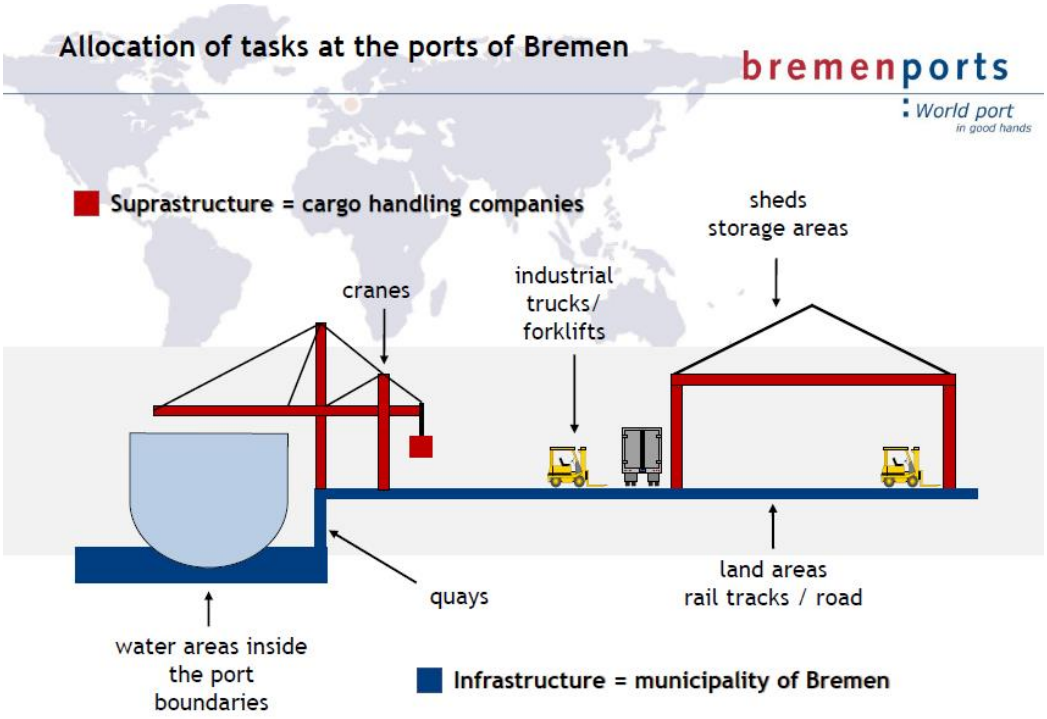
Industrial Port/Neustädter Port:

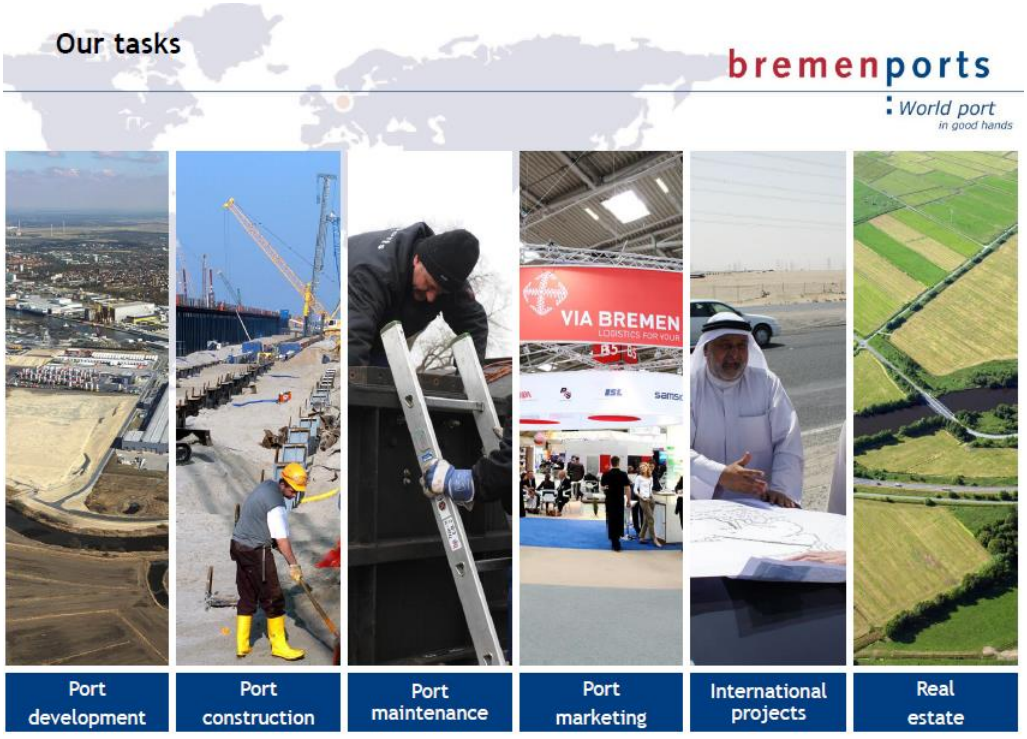
- Bulk cargo (10 mill tons p.a.)
- Conventional project cargo

Who we are?

bremenports
: World port in good hands

- A consulting and engineering company with its own ports - this sums up bremenports GmbH & Co. KG.
- The company has managed the port infrastructure in Bremen and Bremerhaven on behalf of the Free Hanseatic City of Bremen since January 2002.
- bremenports markets its engineering and development competences in port planning, construction and infrastructure operations and maintenance to private and public clients outside of Bremen.
- Projects not only focus on consultancy and engineering services, but also on human resource development in the field of ports and terminals.
- bremenports is 100% state owned by the Free Hanseatic City of Bremen.


Allocation of tasks at the ports of Bremen
bremenports
World port
in good hands
Suprastructure = cargo handling companies
sheds
storage areas
cranes
industrial
trucks/
forklifts
land areas
rail tracks / road
quays
water areas inside
the port
boundaries
Infrastructure = municipality of Bremen


Our tasks
bremenports
World port
in good hands
VIA BREMEN
Port development
Port construction
Port maintenance
Port marketing
International projects
Real estate

Continous expansion of the Container-Terminal

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World port in good hands

Measures/activities:	Technical data:	
Ramming 1.681m sheet pile quay wall Filling up sand for 300ha terminal area	Total quay length:	4.920 m
Soil exchange 400.000m³ Installation of crane runways	Total area:	300ha
Concrete surface 90ha Equipping quay walls with fenders	Container Terminal 4:	quay extended by 1.681m

Enlargement of the sea-lock Kaiserschleuse

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World port in good hands



Measures/activities:	Technical data:	
Enlargement of 110 year old sea lock Demolition of old sea-lock structures	Length of lock chamber:	305m
Soil replacement of 450.000m³ soil 40.000 tons steel processed	Clear passage width at lock heads:	55m
Construction of two road bridges Installation of Sliding-lifting-gates	Lock chamber depth:	13m
Construction of an attached tug boat port		

Updating Bremerhaven's railway terminal

bremenports
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Measures/activities:	Technical data:
Railway tracks extended to 750 m Storage tracks extended (eight additional tracks)	Total length of railway tracks: 183km
Electrification of railway tracks Update of the control, communication and safety system	8 x 750m new tracks at Imsumer Deich
Modernisation of the rail infrastructure radio system	2.000 trains in our ports every month

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Professional port management and infrastructure for the maritime offshore industry

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(1) The universal ports of Bremen and Bremerhaven
(2) Port Infrastructure for the Offshore Industry
(3) International consultancy experience for your benefit

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1	Offshore Industry in Bremerhaven
2	Interims Solution at CT I and ABC-peninsula
3	Logistical Requirements and Challenges: Offshore Terminal Bremerhaven

Offshore logistics at Fishing Port

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Offshore logistics at Fishing Port

bremenports
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Masutes/activities:	Technical data:	
Installation of heavy-load plates in regular quay walls Turnover of nacelles	Surface load factor: Water depth:	7 t/m² (70 kN) 7.10m - 8.10m
Installation of rail tracks from production facility to the edge of the quay wall	Quay length/ number of berths: Tidal range:	280m (heavy lift) 2-3 berths none

Offshore logistics at Fishing Port

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1	Offshore Industry in Bremerhaven
2	**Interims Solution at CT I and ABC-peninsula**
3	Logistical Requirements and Challenges: Offshore Terminal Bremerhaven

Interim solutions at CT I and ABC-peninsula

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Interim solutions at CT I and ABC-peninsula

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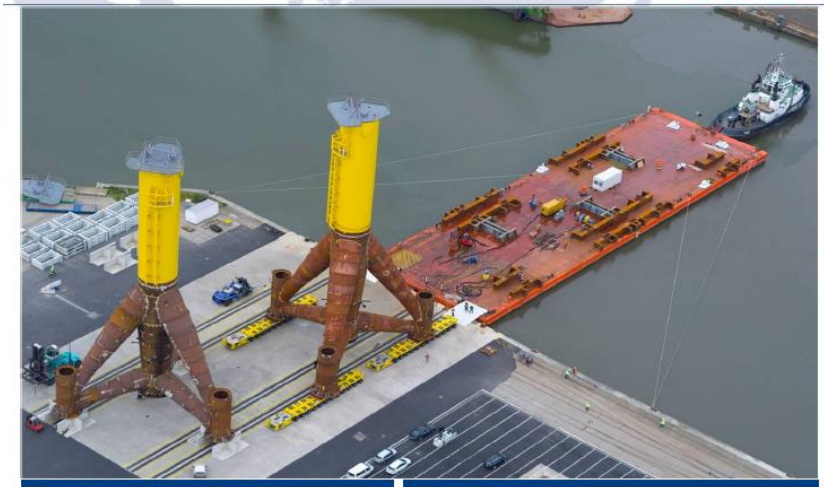

Measures/activities:	Technical data:	
Installation of rail tracks to the edge of the quay wall	Quay length/ number of berths:	900m 2 berths
Surface refurbishment	Surface load factor: Water depth:	10 t/m² (100 kN) 10.50m

17

Interim solutions at CT I and ABC-peninsula

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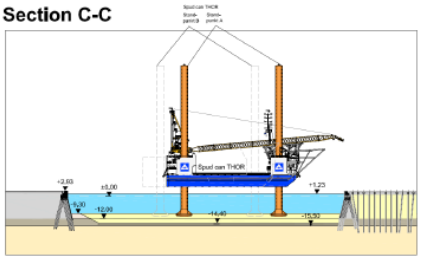
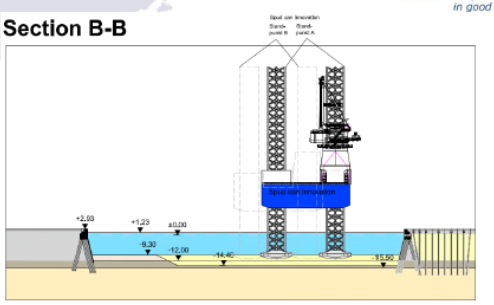
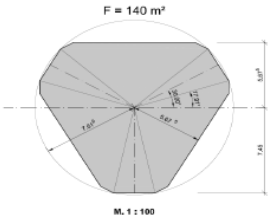
Section C-C



Section B-B





Technical requirements:	
different jack-up barges	Innovation, Thor, Brave Tern, Bold Tern, Aeolus, Victoria Matthias
different spud can systems	area: 80-160 m²
different bearing-load under spud can	65 to 188 t/m²

Interim solutions at CT I and ABC-peninsula

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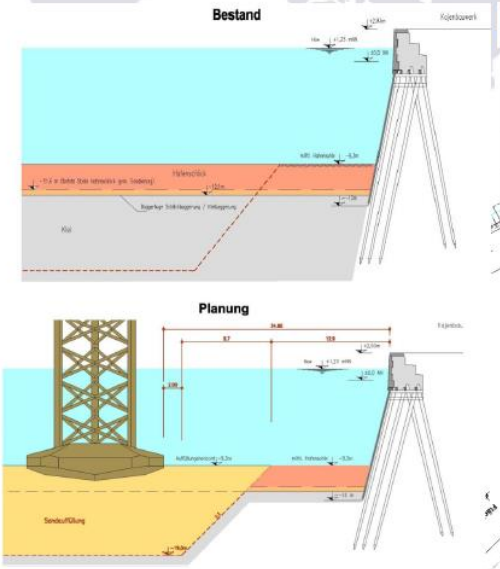
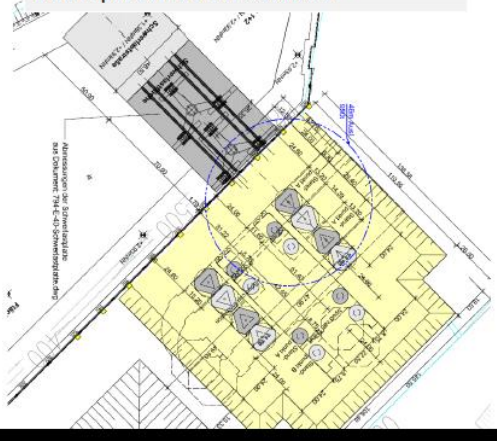


Challenges and Solution:

- Bad soil conditions for jack-up
- Old quay-wall with low bearing capacity
- Minimum 24 m distance to quay-wall
- Soil replacement of 90.000 m²



Interim solutions at CT I and ABC-peninsula

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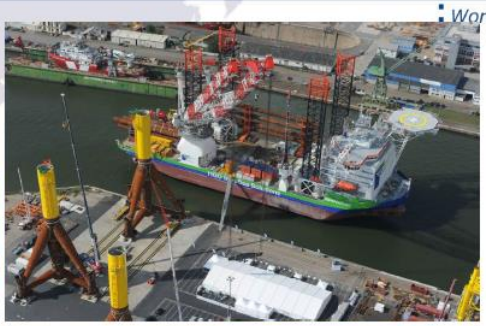

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Interim solutions at CT I and ABC-peninsula

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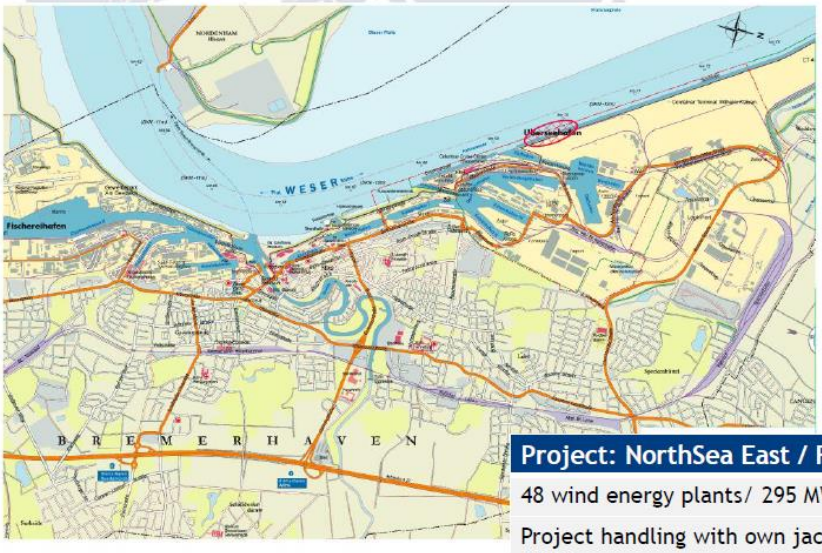
: World port in good hands



Project: NorthSea East / RWE

- 48 wind energy plants/ 295 MW
- Project handling with own jack-up barge

Solution Containerterminal I

bremenports
: World port in good hands

Project: NorthSea East / RWE

- Terminallayout for logistical concept
- Storage plan for windmill equipment at landside and on board
- Design picture of jack-up barge (under construction)
- Jack-up directly in front of quay

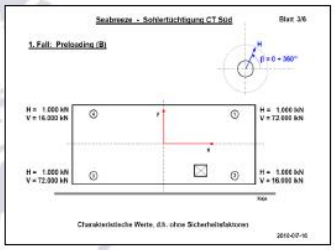
Solution 1: Containerterminal

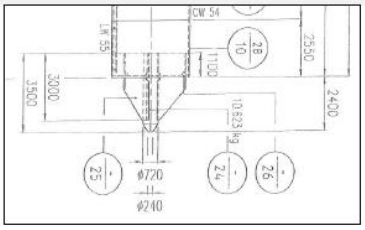
bremenports
World port in good hands

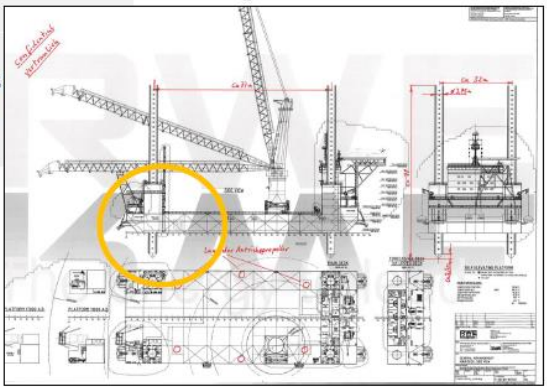
Project: NorthSea East / RWE
Technical Requirements

Seaside:
Plans of jack-up barge
Nautical data for mooring and berthing
Geometrical data of legs
data of vertical loads on seabed
bearing-load under spud can

Landside:
Geometrical data and weights of elements
Logistical concept for storage and loading
Surface loading rates for all activities

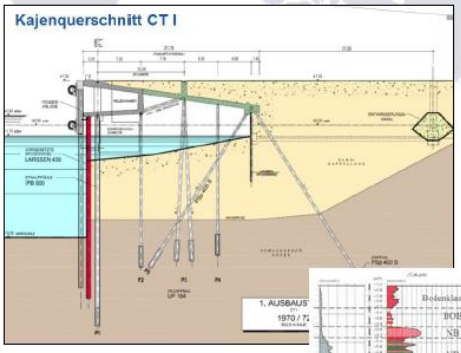






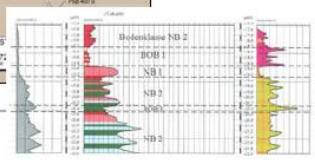
Solution : Containerterminal

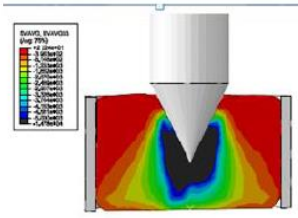
bremenports
World port in good hands

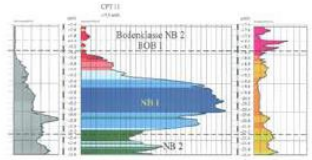


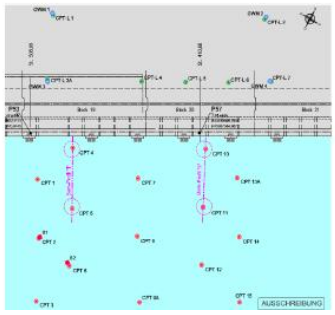
Challenges:

Bad soil conditions for jack-up
quay-wall: 3,5 t/m² bearing capacity
Design distance to quay-wall: close
No spud can system : pointed foot
7.200 t/ 3.5m leg-diameter









Solution Containerterminal I

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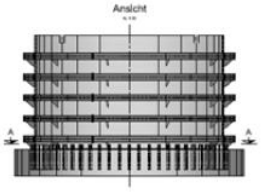
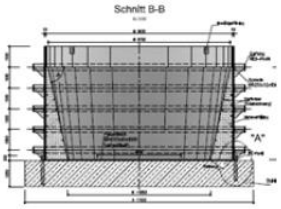
World port in good hands

Solution: Project „Elephant‘s foot“

technical solution:

- Installation of four custom built steel quivers into the river bed
- One-of-a-kind solution to strengthen the quay wall for vessels without spud cans
- Quivers filled with broken granit rocks
- Concrete slab: 11m diameter; 1,25m height
- Steel cylinder: 9 m diameter ; 5,5m heigth





Solution Containerterminal I

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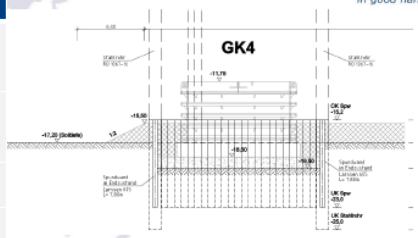
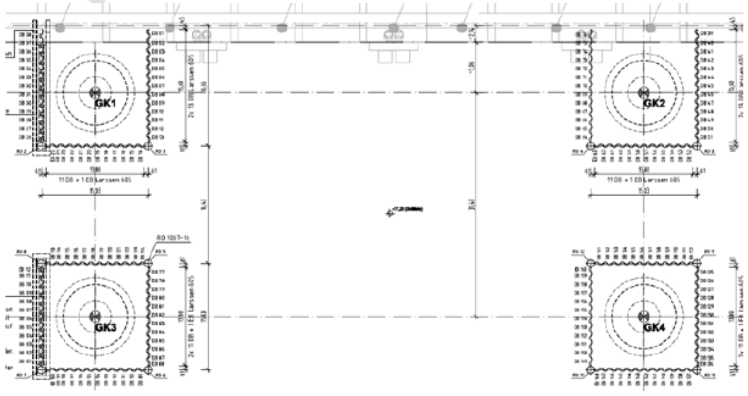
technical realization:

- Installation of four sheet pile walls around the location for the quivers
- Soil replacement: clay to broken stones
  Placing the quivers
- Fixing quivers with stones inside sheet pile-system
- Filling quivers with broken granit





Solution Containerterminal I

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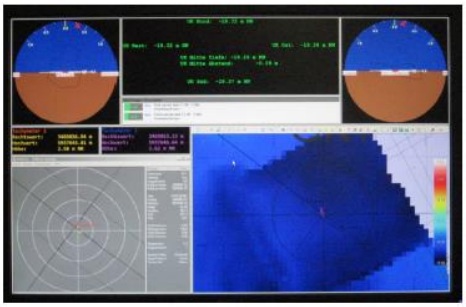
technical realization:

Very high requirements to precision
only 20 cm horizontal deviation permitted
only 1 degree angular deviation permitted

Special equipment for placing the quivers under water without visibility

Special software solution for deviation



Offshore logistics at Container Terminal

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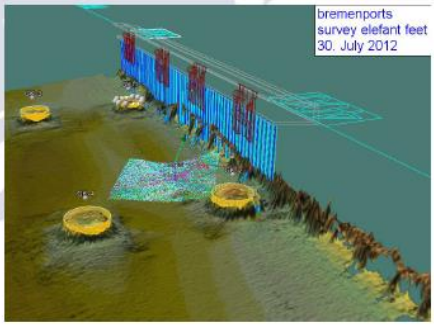
World port in good hands



technical realization:

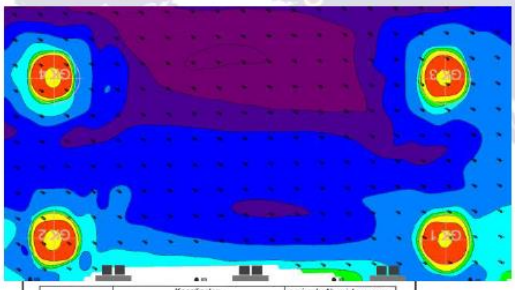
Placing of quivers succesful with low deviation

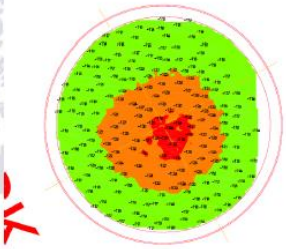
First jack-up procedure: 7.200 tons design-force with sufficient leg-penetration

over 80 usages until today without failures or accidents

Monitoring and safety

bremenports
World port in good hands





	Koordinaten UTM	maximale Abweichung von Sollposition in cm	
	Gründungskörper 1 / LEG 4		
Easting	32469796,566	0,07 m	-0,066
Northing	5935711,088		-0,008
	Gründungskörper 2 / LEG 2		
Easting	32469833,951	0,16 m	-0,161
Northing	5935643,872		-0,022
	Gründungskörper 3 / LEG 3		
Easting	32469769,102	0,08 m	-0,079
Northing	5935695,827		0,043
	Gründungskörper 4 / LEG 1		
Easting	32469806,450	0,17 m	-0,170
Northing	5935628,441		0,029

	Leg Penetration CT1			
	LEG1 GK1	LEG2 GK3	LEG3 GK2	LEG4 GK4
height upper end pots	-11.62	-11.64	-11.63	-11.65
Offset (LEG mark)	64.0	75.0	64.0	64.0
height (measured)	49.3	60.0	49.3	49.2
Penetration Pots	**-3.1**	**-3.4**	**-3.1**	**-3.1**
	in pot	in pot	in pot	in pot

Datum: 10.07.2012

Vermessung geprüft:
(Thorsten Döscher)

Monitoring and safety:

- Surveying and sounding after each usage
- Verifying sufficient filling of quivers
- Permit for each different usage
- User surveys leg penetration and deviation

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The logic consequence: The construction of an Offshore-Terminal

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- Final assembly and offloading facility as goods issue zone for the further development of the offshore-cluster in Bremerhaven.
- Interface between landside production and seaside installation.

Offshore-Terminal Bremerhaven (OTB)

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- The plan approval procedure for the construction of the OTB and the project related compensation measures are prepared and submitted by bremenports.
- The landside development plan exists - 260 ha of industrial land are available for further settlements. The development runs.
- Due to a lawsuit: waiting for building-permission

Technical requirements for the OTB

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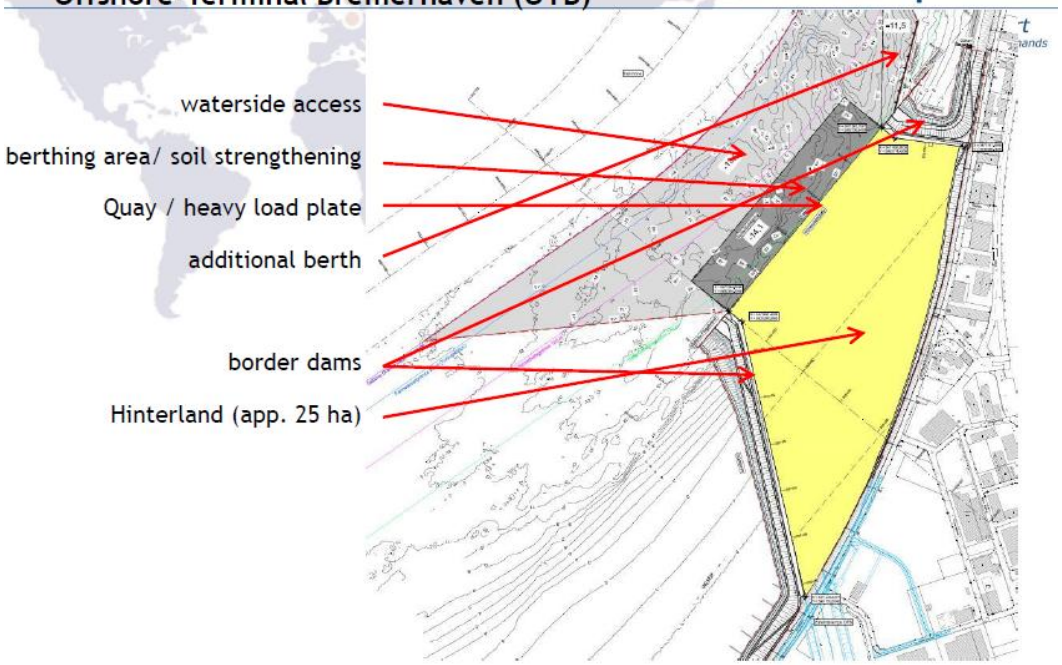
Requirements	
Windfarms supplied	Multi-User, non-discriminatory access
Installation device	Jack-up-vessel/pontoon
Funktion	Storage, assembly, turn-over
Efficiency	Technically 160 plants per season
Connection	-landside accessibility of production-sites via former regional airport. -Backwards waterside accessibility to the fishing port via new heavy-weight quay-wall.

Technical data (of the reference-planning)	
Quay surface load	15-50 to/m² (150-500 kN)
Quay length/berths	500m / 2-3 berths
Water depth	14,10m (tub deck)
Tide	approx. 3,80m
Terminal area	approx. 25 ha

Offshore-Terminal Bremerhaven (OTB)

bremenports



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Professional port management and infrastructure for the maritime offshore industry

bremenports - World port in good hands

(1) The universal ports of Bremen and Bremerhaven
(2) Port Infrastructure for the Offshore Industry
(3) International consultancy experience for your benefit

Taiwan-German Offshore Wind Energy Summit - Bremerhaven 19 May 2017

bremenports International
Your global partner for port development

bremenports

World port in good hands

bremenports International -
your sparrings-partner to plan and develop logistics infrastructure worldwide, whether port or industrial zone, greenfield or brownfield, public or private.

What are our competences?

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Port Development

- Partner for port master planning and feasibility studies
- Port development concepts
- Development of port hinterland connectivity (rail, road, inland waterway)
- Determination of infrastructure requirements and port equipment
- Operations analysis and improvement concepts
- Specification and selection of port handling equipment
- Recommendations for management structures

Environmental Planning

- Environmental spatial planning, landscape conservation projects
- Management and co-ordination of approval process, drafting of approval documents
- Representation of investor at all relevant authorities, including stakeholder management
- Compensation planning and compensation area identification, conversion and management
- Review of environmental impact

Port Finance and Investment

- Financial modeling and appraisal
- Cost-benefit analysis
- Financing structures
- Design and management of port concessions and land-lease agreements
- Investor identification and liaison
- Project development

Training/Human Capacity Building

- Competence management for staff of port-related organizations
- Development of curricula for management trainings
- Implementation of trainings (in-house), internationally and in Bremen
- Train-the-trainer programmes

Offshore Wind Energy: Services bremenports International Can Provide

bremenports
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Port Development

- 2nd opinions on existing studies and due diligence documents
- Drafting of business plans; evaluation of investment proposals
- Identification of suitable port organisation structures
- Advisory towards drafting and awarding of concessions

Landlord Port Organisation Structure
Ports of Bremen and Bremerhaven

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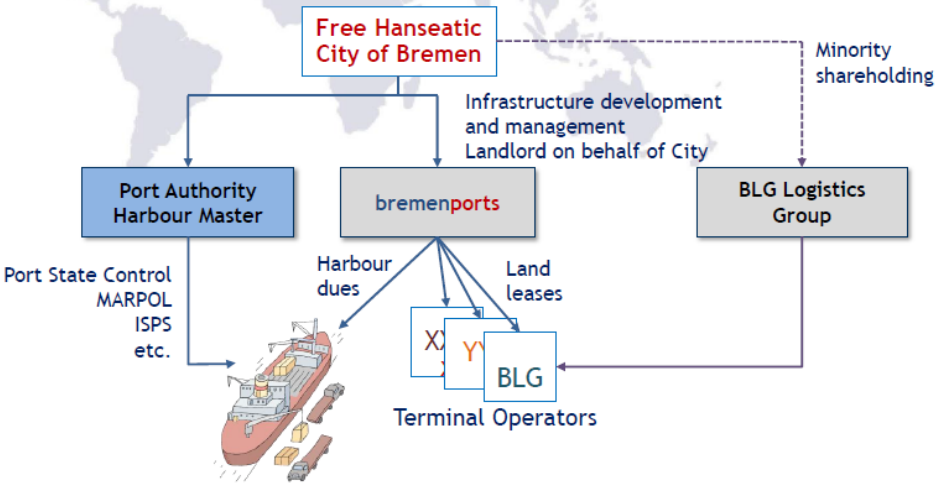
Infrastructure = public
Suprastructure and cargo operations = private



Alternative Port Organisation Structure

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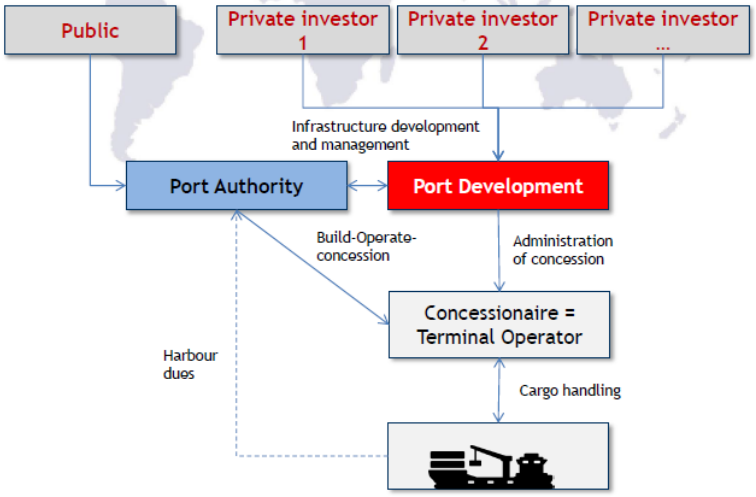
based on an internationally accepted Build-Operate-Transfer-concession, with private port development company:



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References: Our global project presence

bremenports
World port in good hands

All the services that we provide to run our world-class offshore ports can also be offered to you!

Why work with us?

bremenports
World port in good hands

- We combine our know-how and skills from managing our own ports with our international consultancy experience for your benefit.
- Strong balance sheet of publicly owned, but commercially minded organization confirms our corporate reliability.
- Own assets under management of >1 bn EURO ensure that we understand investor´s needs.
- Holistic view as asset management not only includes maritime infrastructures, but also roads and rail infrastructure.
- Own port facilities provide total-cost-of-ownership view, including planning, construction and operations/maintenance.
- ISO 9001:2008 certified

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Thank you

Visit our virtual presentation at www.bremenports.de

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附件 7　EUROGATE 簡報

EUROGATE WIND ENERGY - FULL SERVICE BASEPORTS

Taiwan Wind Energy Delegation

Bremerhaven, 19.05.2017

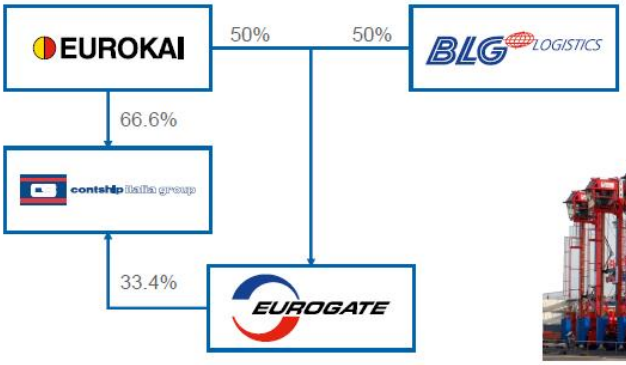
Agenda

1. Introduction EUROGATE Group
2. EUROGATE Wind Energy
3. Port requirements for Offshore Wind Components
   - Area
   - Quay Line / Jacking of Installation Vessel
   - Equipment
   - Terminal Qualities

1. The EUROGATE Group

Facts and Figures

Two companies, rich in tradition, merge their business units Container Handling (1999) to build Germany's largest container terminal group:



1. The EUROGATE Group

1. The EUROGATE Group

Our key business areas

Container handling

Intermodal Transport

Cargomodal Logistics

2. EUROGATE Wind Energy

Terminals for Wind Energy Components

BREMERHAVEN

	Wind Energy	Total
Area	250,000 m²	3,000,000 m²
Quay	500 m	4,680 m
Water depth	12.5 - 15.5 m	

WILHELMSHAVEN

	Wind Energy	Total
Area	150,000 m²	1,300,000 m²
Quay	250 m	1,725 m
Water depth	18.0 m	

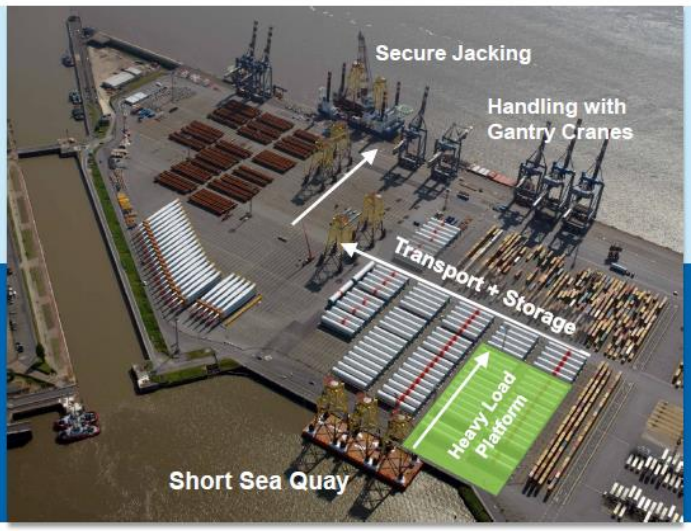
Base port for everything: Towers, Turbines, Hubs, Blades, Foundations & Piles

2. EUROGATE Wind Energy

Facts and Figures – Container Terminal Bremerhaven

2. EUROGATE Wind Energy

Offshore Component Handling – OWF „Nordsee Ost“ 2011 – 2014 (48x 6MW WTGs)



BASE PORT
for RWE and SENVION

Handling, Storage and
Pre-assembly of

- Jacket Foundations
- Foundation Piles
- Tower Sections
- Turbines
- Hubs
- Blades
- ...

2. EUROGATE Wind Energy

Offshore Component Handling – OWF „Nordsee Ost“ 2011 - 2014

2. EUROGATE Wind Energy

Offshore Component Handling – OWF „Nordergründe“ 2016 (18x 6MW WTG)

3. Port requirements

Area Load

- The EUROGATE Terminals comply with the requirements for handling very heavy goods
  e. g. jacket foundations (~ 550 t) or gantry cranes (> 1.000 t)
- Our terminals in **Bremerhaven** and **Wilhelmshaven** are completely intended for heavy duty class „SWL60“
  Area Load up to 20t/m²
- Existing and approved **Ro/Ro-solution** in Bremerhaven Nordhafen

3. Port requirements

Jacking of Installation Vessels

- *„Jacking“* of installation vessels is possible at both locations
- Many vessels are already positively checked with a short distance to quay:

Brave Tern and **Bold Tern**	(Fred Olsen)	**Adventure** and **Enterprise** *(ex OLC Victoria Mathias)*	(MPI)
Vole au vent *(ex Hochtief Vidar)*	(Jan de Nul)	**Torben** *(ex OLC Friedrich Ernestine)*	(ZPMC)
Pacific Orca and **Pacific Osprey**	(Swire Blue Ocean)	**Innovation**	(Hochtief/Deme)
Sea Installer and **Sea Challenger**	(A2Sea)	**Aeolus**	(Van Oord)
Zaratan, **Scylla**, **Kraken**, **Leviathan** and **Hydra**	(Seajacks)		

3. Port requirements

Equipment

- World's biggest super-post-panmax gantry cranes
- Terminaltractors with a variety of different trailers
- Large fleet of reach stackers and fork lifts
- Numerous lifting tackles like spreaders, various slings and shakles
- Additional equipment such as mobile cranes, semi trailers or SPMT is supplied in collaboration with powerful longterm partners (*e.g. ARGE EG/SARENS*)



3. Port requirements

Special Equipment in Bremerhaven

- Shifting of two gantry cranes onto the second and third crane rail in order to lift cargo with overlength
- Handling of vessels with a width up to 28 m
- Maximum capacity of 163 t *(tandem-lift)*

Terminal Qualities

Flexibility

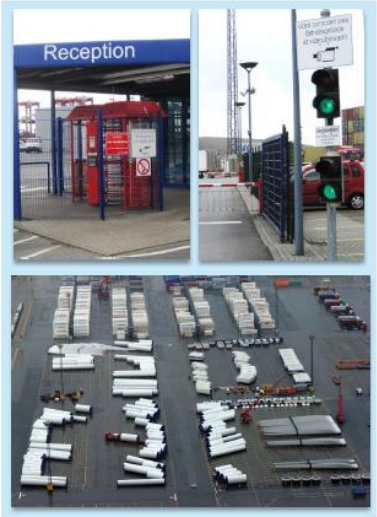
- Operating ***24 hours 365 days per year***
- Flexible availability of berths, area and staff

Exclusivity

- Opportunity to rent exclusive quay and area for a maximum of planning reliability

Security

- All EUROGATE Terminals are ***ISPS-Certified:*** Totally fenced, video controlled and restricted access only for authenticated persons



Terminal Qualities

Health, Safety and Environment

As an integral part of global supply chains we are convinced to be responsible for a **sustainable future**. Therefore, the **safety of people, equipment and environment** is of the highest priority and a central part of our corporate philosophy.

- All processes are based on detailed method statements and risk analyses
- High standards on safety regulations and protective clothing
- Experienced and high qualified staff with all common trainings and health checks
  (Height training, electrical instructed person, G25/41, first aid, etc.)

EUROGATE Wind Energy

References

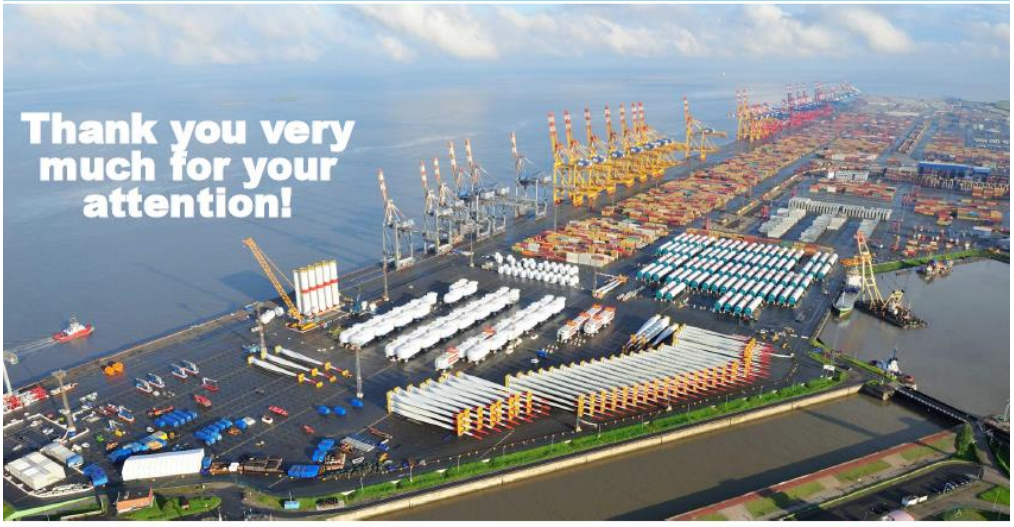
❖ **Offshore**

- Foundation piles and Jackets „Nordsee Ost“
- WTG-Components „Nordsee Ost“ + „Nordergründe“
- WTG-Components „Global Tech 1“
- 2x 6MW Offshore Prototype
- Special wind energy equipment for the Mob-/Demobilisation of Installation Jack-Up Vessels

❖ **Onshore**

- WTG-Components since 2009
- WTG-Components
- WTG-Components

EUROGATE WIND ENERGY- FULL SERVICE BASEPORTS



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