

Carbon Trust Offshore Wind Accelerator 英國碳信託公司 離岸風電加速開發計畫

Collaborative R&D: An effective way of pulling innovation to market
協作研發：一種將創新引進市場的有效方法

Megan Smith, Carbon Trust

CARBON
TRUST


Department
of Energy &
Climate Change


The Scottish
Government

 MAINSTREAM
RENEWABLE
POWER

 RWE

 SCOTTISHPOWER
RENEWABLES

 SSE
Renewables

 Statkraft

 Statoil

 VATTENFALL

The Carbon Trust has accelerated sustainable, low carbon development for over 15 years

Carbon Trust致力於促進永續低碳開發超過15年



We are independent experts with a mission to accelerate the move to a *sustainable, low carbon economy*

我們是一家獨立的專業公司，以促進邁向永續低碳經濟為己任。

We **advise** businesses, governments and the public sector on opportunities in a sustainable, low carbon economy

我們針對邁向永續低碳經濟商機，為企業、政府和公部門提供顧問服務。

We **measure and certify** the environmental footprint of organisations, products and services

我們計量和認證機構、產品和服務的環境足跡。

We **help develop and deploy** low carbon technologies and solutions, from energy efficiency to renewable power

我們幫助開發及部署低碳技術和解決方案，包括能源效率和再生能源。

- › Trusted independent experts
- › 受信任的獨立專業公司
- › Global offshore wind specialists
- › 全球離岸風電專家
- › Mission led organisation
- › 任務導向機構

We are increasingly working outside the UK



International Work:

- **World Bank (infoDev):** SME clean tech project focuses on 145 developing countries
- **DFID (with DECC):** Review of current activity in small-scale concentrated solar power and potential for UK climate finance to accelerate deployment
- **DECC:** Advice to the UK's International Climate Fund to help prioritise technologies to support with UK climate finance
- **International Energy Agency:** Policy recommendations to support innovation in next generation renewables
- Certified carbon, water and waste reductions of over 1,000 organisations and completed over 28,000 product carbon footprints in over 20 countries

FCO China:

- Organisational carbon footprinting scheme
- Blueprint for an offshore wind programme
- Reducing carbon emissions in Jiangsu province's heavy industry
- Developed a standard for low carbon product assessment for the Chinese National Standards Institute
- Catalysing corporate supply chain carbon footprint reporting in China's export industries
- City level approach to low carbon planning and strategy in Nanchang

UNDP: Strategic support for greening 2014 Sochi Olympics

FCO Mexico:

- Economy-wide review of carbon abatement opportunities and best practice policies in the non-domestic
- Development of an SME energy efficiency advice and finance programme

Technology Centre Mongstad: CCS project in Norway

Offshore Wind Accelerator (OWA): Collaborative R&D programme to reduce the cost of offshore wind, operating in Norway, Denmark, Sweden, Germany, UK and Ireland

Chinese Manufacturers' Association of Hong Kong: Design and implementation of a product carbon labelling scheme

FCO Mexico/SEMARNAT: Footprinting and eco-labelling scheme

FCO Peru: Energy management training and company diagnostics

ITRI: Delivering Taiwan footprinting scheme

Anglo American Platinum & Limpopo Government: Feasibility study for the Limpopo fuel cell supply chain initiative

World Bank/InfoDev: Assessment of the opportunities for SMEs in clean tech sectors in developing countries, with deep dive research in Kenya and India

WWF-Vietnam and Thua Thien Hue's Department of Industry and Trade: Quang Dien District energy efficiency project

FCO Brazil:

- Energy resilience review before Rio Olympics
- Energy efficiency recommendations based on UK public sector experience
- Impact assessment manual and training course for energy policy appraisal
- Review of UK's approach to low carbon technology innovation
- Review of energy efficiency finance experience for Brazil's national development bank
- Review of time-varied electricity pricing to inform electricity regulator's development of a new tariff

DFID:

- Support to develop bilateral low carbon development programme and development of the business case for an energy efficiency programme
- Technical assistance to help the local implementer set up a DFID funded energy efficiency programme

European Commission and SIRIM: Developing an ecolabelling scheme for the construction and building materials sector in Malaysia

FCO Indonesia: Assessment of the opportunity for deployment of waste to energy technology and development of policy recommendations

FCO Vietnam: Prawn industry energy efficiency project

我們的營運日益跨出英國



國際工作：

- **世界銀行(infoDev計畫):** 中小型企業(SME)潔淨科技計畫聚焦於145個開發中國家。
- **DFID (與DECC合作):** 檢討當前小規模聚熱式太陽能發電的活動，以及英國氣候融資加速部署的潛力。
- **DECC:** 為英國國際氣候基金(ICF)提供諮詢，協助排定技術開發優先性，支援英國氣候融資。
- **國際能源總署(IEA):** 提供政策建議，以支援新一代再生能源創新。
- 完成超過1,000個機構的碳、水和垃圾減量認證，並在20多個國家完成超過28,000項產品的碳足跡認證。

FCO中國：

- 機構碳足跡計畫
- 離岸風電計畫藍圖
- 降低江蘇省重工業碳排放量
- 為中國國家標準局發展低碳產品評估標準
- 為中國出口產業催生企業供應鏈碳足跡通報機制
- 在南昌市推動城市級低碳規劃與策略方法

聯合國開發計劃署 (UNDP):
為2014年索契冬季奧運提供環保策略支援。

FCO墨西哥：

- 檢討全國減碳機會和非國內最佳實務政策。
- 提供中小型企業(SME)節能建議和發展融資計畫。

Mongstad技術中心：

挪威碳捕集和封存(CCS)計畫

離岸風電加速開發計畫 (OWA)：

協同研發計畫，以降低在挪威、丹麥、瑞典、德國、英國和愛爾蘭營運離岸風電的成本。

香港中華廠商聯合會 (CMAHK):
設計和執行產品碳標籤計畫

FCO墨西哥/SEMARNAT：

足跡和生態標籤計畫

FCO秘魯：

能源管理訓練和企業診斷

工業技術研究院 (ITRI): 協助擬定台灣碳足跡計畫

FCO巴西：

- 2016年巴西里約奧運前，能源彈性檢討。
- 根據英國公部門經驗，提供節能建議。
- 影響評估手冊和能源政策評鑑訓練課程。
- 英國低碳技術創新方法檢討。
- 為巴西國家開發銀行提供節能融資經驗檢討。
- 檢討按時段電費定價政策，以通知電力監管機關制定新電價時機。

英美鉑業公司(AAP)&凌波省政府：

凌波省政府：凌波省燃料電池供應鏈行動方案可行性研究。

WWF-越南和承天順化省工商局: Quang Dien區節能計畫

世界銀行/InfoDev:

評估開發中國家中小型企業(SME)參與潔淨科技產業的機會，尤對肯亞和印度進行深入研究。

FCO 越南: 草蝦業節能計畫

英國國際開發部(DFID):

- 支援發展雙向低碳發展計畫和節能計畫營運企劃案。
- 提供技術支援，協助地方執行單位擬訂DFID資助的節能計畫。

歐盟委員會與SIRIM:

為馬來西亞營造及建材業發展生態標籤計畫。

FCO 印尼: 廢棄物能源化技術部署和政策建議機會評估。

Our interest in offshore wind has grown

我們對離岸風電的興趣升高

We have been supporting government and industry to accelerate the offshore wind industry for over 7 years
過去七年來，我們一直支援政府和業界加速發展離岸風電產業。



Offshore wind: Big challenge, big opportunity (2008)

離岸風電：大挑戰·大機會 (2008年)

UK government funded
英國政府出資

Recommendations for Government and industry to accelerate development of offshore wind industry
為政府和業界提供加速發展離岸風電產業的建議。



Technology Innovation Needs Assessment (2012 and 2015)

技術創新需求評估(2012-2015年)

UK government funded
英國政府出資

Quantifying the value of innovation for offshore wind, and recommending actions for Govt and Industry
鑑定離岸風電創新的價值，並為政府和業界建議行動。



Cost Reduction Task Force (2012)

降低成本任務小組(2012年)

Industry-wide initiative
業界整體行動方案

Providing evidence on need for demonstration to commercialise new turbines and foundations
提供商業化新渦輪機和底座之展示需求的證據。



Appraisal of Offshore Wind in Japan (2014)

日本離岸風電評估(2014年)

British Embassy funded
英國大使館出資

Study of policy and regulatory framework, costs, financing and technology
政策與監管架構、成本、融資和技術之研究



Appraisal of Offshore Wind in China (2014)

中國離岸風電評估(2014年)

British Embassy funded
英國大使館出資

Study of policy and regulatory framework, costs, financing and technology
政策與監管架構、成本、融資和技術之研究

Offshore renewable energy Catapult (2012 onwards)

離岸再生能源整合開發中心(2012年- 持續中)

Innovation programme, UK gov't funded
創新計畫·英國政府出資

Shaping development of the Catapult, in collaboration with Narec, Scottish Enterprise
與Narec、蘇格蘭工商委員會合作，擬定整合開發中心發展計畫。



Offshore Wind Accelerator (2009 onwards)

離岸風電加速開發計畫(2009年- 持續中)

Joint industry project, UK gov't funded
Design, set-up and delivery of a JIP innovation programme to reduce costs
聯合產業計畫·英國政府出資

設計、建立和交付一項JIP創新計畫，以降低成本。



Offshore Wind Accelerator (OWA)

離岸風電加速開發計畫(OWA)



Objective: Reduce cost of energy by 10% in time for UK Round 3 projects
目標：英國實施第三回合計畫時，降低能源成本10%。

72% (31GW) of licensed capacity in UK waters
佔英國海域有照發電量72%(31GW)

- **Joint industry project involving 9 developers + Carbon Trust**
- **9家開發商 + Carbon Trust參與的聯合產業計畫。**

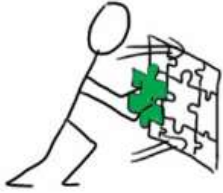
- **Only developers are members**
- **僅開發商可成為會員**
 - Aligned interests 利益一致
 - Commercially-focused 商業化焦點
 - Preferential access to new technology
 - 優先取得新技術

- **£88m programme**
- **投資8,800萬英鎊的計畫**
 - 2/3 industry, 1/3 government
 - 2/3 來自業界，1/3來自政府

- **Focus on overcoming near-term technical challenges**
- **聚焦於克服近期技術挑戰**

Industry driven RD&D is what makes the OWA programme a success 產業驅動研發&示範是OWA計畫的成功原因

Technology push versus Market Pull 技術推動 vs市場拉動



- Technology tries to find application
- 技術試圖找到應用機會
- May not meet customer needs
- 可能不符合顧客的需求

OWA approach OWA方法



- Research is close to market and commercially-focused
- 研究接近市場，並以商業化為焦點。
- Industry involved in the innovation process.
- 產業參與創新過程。
- Technology will meet market needs 技術符合市場需求
- Aligned objectives 目標一致

Flexible to utilise opportunities 彈性利用機會



- Funding available when needed
- 需要時有資金供應。
- Annual funding allocated by Government
- 年度經費由政府分配。
- No requirement to apply for funding
- 請領資金無特別要求。
- This makes it possible to utilise opportunities for testing and demonstration when they arise.
- 當機會到來時，這市場可能利用機會測試和示範。

Good leverage 良好的槓桿

- 9 industry partners 9家業界夥伴
- 2/3 industry funding 2/3 業界基金
- 1/3 public funding 1/3 公共基金
- For Common R&D we have a leverage of 1:13.5
- 就共同研發而言，我們的槓桿率是1:13.5。
- For every £ a partner invest he will get £13.5 of research
- 夥伴每投資一英鎊，便可獲得13.5英鎊的研究成果。



Effective way of learning from each other 互相學習的有效方法



- Five working groups for different disciplines
- 五個工作小組分別負責不同領域。
- Steering Committee providing strategic direction.
- 指導委員會提供策略方向。
- Over 60 experts involved
- 超過60位專家參與。
- Open discussions and exchange of information
- 開放討論和資訊交換。

OWA has made real impact so far

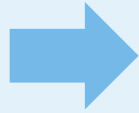
目前為止，OWA已發揮實質影響

Some examples of the research projects we have delivered are below
 列舉我們已交付的研究計畫實例如下：



Reducing O&M cost
 降低運維成本

New vessels concepts
 新船舶概念



Fjellstrand



Prototype 原型: 2013

NautiCraft



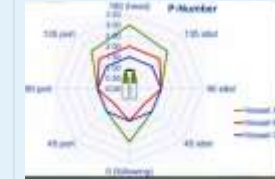
Prototype 原型: 2014

WaveCraft



Prototype 原型: 2015

Performance plots
 性能表現圖



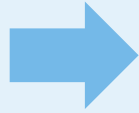
Published 已發行: 2015

Still to come
 更多船型

- PDV vessel
- P-plots
- Divex
- Mothership

Reducing Foundation cost
 降低底座成本

New foundation concepts
 新底座概念



Keystone 拱心石



Installed 安裝: 2011

Universal 通用型



Installed 安裝: 2013

Suction Bucket Jacket
 吸筒型夾套



Installed 安裝: 2014

Trial installation
 試安裝

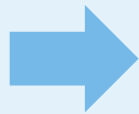


Trialed 試用: 2014

- UF demo
- Keystone demo
- GBF demo

Reducing Financing cost
 降低融資成本

New wake models & LIDAR
 新尾流模型 & 光達



FLIDAR



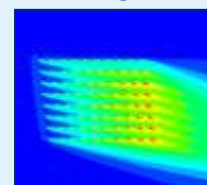
Installed 安裝: 2012

Babcock



Installed 安裝: 2013

Fuga



Prototype 原型: 2011

Wake Campaign

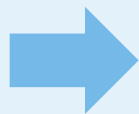


Installed 安裝: 2012

- Measured TI (LIDAR), modelled TI (Frandsen), scanning LIDAR

Reducing Elec. System cost
 降低電氣系統成本

Higher voltage arrays
 較高電壓陣列



66kV switchgear



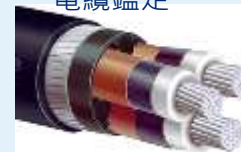
Commercial 商轉: 2014

66kV



Commercial 商轉: 2015

Cable qualification
 電纜鑑定



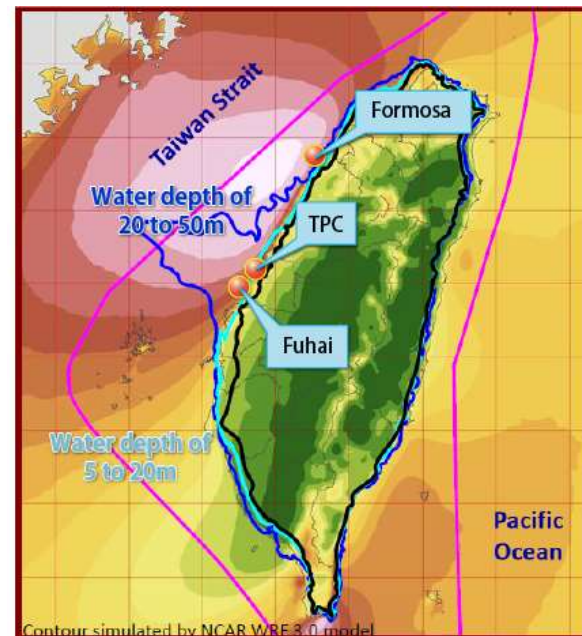
Commercial 商轉: 2015

- 66kV demo
- Dynamic cable demo

Considerations for the Taiwanese market

針對台灣市場的考量

- A **young industry** with **aims of rapid expansion**
- 以快速擴展為目標的年輕產業
 - target of **4GW by 2030**
 - 目標：2030年4GW
- Thousand Wind Turbines Project
- 千架海陸風力機計畫
 - covering both offshore and onshore wind
 - 包括離岸和岸上風電
 - **feed-in tariff** for 20 years
 - 政府電力收購制度 – 20年
 - **capital subsidy** for **demonstration sites**
 - 示範場址資金補貼
- Undeveloped market 未開發市場
 - no set of established **developers**
 - 缺乏成熟的開發商
 - **supply chain** challenges
 - 供應鏈挑戰
 - environmental and **consenting risks**
 - 環境和符規風險
 - many **cost reduction opportunities**
 - 許多降低成本機會



A coherent approach to create attractive market conditions for investors is important

以一貫的方法為投資人創造誘人的市場條件非常重要



Example 1: LCICG

實例1：低碳創新協調小組

The Low Carbon Innovation Co-ordination Group (LCICG) brings together 16 public sector organisations that are supporting low carbon innovation in the UK. It builds a Strategic Framework to coordinate Low Carbon Technology Innovation Support

低碳創新協調小組(LCICG)召集16個公部門機關，共同支援英國的低碳創新。LCICG建立一個策略性架構，協調低碳技術創新支援工作。



Example 2: OWPB

實例2：離岸風電計畫委員會

The Offshore Wind Programme board brings together senior representatives from industry, UK and Scottish government, The Crown Estate and Statutory Nature Conservation Bodies. It treats the UK's offshore wind sector as one business to find and implement solutions in partnership with the wider industry.

離岸風電計畫委員會(OWPB)由業界、英國及蘇格蘭政府、英國皇家地產公司、和法定自然保育機關的資深代表組成。OWPB將英國的離岸風電產業視為需要與更廣泛產業界合作擬定和執行解決方案的事業。



How Carbon Trust can support Taiwan

Carbon Trust如何支援台灣



- Appropriate policy approach is critical to support the fledgling industry
- 適當的政策方法對於支援新興產業極為重要。
 - Carbon Trust has a strong track record of **advising governments** on how to most effectively support Offshore Wind
 - Carbon Trust在建議政府如何以最有效方式支援離岸風電開發方面，擁有優良的過往紀錄。
 - We currently work with multiple agencies across Europe to maximise industry impact
 - 我們目前正與歐洲許多機構合作，發揮最大的產業影響。

- Industry support has many forms
- 產業支援有多種形式
 - Generation **subsidy** 發電補助
 - **Grid** and network charging mechanisms 電網和網路收費機制
 - Technology **grants** 技術補助金
 - Facilitation such as port **infrastructure** 便利設施，如港口基礎建設
 - Innovation and **collaboration programmes** 創新和協同計畫

- Carbon Trust experts can advise on all above areas, bringing together industry and public bodies to a coherent solution
- Carbon Trust專家有能力在以上所有領域提供諮詢，幫助業界和政府機構找出一貫的解決方案。



Carbon Trust Offshore Wind R&D to date – examples

Carbon Trust目前為止參與之離岸風電研發 – 實例

UF MetMast in Dogger Bank Dogger Bank 離岸風場 UF MetMast 氣象桅杆

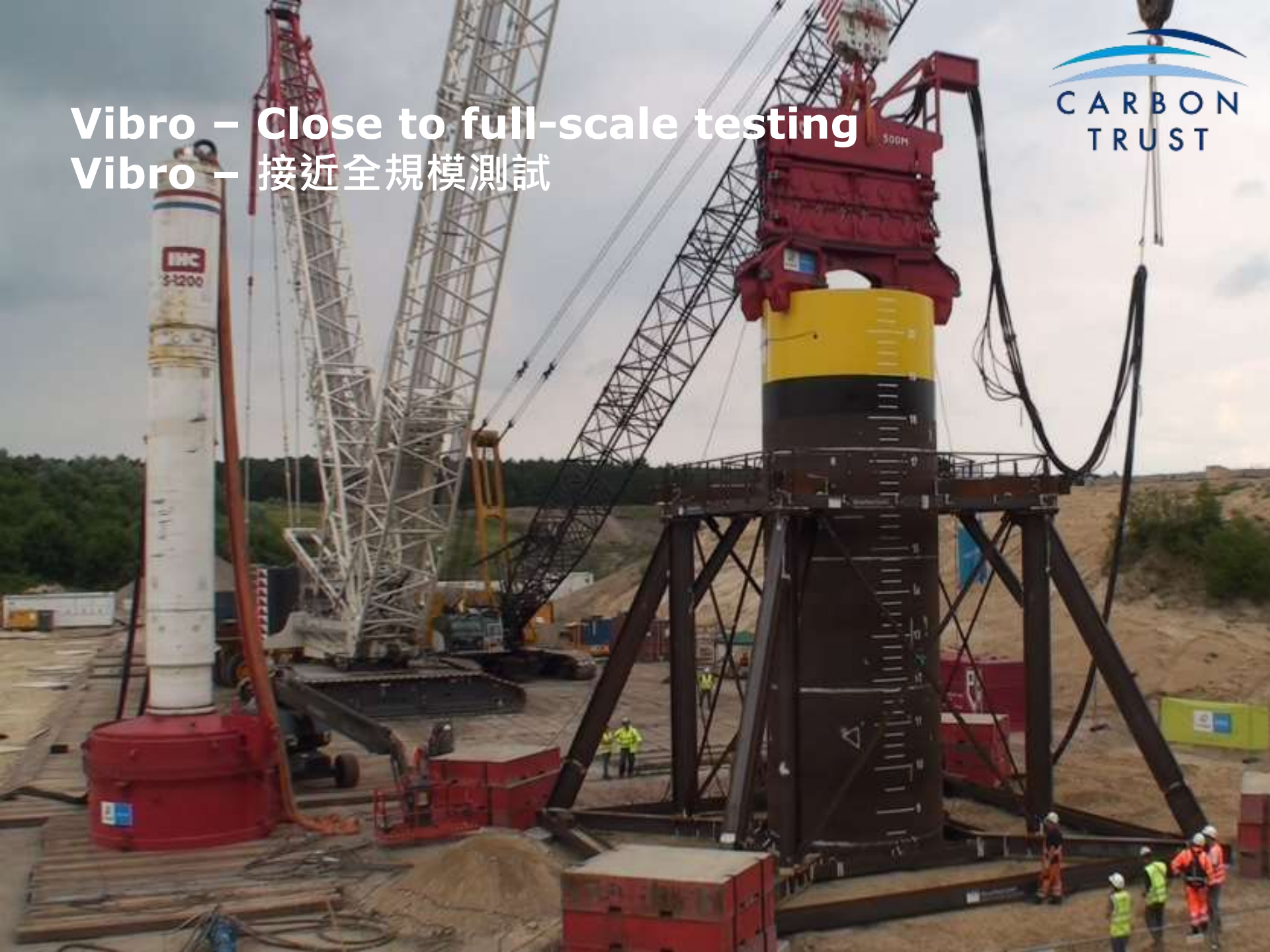


UF MetMast installed in 2013
Only 7h from deck to seabed!
2013年安裝UF MetMast氣象桅杆
從甲板到海床僅花7小時



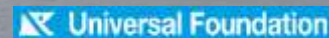
Vibro – Close to full-scale testing

Vibro – 接近全規模測試



Suction Bucket Trial Installation

吸桶試安裝



Sites: 場址：
Dogger Bank
HornSea
Dudgeon



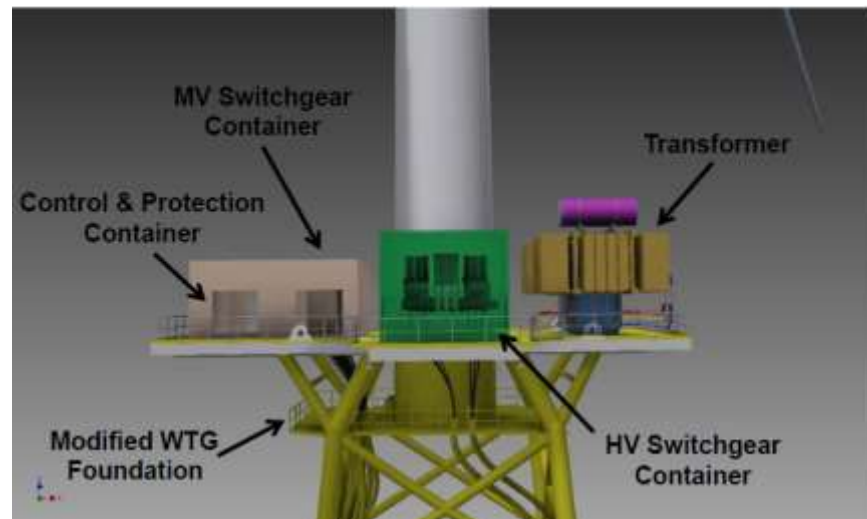
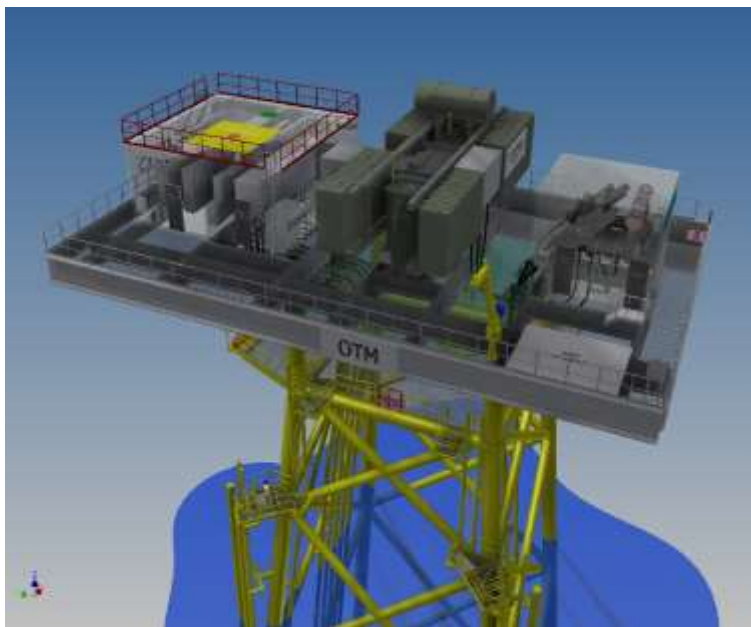
Structure 結構	Dimensions 尺寸	Clay chambers 黏土倉	Nozzle in skirt rim 裙邊噴嘴	Soil levelling 土壤整平
UF Bucket UF吸桶	Ø8m, H6m	3x	Yes (3 sectors) 有 (3扇區)	Yes 有
Ref Bucket 參考吸桶	Ø4m, H6m	No 無	Yes 有	No 無

Feasibility in different soil types proven
驗證不同土壤類型之可行性

Offshore Transformer module

離岸變壓器模組

- OWA is investigating the feasibility of the integrated AC substation concept
- OWA正在評估整合式AC變電站概念的可行性。



Floating LIDAR

浮式光達



Measurement campaign - Rødsand II

測量活動 - Rødsand II



Six LIDAR units installed in March 2013

2013年3月安裝六個光達單元

- 2 x long-range LIDAR to measure wake effects throughout farm
- 2個長程光達，用以測量整個風場的尾流效應。
- 4 x nacelle-mounted LIDARs to record inflow and wakes at specific WTGs
- 4個短艙安裝光達，用以記錄特定渦輪機的進流和尾流。



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