A career with large rotating machinery

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A talk to University of Cambridge, Engineering Department

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Career in a nutshell

University of Cambridge (Newnham).

BA in Natural Sciences; PhD in Metallurgy, Steels Group

Newcastle: NEI Parsons, steam turbine manufacturers.

Graduate trainee rising to Senior Metallurgist

University of Nottingham, Dept Mechanical Engineering.

Post-doc researcher then Lecturer

Loughborough University, MSc in Renewable Energy Systems Technology

Bristol: Garrad Hassan (now DNV GL), consultants in renewable energy

- Sales & support manager for wind farm design software
- Offshore wind logistics

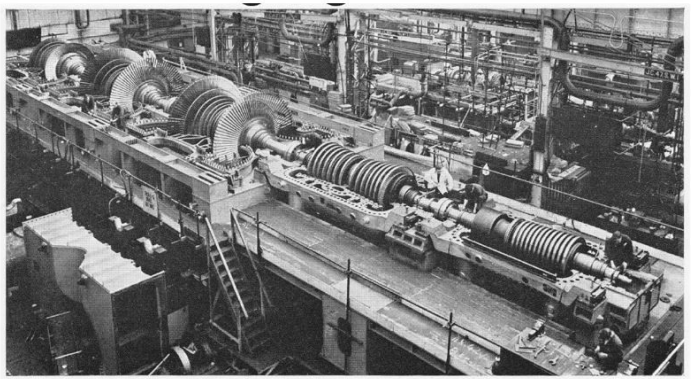
NEI Parsons, Newcastle upon Tyne

Steam turbine manufacturers

Graduate trainee

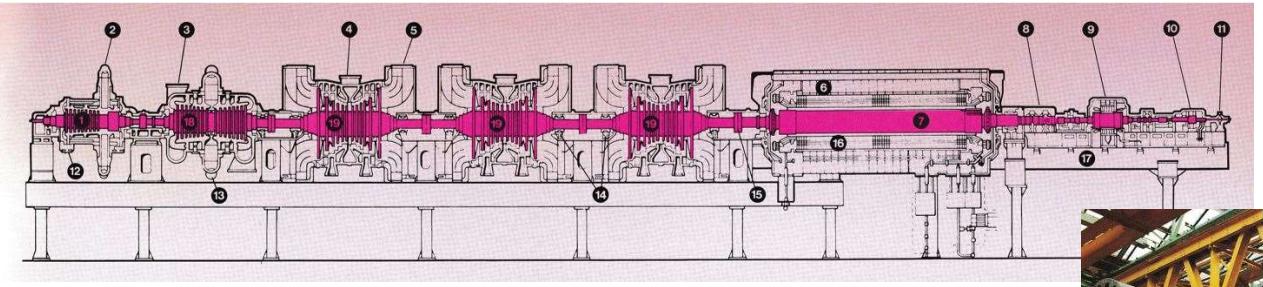
Metallurgist rising to Senior Metallurgist

Steam turbine manufacture



British Steel Corporation has supplied many complete rotor sets — seventy four forgings to date – for 660 MW turbine generators. This unit is being test assembled at the Newcastle Works of C A Parsons & Co Ltd (C A Parsons & Co Ltd photograph). Typical were five complete sets – HP, IP, LP, and alternators comprising thirty rotors in all – for the Isle of Grain, SE England.

1 HP turbine
2 HP steam inlet
3 Steam outlet to LP turbine
4 Steam inlet from IP turbine
5 Steam outlet to condenser
6 Generator
7 Rotor
8 Generator brushgear
9 Main exciter
10 Pilot exciter
11 Oil pump
12 Steam outlet to reheater
13 Reheated steam inlet to IP turbine
14 Shaft bearings
15 Shaft coupling
16 Stator windings
17 Supporting steelwork
18 IP turbines
19 LP turbines



Drax, the last UK coal-fired power station to built. Completed 1986.

6 x 660 MW. Steam at 565°C. 3000 rpm.

Highlights as a metallurgist

- X-ray diffraction for stress measurement
- Validating new manufacturing processes
- Water droplet erosion protection
- Exploring titanium to replace steel blades

- Failure investigations
- Remanent life assessment

Dynamic vibration rigs, for the study of vibration behaviour of bladed wheels for the largest turbines.

Influences

- Line manager and team support
- Graduate training scheme
- Programme of research (triggered by failure)
- “Create your own luck”

Aerial view of Heaton Works, Newcastle upon Tyne.

Moving on

- Business was contracting
- My interest in green energy

University of Nottingham

Department of Mechanical Engineering

Post-doc research in composites structures and testing

Lecturer

From steam turbines to wind turbines

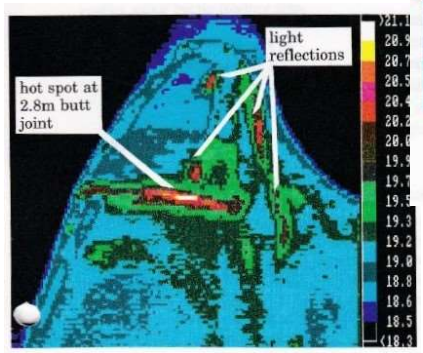
Research on non-destructive evaluation of wind blades

Glass fibre composite and wood laminate

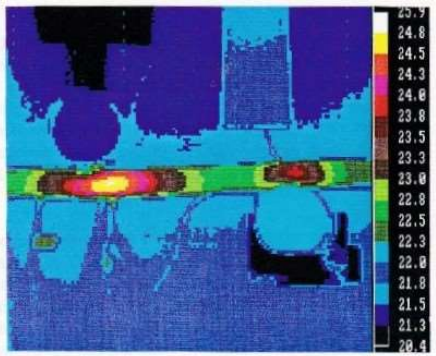
Thermographic imaging

Passive – heat difference from cyclic stress and damage growth

Active – heat applied



Full-scale khaya/epoxy wind turbine blade fatigue test :
- thermogram of butt joint at 2.8m section shortly before failure [1]

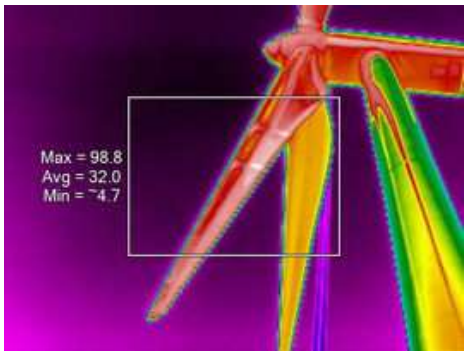


Glass/polyester three point bend fatigue test :
- thermogram showing hot spots along central delamination [2,3]

Latest developments:

Thermo inspection of operating wind turbines

- From the ground
- From drones
- Better image processing and geolocating



Influences

The attractions

- Wind energy, including BWEA conference
- A different family of materials
- University environment


Delabole Wind Farm

Moving on

- Towards full time on renewables
- Towards more direct impact
- University metrics

Career break – a year of fun

MSc in Renewable Energy Systems Technology

Loughborough University

Taught modules on wind, solar, biofuels, hydro/wave/tidal, integration

Project on access to offshore wind farms

Garrad Hassan & Partners / DNV GL

Renewable Energy Consultant Engineers

Sales and Support manager for wind farm design software

Offshore wind engineering – marine logistics, training

Software sales and support for *WindFarmer*

Wind farm design

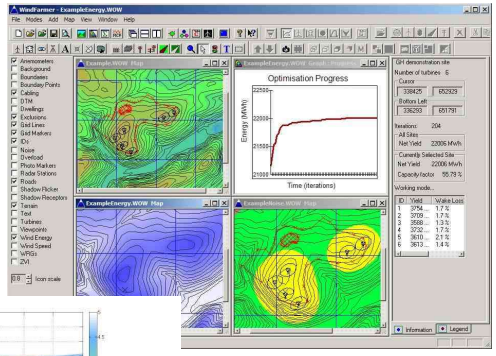
Find optimum turbine locations

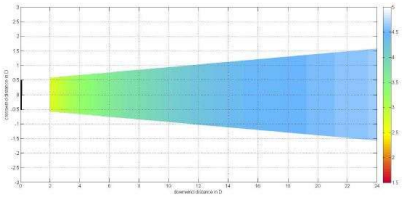
- Analyse wind statistics
- Include wake effects
- Maximise energy yield
- Minimise environmental impact

Highlights

- Coordinating sales & support team
- Running training worldwide
- Proposing and testing new features

2012, time for a change to offshore wind





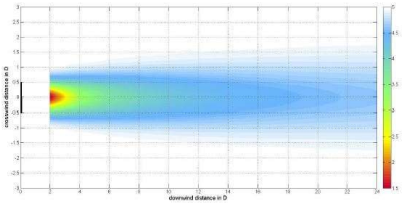
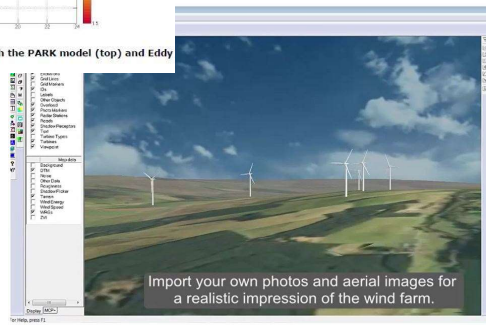


Figure 4: Wind speed behind a single turbine modelled with the PARK model (top) and Eddy Viscosity model (bottom)



Source: DNV GL WindFarmer

How to build an offshore wind farm

Hornsea One – under construction

120 km off Yorkshire coast

174 turbines, each 7 MW = 1.2 GW

Part of the 5 MW Hornsea cluster

Hornsea Project One in numbers.

Turbines

Blade length = 89 m

Tip above sea level = 190 m

For more info: http://hornseaprojectone.co.uk/

Hornsea One layout and timeline

2010 Exclusive rights won

2014 CfD power purchase won

2014 Consent awarded

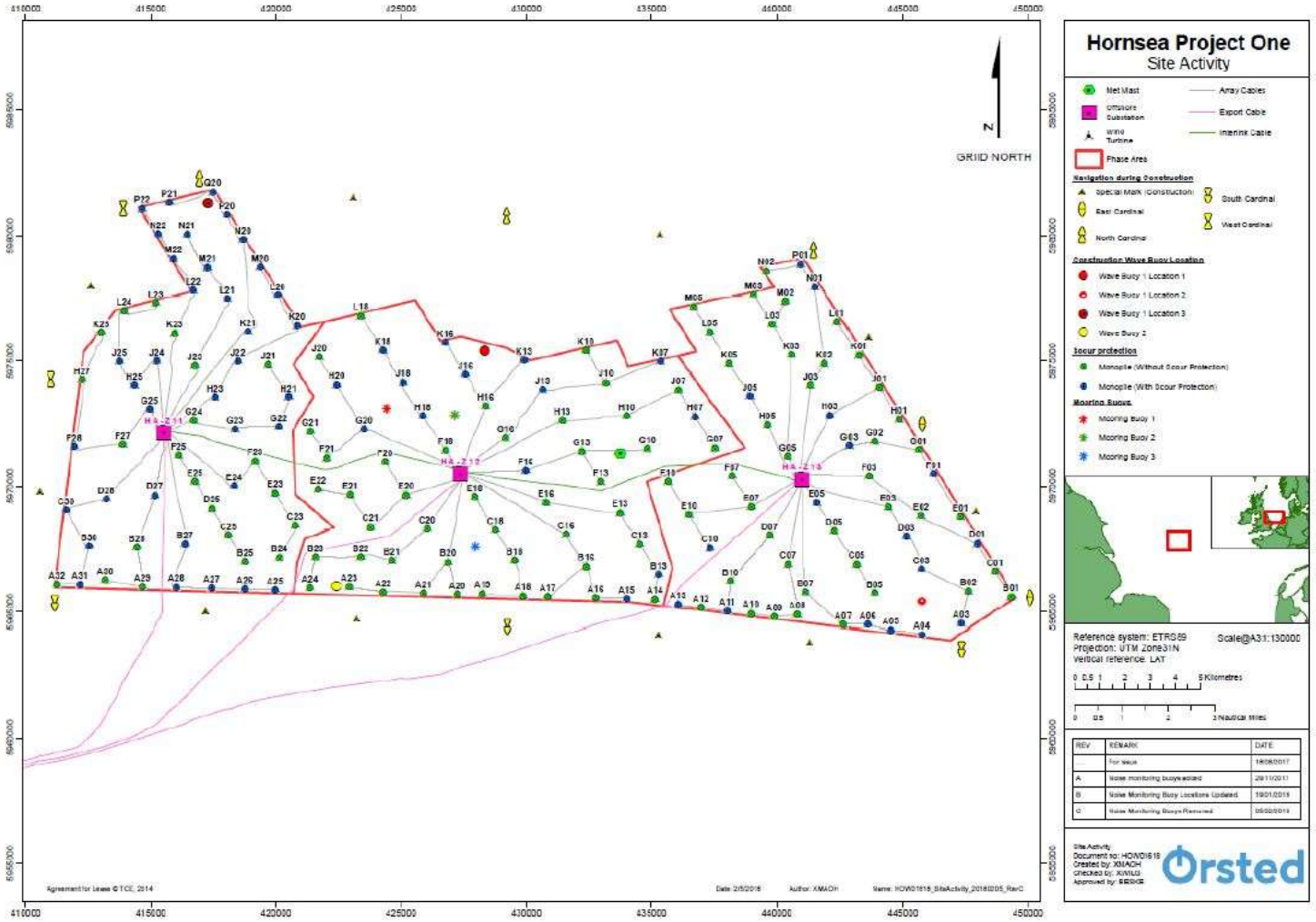
2015 Detailed surveys

2016 FID “all systems go”

Start onshore work

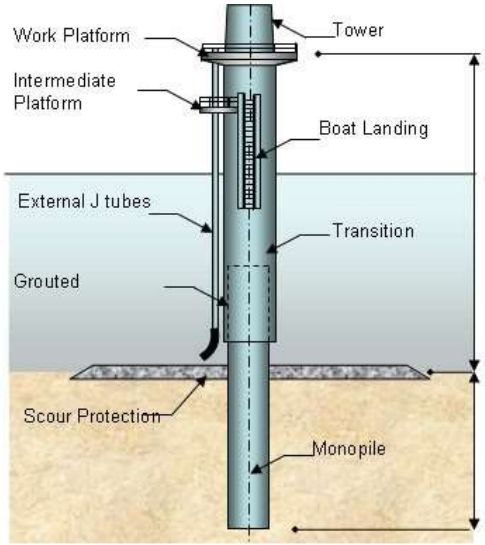
2018 Start offshore work

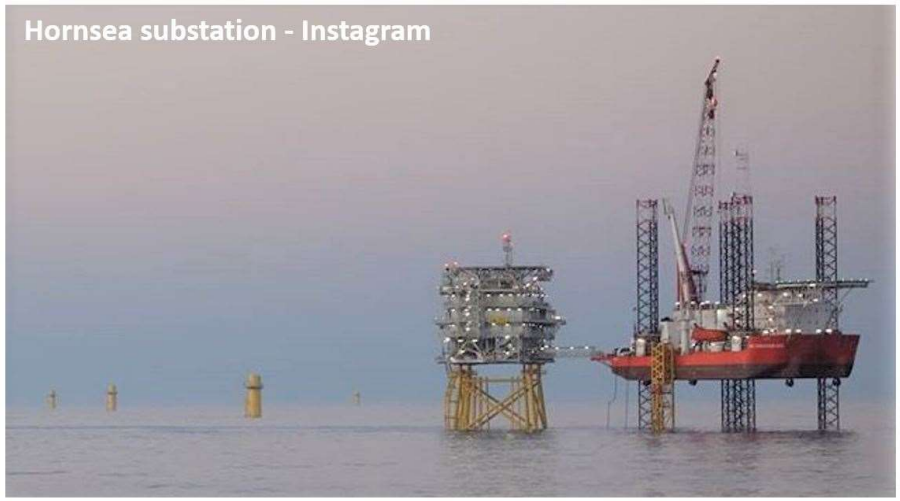
2020 Complete



Source – Notice of Marine Operations

Foundation and substation installation





Monopiles 900t, 65m long, 8.1m dia
Noise muffler during piling

Transition pieces 350t
Grouted (cemented) or bolted to MP

Offshore substations on jacket

Turbine installation

Typical jack-up for 7-8 MW turbines
Length 100 to 150 m
Width 30 to 50 m
Crane 800 t to 2000 t
Jack-up water depth 40 to 60 m
Self-propelled, Dynamic Positioning
Operate 24/7
Can cost £100,000+ per day.

Efficient logistics depends on
- Capabilities of vessel
- Port location
- Weather conditions
- Choreography

Trends in offshore turbines

Example UK offshore wind farms

Scroby Sands	2004	30 x 2 MW
London Array	2013	175 x 3.6 MW
Westermost Rough	2015	35 x 6 MW
Burbo Extension	2017	32 x 8.06 MW
Walney Extension	2018	47 x 7 MW & 40 x 8.25 MW
Hornsea One	2020	174 x 7 MW
Triton Knoll	2022?	90 x 9.5 MW

Influences

The attraction of wind energy

- Commercially mature but growing rapidly
- Being involved in a success story
- Everything is huge!

Recently announced

- 12 MW, 220 m rotor

More information on offshore wind energy

Guide to an offshore wind farm (The Crown Estate and ORE Catapult), updated 2019

Job Roles in Offshore Wind, 2017 (for Green Port Hull)

Innovation: ORE Catapult, ORE Supergen, Carbon Trust

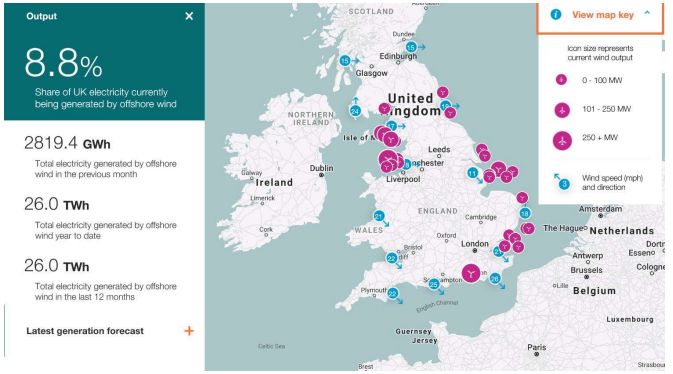
Trade bodies: RenewableUK, WindEurope

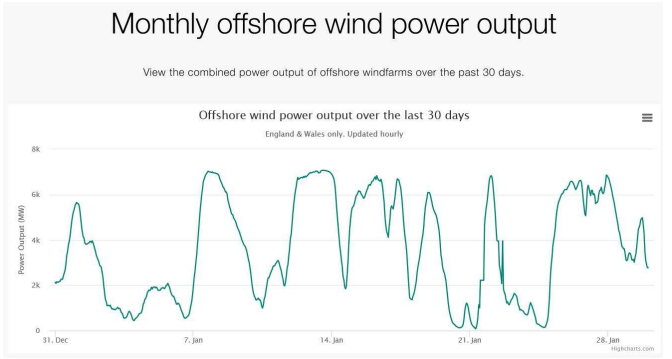
News feeds: Offshore Wind Biz; Renews; Carbon Brief

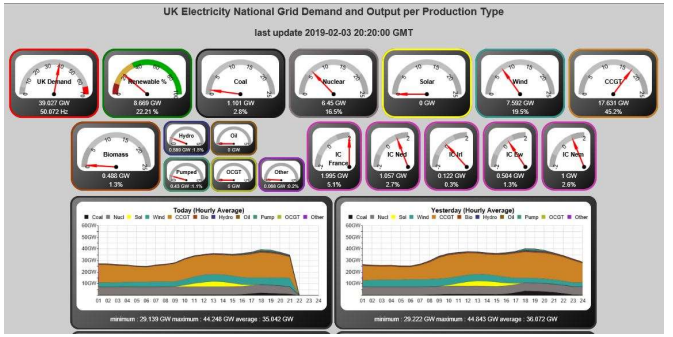
The Crown Estate – live offshore wind map

https://www.thecrownestate.co.uk/en-gb/our-places/asset-map/#tab-2

Gridwatch - http://gridwatch.co.uk/







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