

Study on the Economics of the Offshore Grid for Connection of the Round Two Wind Farms

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ECONNECT

Innovating Solutions for the Grid Integration of Renewable Energy



Agenda

- Objectives
- Methodology
 - Process
 - Costing / Design Ethos & Assumptions
- Discussion
 - Results
 - Analysis

Aim

- An assessment of the costs for connection of the Round Two Offshore Wind farms to the onshore Transmission Network

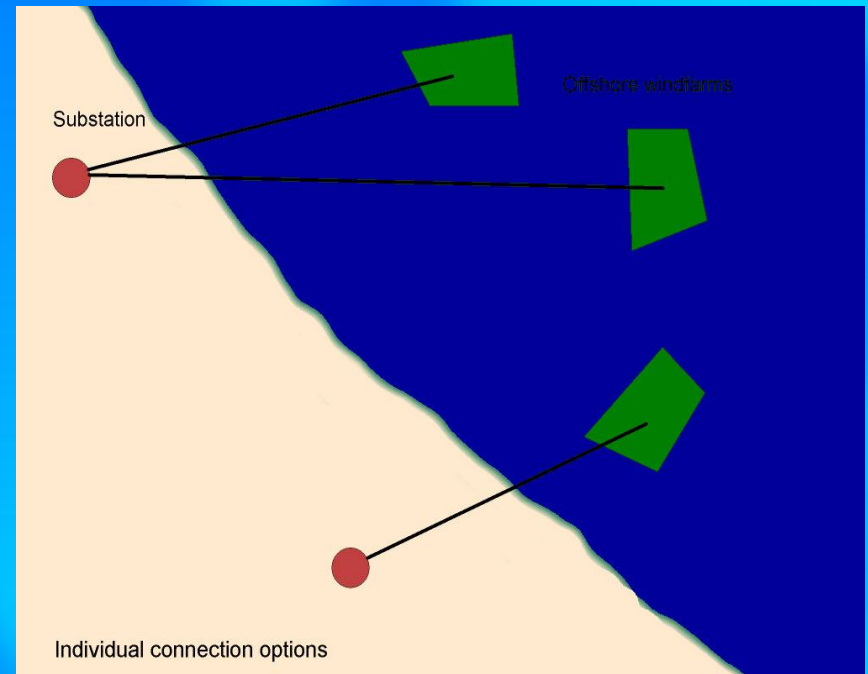


Round Two Wind farms

Round Two Project	Capacity
Thames Estuary	
London Array	1000MW
Greater Gabbard	500MW
Thanet	300MW
Gunfleet Sands 2	64MW
Greater Wash	
Triton Knoll	1200MW
Race Bank	500MW
Docking Shoal	500MW
Sheringham Shoal	315MW
Dudgeon East	300MW
Humber Gateway	300MW
Lincs	250MW
Westermost Rough	240MW
North West	
Gwynt Y Mor	750MW
West Duddon	500MW
Walney	450MW

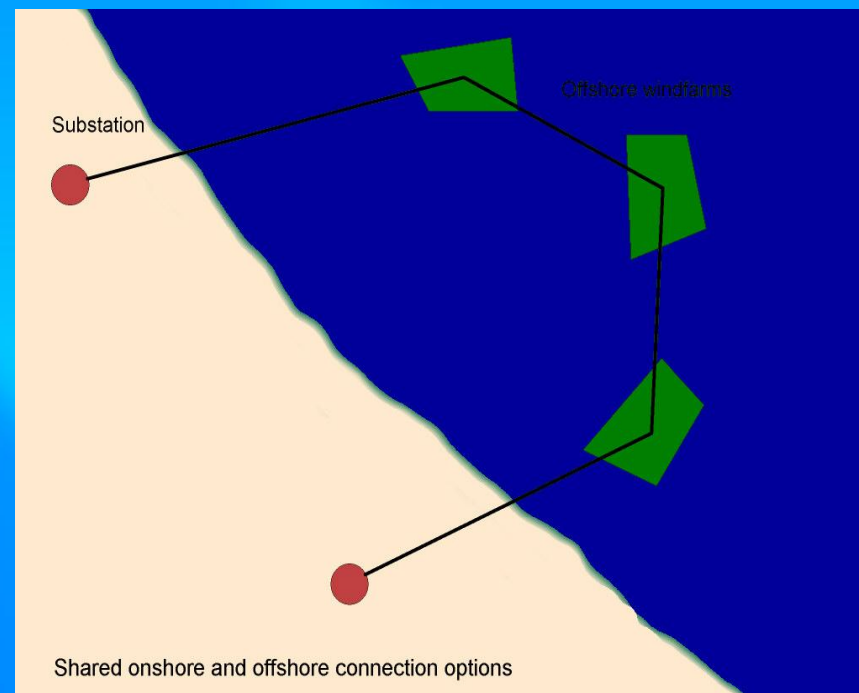
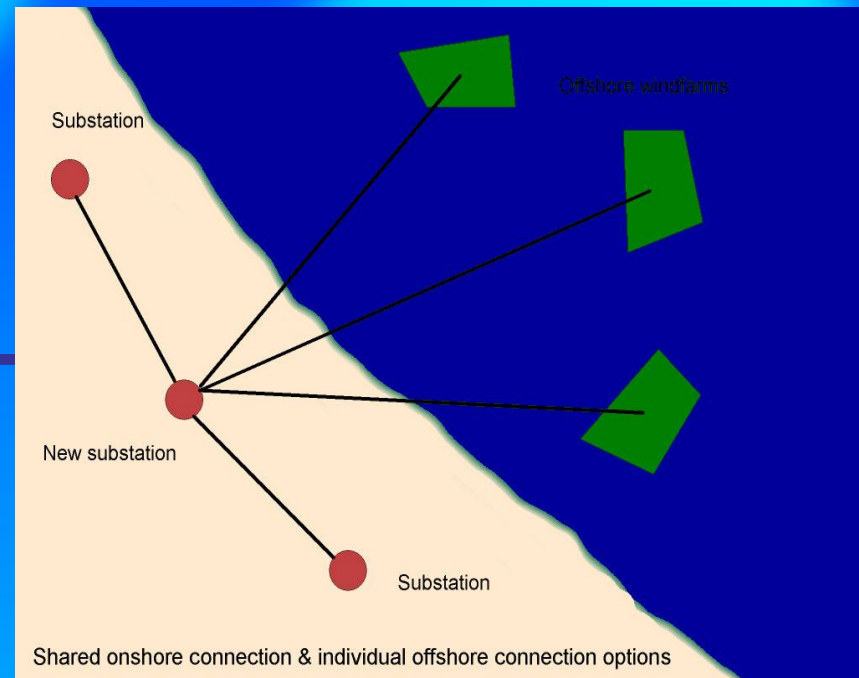
Objectives

- Determine Technical Solutions
 - Individual Connection



Objectives

- Determine Technical Solutions
 - Joint Connection
- Derive costs for these Solutions



Methodology

Two Track Process

(1) Costing

- Price Information Collation
 - Arriva / Siemens / ABB / Nexans / Pirelli / Marine Projects International
 - + Econnect Cost dBase
- Cost Spreadsheet Compilation

Costing Philosophy

- Where gaps in cost estimates
 - Nearest specification alternative substituted (Transformers)
 - Extrapolated from known cost estimate (Offshore Platforms)
- Cost estimates benchmarked where possible
 - Econnect cost data validated on North Hoyle
- Installation costs fixed for unit cable length

Costing Philosophy

- 15% capitalised Operation & Maintenance
 - Access / Adverse environment
- Contractual Risk
 - Weather / Sub-Contractor Delays
 - Econnect experience =10-20% contingency

Costing Philosophy

- Transmission Infrastructure Costs
 - Connection equipment necessary to transmit power
 - Some solutions require new Grid substation
 - For comparison these costs must be included
 - Capital costs may be borne by TO and recovered through TNUoS charges
 - Deep reinforcement of onshore network not included

Methodology

Two Track Process

(2) Design

- Consultation with Developers/Stakeholders
 - Round Two Developers / Ofgem / NGT / ENA / Crown Estate
- Individual Project Design Review Meeting
 - Individual Connection options proposed / debated / costed
 - Suitable connection points / Transmission technology / Equipment requirements

Methodology

Two Track Process

(2) Design

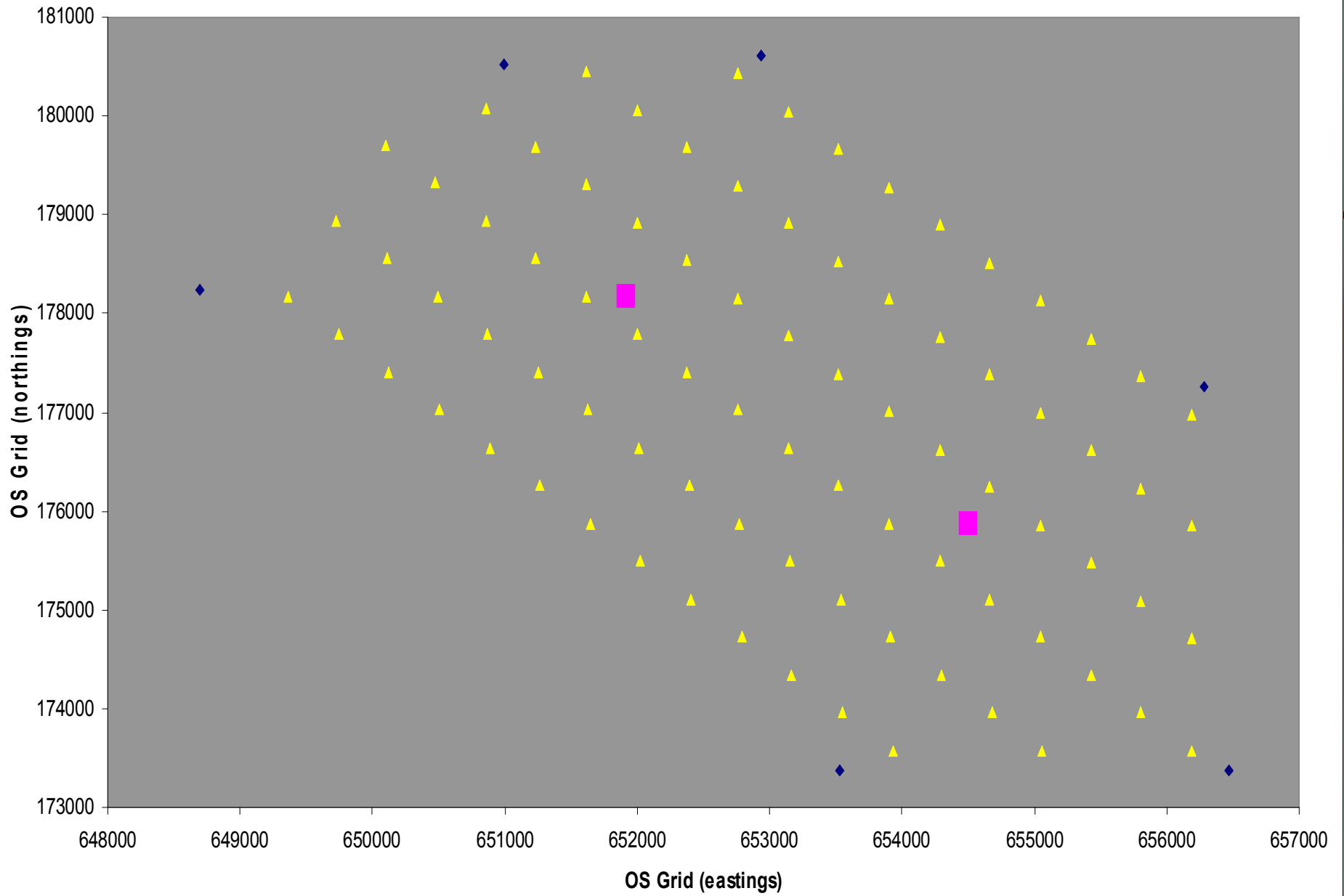
- Joint Project Design Review Meeting
 - Joint Project Connection options proposed / debated / costed
 - Suitable connection points / Transmission technology / Equipment requirements

- Connection Option Review
 - Modelling of technical parameters
 - Solutions with no technical/cost/viability advantages rejected
 - Design / Costs for remaining solutions finalised

Methodology

Design Assumptions

- Windfarm Location
 - Crown Estate / Developer long/lat co-ords converted to OS grid references
- Offshore Platform Location
 - Turbine separation / array area power density
 - Array sea area within boundary calculated
 - Platforms located to limit array collection cable lengths



Methodology

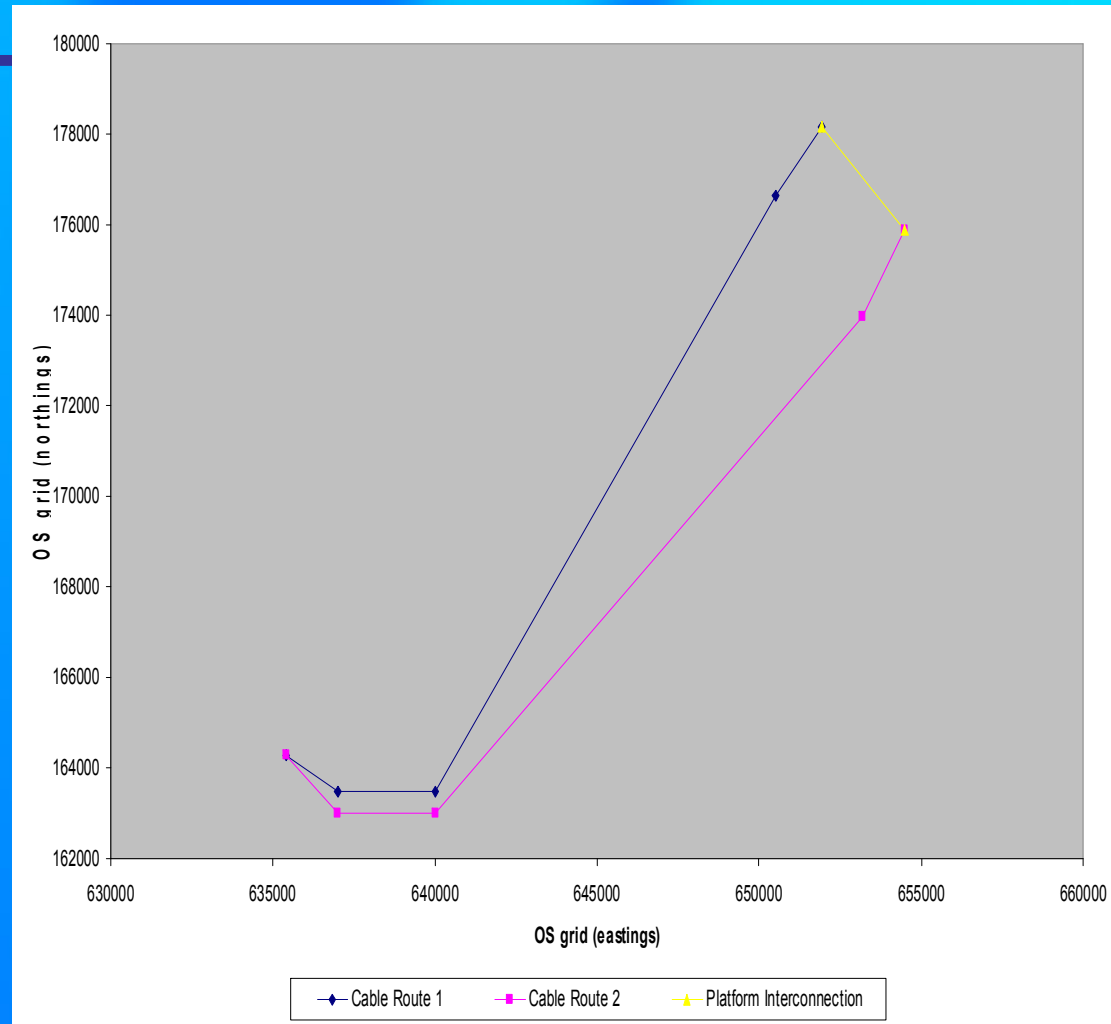
Design Assumptions

- Platform Collection Potential
 - Array cable sizing / number / losses / turbine size
 - 195MW (132kV) / 360 MW (245kV)
- Reactive Compensation
 - Determined using PSS Viper model to achieve useful power carrying capacity
- Partial Redundancy
 - Maintain ability to generate for loss of single shorelink cable
 - Windfarm capacity factor / repair time / loss of income

Methodology

Design Assumptions

- Offshore Cable Route
 - Most direct unless developer specified
 - Avoid other Round 1 and 2 wind farm sites, pipelines
 - Follow channels to ease installation
 - 'Knee' points fixed with OS Grid Ref
 - Cable lengths calculated using trigonometry
 - 10% contingency added for deviation
 - Allow Transmission of Full Capacity



Methodology

Design Assumptions

- Onshore Cable Route
 - Cable preferred to Overhead Line (planning)
 - Landfall points avoid obstacles
 - Cable route follows local roads
 - Cable lengths measured from OS maps

Methodology

Design Assumptions

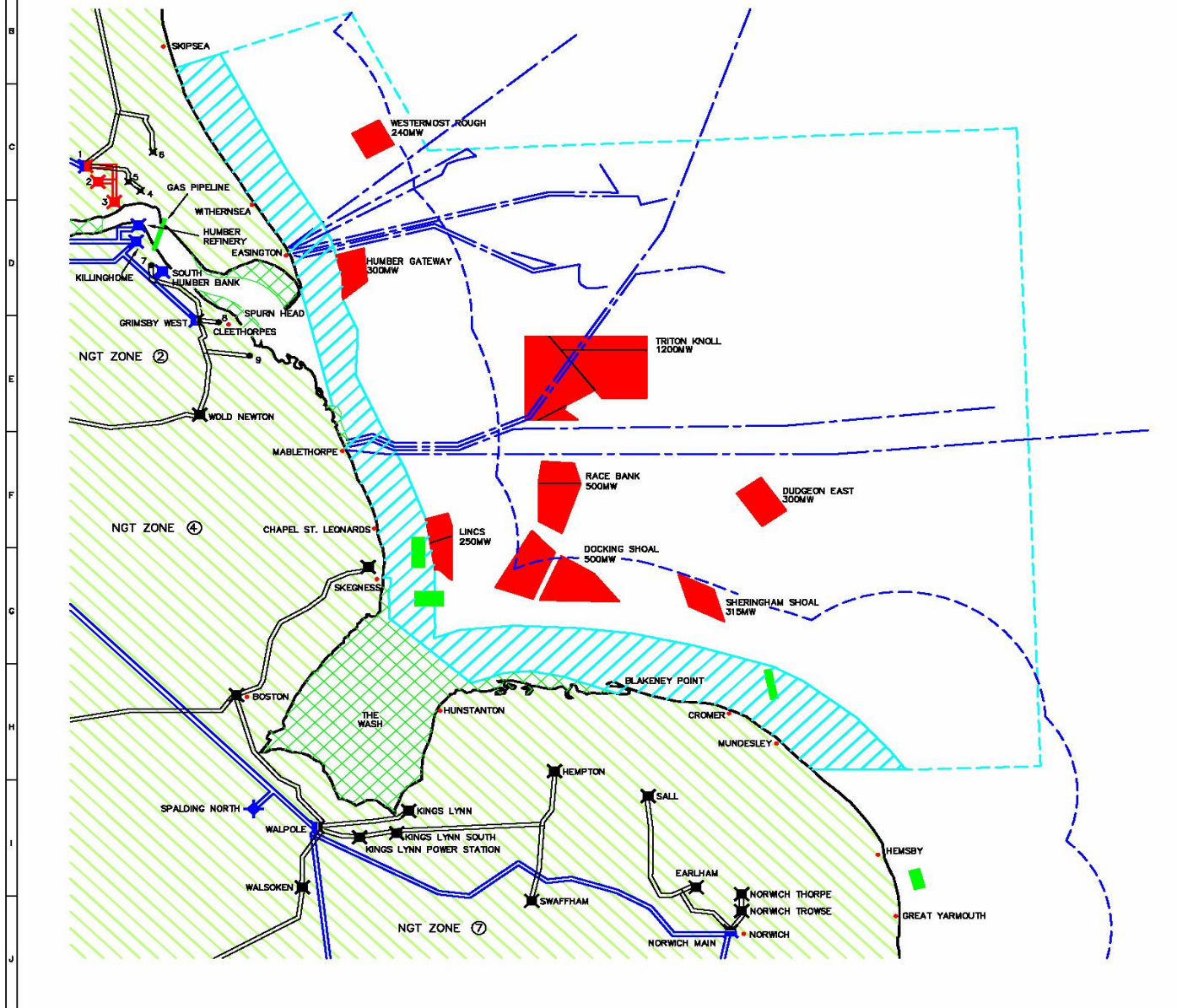
- Point of Connection (POC)

Individual














- Nearest POC with sufficient capacity that does not require significant onshore network upgrades
- Or new substation where specified by developer

Joint

- Upgrading of existing Transmission / Distribution lines & Construction of new lines also considered



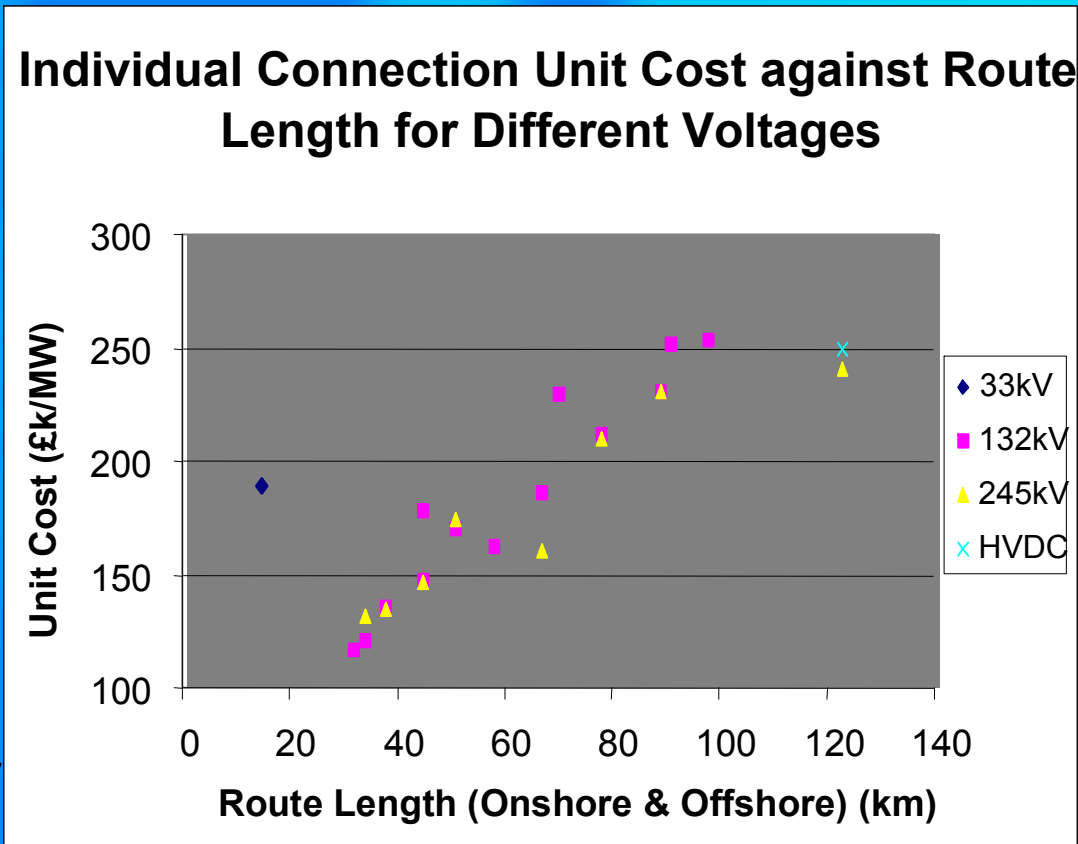
Legend

- | | | | | | |
|---|--|---|--|---|---|
|  | ROUND 1 WIND FARM SITES |  | SITE OF SPECIAL SCIENTIFIC INTEREST &/OR SPECIAL PROTECTION AREA |  | LOW CONNECTION POTENTIAL (UP TO 0.75GW) |
|  | ROUND 2 WIND FARM SITES |  | 132KV CIRCUITS (WITH SUBSTATIONS) |  | MEDIUM CONNECTION POTENTIAL (UP TO 1.5GW) |
|  | DTI EXCLUSION ZONE |  | 275KV CIRCUITS (WITH SUBSTATIONS) |  | MEDIUM CONNECTION POTENTIAL (UP TO 1.5GW) |
|  | DTI STRATEGIC ENVIRONMENTAL ASSESSMENT |  | 400KV CIRCUITS (WITH SUBSTATIONS) | | |
|  | 12 MILE LIMIT |  | SUBMARINE PIPELINE | | |

Discussion

Individual Connection Options

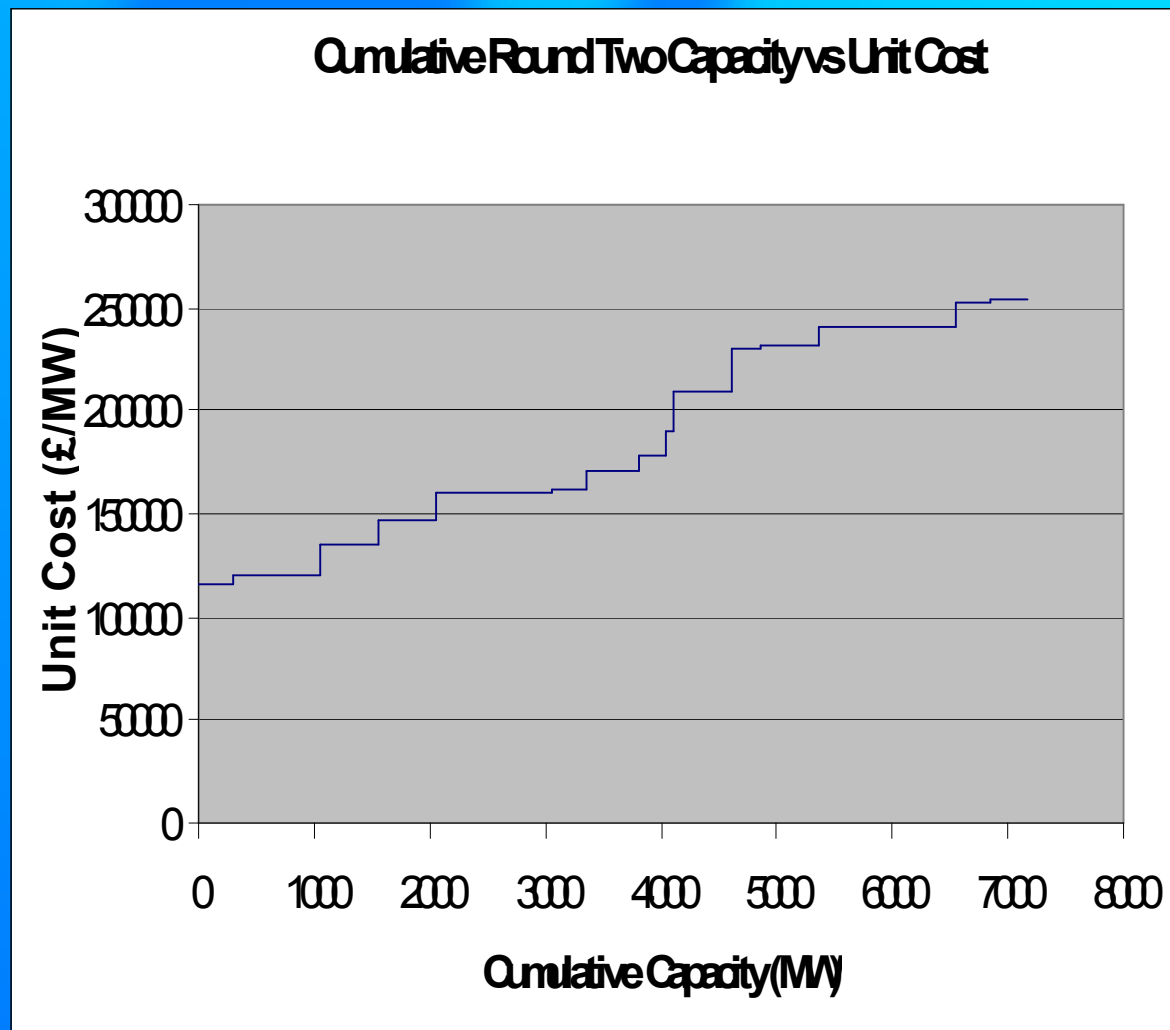
- Unit Cost Range
£115k/MW ~ £255k/MW
- Unit Cost proportional to distance
- Lower unit cost options generally have higher cable loadings (*losses*)
- HVDC only cost effective with significant distance and power transfer (e.g. Triton Knoll)



Discussion

Individual Connection Options

- 4GW of Round 2 offshore capacity available at connection cost < £200k/MW
- Large project size does not correlate with lower unit cost



Discussion

Individual Connection Options

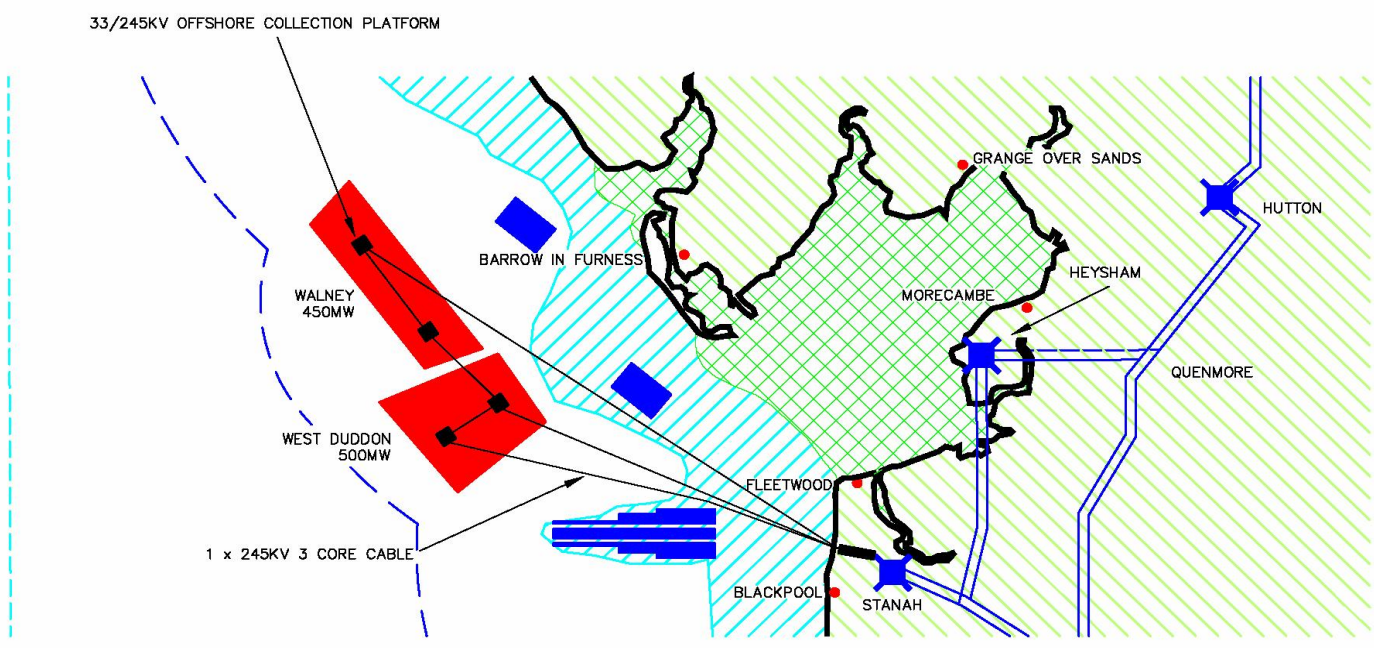
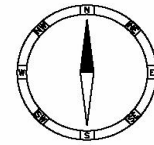
- No economies of scale due to modularity of connection assets (except with HVDC)
- But allows phased Wind farm construction
- Connection options allow transfer of full capacity – not always optimal
 - Capacity vs Cable Rating

Discussion

Joint Connection Options

North West

- *Walney / West Duddon*
 - 132kV or 245kV
 - 16% Cost savings for Joint Connection over Combined Individual Connection
 - Reduced number of shorelink cables



Notes And Legend

- ROUND 1 WIND FARM SITES
- ROUND 2 WIND FARM SITES
- DTI EXCLUSION ZONE
- SITE OF SPECIAL SCIENTIFIC INTEREST &/OR SPECIAL PROTECTION AREA
- 400KV CIRCUITS (WITH SUBSTATIONS)
- LOW CONNECTION POTENTIAL (UP TO 0.75GW)
- DTI STRATEGIC ENVIRONMENTAL ASSESSMENT
- 12 MILE LIMIT

REV	Description	By	DATE	CHK'D	APP'D
0	DRAFT ISSUE FOR CLIENTS APPROVAL	RTR	20/11/14	AO	MJD

Econnect Ltd
Energy House
19 Haugh Lane Ind Est
Heysham
Northumberland
NE46 3PU UK
Tel : 01434 813600
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Reference Drawings:	SLD No. 1312/052
Scale: N/A	Original Size A4
Title: NORTH WEST JOINT CONNECTION OPTION 1	
Client: DTI	
Dwg No. 1312/049	Rev. 0
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Joint Connection Cost £130k/MW

Combined Individual Connection Cost £153k/MW



Discussion

Joint Connection Options

Humber

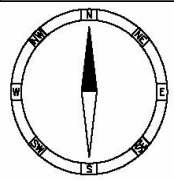
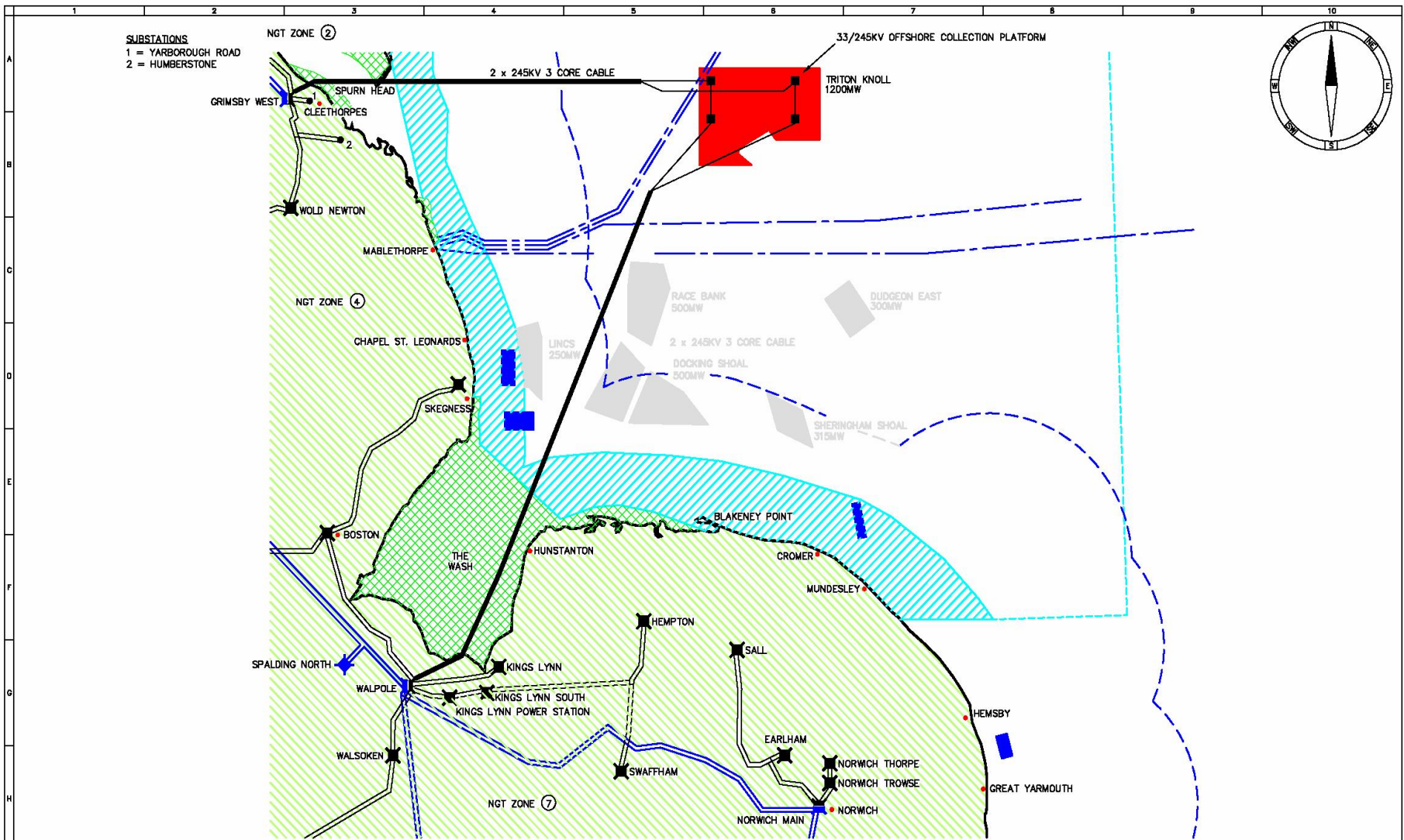
- Humber Gateway & Westermost Rough
 - 6.5% saving on Combined Individual costs if new Double Circuit 275kV Overhead Line from Creyke Beck to coastal sub
 - No saving if 275kV cable

Discussion

Joint Connection Options

Greater Wash

- Triton Knoll Interconnection
 - Grimsby West / Walpole
 - 11% Cost saving
 - Fully utilises connection assets
 - Augments Transmission Network
 - Require further study to ensure adequate power flow control through interconnection



Notes And Legend

- ROUND 1 WIND FARM SITES
- ROUND 2 WIND FARM SITES
- DTI EXCLUSION ZONE
- SITE OF SPECIAL SCIENTIFIC INTEREST &/OR SPECIAL PROTECTION AREA
- DTI STRATEGIC ENVIRONMENTAL ASSESSMENT
- 12 MILE LIMIT
- 132KV CIRCUITS (WITH SUBSTATIONS)
- 400KV CIRCUITS (WITH SUBSTATIONS)
- SUBMARINE PIPELINE
- ② LOW CONNECTION POTENTIAL (UP TO 0.75GW)
- ④ MEDIUM CONNECTION POTENTIAL (UP TO 1.5GW)
- ⑦ MEDIUM CONNECTION POTENTIAL (UP TO 1.5GW)

REV	Description	By	DATE	CHKD	APP'D
0	DRAFT ISSUE FOR CLIENT APPROVAL	RTR	28/11/24	AO	MJD

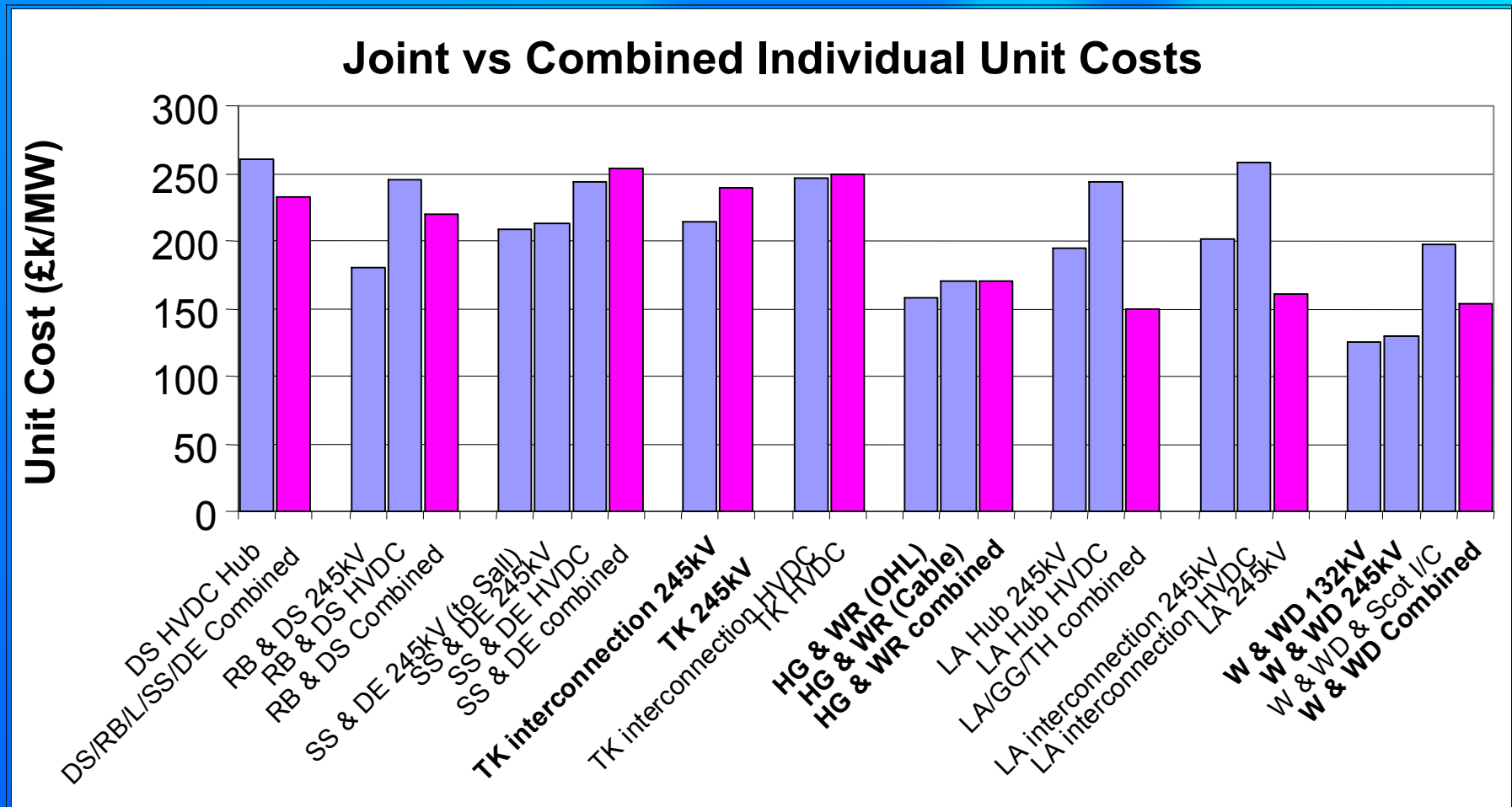


Econnect
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 Tel : 01434 813800
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Reference Drawings:	SLD No. 1312/068
Scale: N/A	Original Size NTS
Title: GREATER WASH JOINT CONNECTION OPTION 7	
Client: DTI	
Dwg No. 1312/041	Rev. 0
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Discussion

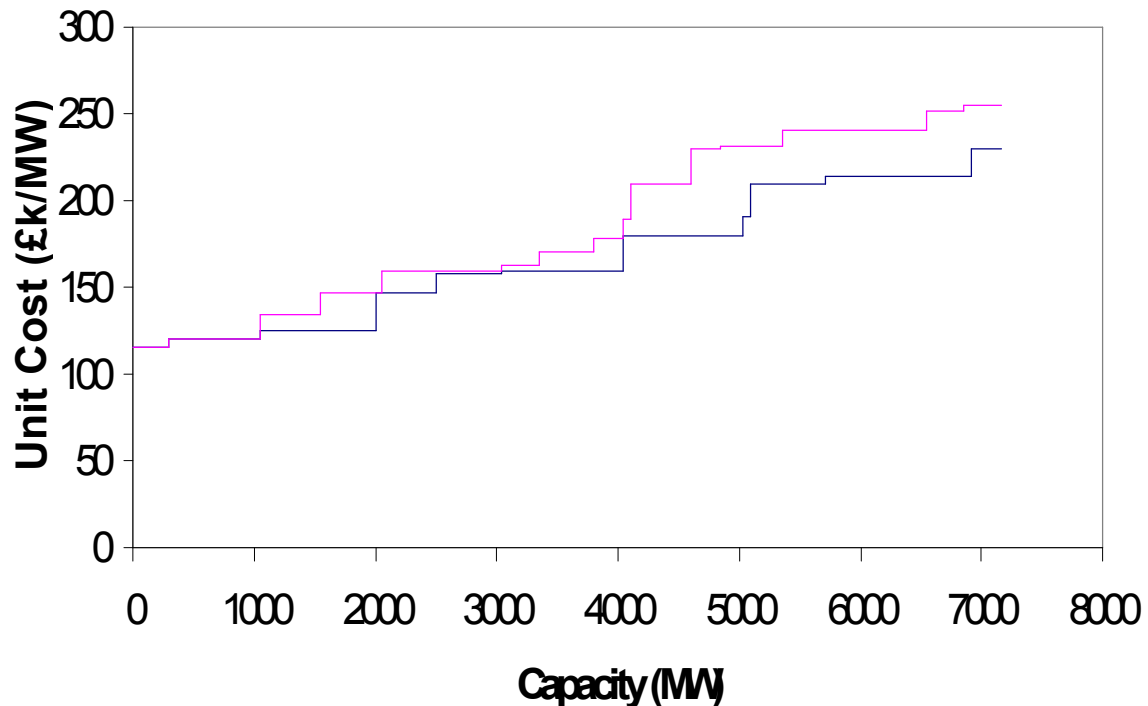
Joint Connection Options



Summary

Joint vs Individual Analysis

Round Two Capacities vs Unit Costs



Average Unit Cost falls from £185k/MW Individual to £167k/MW Hybrid

5GW now connected for £200k/MW Unit Cost

Generally due to reduced shorelink cable requirements or where OHL specified onshore

Summary

Risks / Sensitivities

- **Generic Designs**
 - Consistent methodology to allow Individual vs Joint connection comparison – NOT detailed design
- **Contract Risk / Cost Breakthroughs**
 - New Technologies (245kV)
- **Seabed conditions for cable burial**
 - Cable Lengths
- **Environmental Restrictions**
 - Number of cables through Wash
 - Twelve 132kV & Four 245kV

Summary

Risks / Sensitivities

- Impact of Losses
 - May not be optimal to run cables close to thermal ratings / value of lost energy
 - Location of metering
- Impact of Partial Redundancy
- Charging
 - Who pays for the assets

