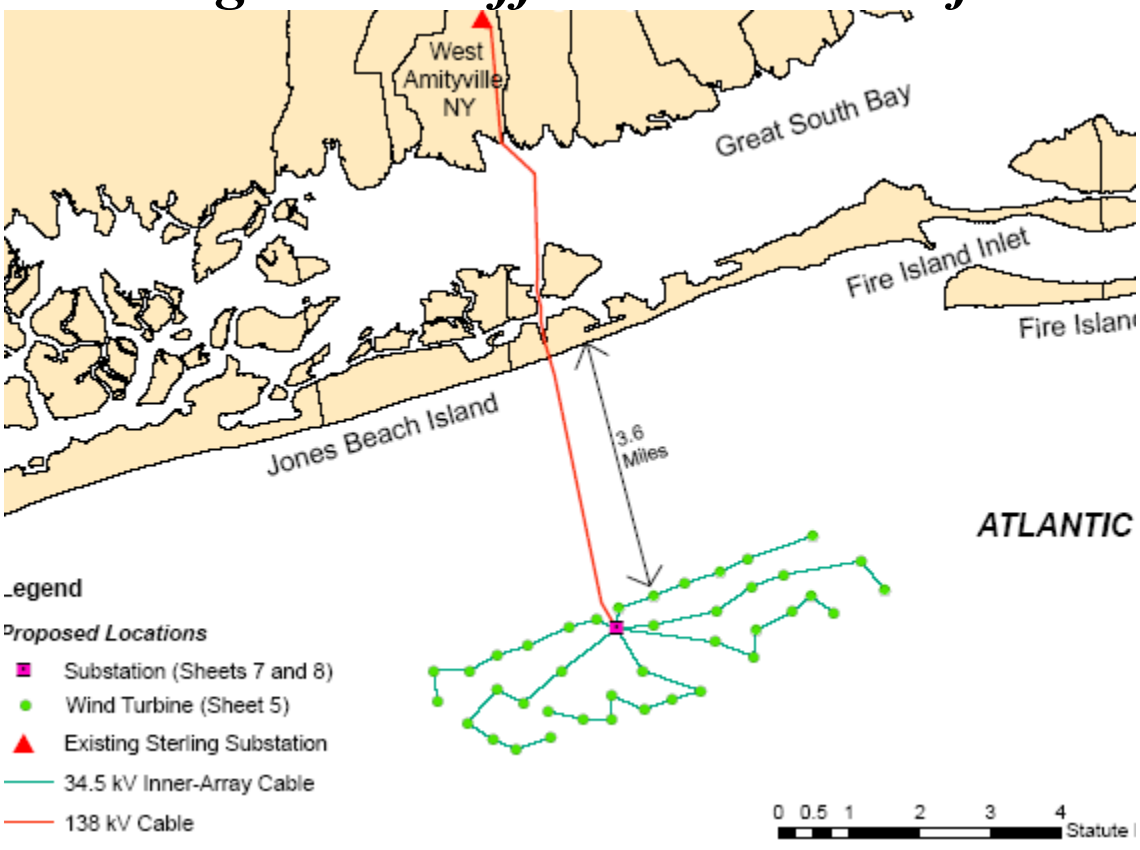
View from Jones Beach - Field 6

Town of Babylon Cost Accounting:

Long Island Offshore Wind Project



Steve Bellone, Supervisor **Dorian Dale, Energy Director**

Babylon's Cost Accounting: Long Island Offshore Wind Project (LIOWP) relied, for the most part, on open source data, integrated with proprietary market data and on-going exchanges with industry sources. The principle costing model was the "**Study of the Costs of Offshore Wind Generation"** by Offshore Design Engineering (ODE) Ltd commissioned by the United Kingdom's Department of Trade & Industry (DTI) and the Renewables Advisory Board which was issued at the beginning of this year, 2007. This study was modeled on a 30-windmill offshore project using 3.6MW turbines, thus providing an evaluation of LIOWP extrapolated by a factor x1.33. Other data referenced was based on both total project cost, from Douglas Westwood Ltd, a business researcher and market modeler specializing in renewable energy, and cost-per-megawatt estimates, published by the International Energy Agency (IEA) and Denmark's RISO National Laboratory, which had to be adjusted based upon the year it was generated. Note that all these are primary sources providing support and evaluation services for wind generation.

It is relatively simple matter to derive thumbnail estimates. Average, for example, the capital cost provided by the IEA (http://www.iea.org/textbase/papers/2005/offshore.pdf p14, below) of two Danish projects, Horns Rev and Nysted, completed in 2003, adjust for the megawatt (MW) differential and derive the '03 equivalent cost LIOWP: $343.5 million. Given that, "*turbines themselves have increased in cost by up to 60% over the last 4 years and on one project increased by 30% during the project development phase*(DTI/ODE)," it is not unreasonable to apply a 10%/yr inflation rate, considering that ODE projects capital expense (CAPEX) increases of 12% in '07-'08 and 17% in '09-'10. Extrapolating at 10% to a projected commissioning date of 2010 for LIOWP, the project total would be $669,380,000.

Table 3.1 Published total technical capital costs for offshore wind farms

Project name	Rated power (MW)	Date installed	Capital cost (€M)	Specific capital cost (€M/MW)
Horns Rev[3]	160.00	2001-03[5]	300.00	1.9
Samsoe	23.00	2002-03	35.00	1.5
North Hoyle	60.00	2003[5]	105.70	1.8
Nysted	158.40	2003[5]	268.80	1.7

Nysted

Location: Danish Baltic
Wind farm rating: 166MW
Wind turbines: 72 Bonus 2.3MW

Status: Start-up of operations 2003

Picture courtesy: Energi E2 A/S

Take as another simple thumbnail, estimates from Denmark's RISO National Laboratory [http://www.ieawind.org/GWEC_PDF/GWEC%20UK_DK%20presentation.pdf, p22]. Total installed costs of existing operational projects for North Sea was typically £1.22M to £1.36 {$2.4-2.68/MW}. Estimates for remaining planned projects range from £1.55 to £1.85M/MW {$3.05-$3.64/MW}. Split the difference between those last two numbers, average the completion dates, apply the 10% CAPEX rate inflation and the LIOWP equivalent comes up at $468,300,000 two years before its best case scenario completion date. By 2010, this approach would peg the total CAPEX at $566,643,000.

The turbine sector is particularly uncertain. The British Wind Energy Association (BWEA) reported in "Offshore Wind: At a Crossroads," April, 2006 that "for onshore projects, turbine prices have risen 10-20% in the last two years…. The growth of the UK offshore market between 2009 and 2012 will be limited by turbine availability." ODE reports "at current rates, a turbine ordered from a major supplier during 2006 is unlikely to be delivered before the end of 2008." One developer reported to us that they were obliged to go with 2.5MW turbines from Clipper when GE withdrew its 3.6MW and the backorder of Siemens 3.6MW proved preclusive. LIOWP was based on 40 3.6MW turbines. We were also informed that there are only two jack-up vessel that are equipped to install these turbines and they are booked for well over two years. Then there is the pressure Asia is putting on the supply chain. ODE reports that, "current difficulties regarding turbine supply, cable prices, steel prices, consent delays and the installation costs make projects marginal at best and is reflected by the sale of projects from one developer to another." BWEA reports that, "there is a general (but not universal) consensus amongst developers that there is an economics gap equivalent to up to around 25% of installed project cost [http://www.bwea.com/pdf/OffshoreWindAtCrossroads.pdf p3]," rendering European offshore wind untenable without substantial government support.

Table 1. National average wind farm load factors achieved in the UK during the last two Office of Gas and Electricity Markets (Ofgem) periods

Load factor in UK	England	Scotland	Wales
First ROC period, April 2002–March 2003	24·0%	25·5%	23·4%
Second ROC period, April 2003–March 2004	23·8%	25·6%	23·9%

ROC, renewables obligation certificate

This same BWEA report states that "the industry is only now starting to build up a picture of the real costs of operations and maintenance. Operational costs for early projects have frequently exceeded original estimates, mainly as a result of unexpected levels of component failure (p4)." BWEA further notes the problem of tying up "vessels suitable for installation of large turbines with maintenance activities (p8)." The main concern with the regards to maintenance work is the high cost involved with access to the turbines for maintenance and inspections. Furthermore the maintenance can only be conducted during the right weather conditions, rendering turbines unproductive for days. While onshore O&M has been reported at 2%, North Hoyle reported a 3.6% rate and insurance rates at seven times onshore [www.dti.gov.uk/files/file32844.pdf, p1]. Without gaining a realistic estimate of total CAPEX, one is unlikely to come up with useful projections of operating expenses (OPEX) and, thus, credible cost-per-kilowatt/hour (kW/hr).

View from Gilgo Beach

The Babylon Cost Accounting: Long Island Offshore Wind Project delved into considerable detail and opted for conservative measures. We might have, for example, simply taken a thumbnail projection based upon project costs from two Danish projects and gone with a total of over $669 million for LIOWP. Instead we submit two scenarios, one ultra-conservative and the other conservative.

Applying a conservative CAPEX inflation rate of 10% combined with the lower turbine expense from Douglas Westwood Ltd (DWL), the total for LIOWP completed in 2010 would be $474,059,369. Applying the lower DWL turbine price and ODE's CAPEX inflation rate of 12% for '07-'08 and 17% for '09-'10*, the total comes to **$556,117,808**. Utilizing DTI's reported UK offshore load capacity for '04-'05 of approximately 26% (http://www.dtistats.net/energystats/dukes7_4.xls), a completed LIOWP would cost anywhere from $13.5M/MW to $15.9M/MW. Utilizing LIPA's best case load capacity of 35% and the result is $9.7-12.7M/MW. Given multiple uncertainties, it is unlikely that LIOWP would, in fact, be completed by 2010. Delayed to 2011, ODE's rate would peg the LIOWP total at $637,862,065.

LIOWP: *10% CAPEX*	**LIOWP:** *ODE CAPEX*
'06- $323,861,284	'06- $323,861,284
'07- $356,247,412	'07- $362,724,638
'08- $391,872,153	'08- $407,251,595
'09- $431,059,369	'09- $475,314,365
'10- $474,059,369	**'10- 556,117,808**
'11- $521,581,836	'11- $637,862,065

<u>CONCLUSION</u>: It is conceivable that, given countervailing factors like equipment availability, LIOWP could run as high $669 million, as extrapolated from the International Energy Agency data or ODE's turbine costs. This cost accounting opts to draw upon conservative, credibly sourced data to conclude that the CAPEX for the Long Island Offshore Wind Project, if completed in 2010, comes in at over $556 million.

LIOWP: ***ACTIVITY***	**note**	***2006 COST***	**time**
Consenting Phase			
Scoping	ode-1	$ 292,500	80dys
Assess Grid Connection	"	$ 195,000	70dys
Environmental Statement	"	$ 909,773	250dys
Outreach	"	$ 351,000	"
Preliminary Geotechnical Surveys	"	$ 195,000	15dys
Preliminary Bathymetric Surveys	"	$ 58,500	30dys
Procure/Install Met Mast	"	$ 3,510,000	120dys
Front End Engineering	"	$ 1,949,513	250dys
Compilation/Consent	"	$ 87,500	250dys
Post Consent Geotech /3rd Party Verify	"	$ 3,242,167	
Procurement Phase			
PO-Wind Turbine Generators (3.6MW)	DWL +2yrs (ode)	$ {3,368,640@x40=} 134,745,600 $ {5,851,921@x40=} (234,077,000)	600dys
PO-Foundations (365tons@)	ode	$ {993,200@x40=} 39,728,000	180dys
PO-SCADA	"	$ 1.950,000	270dys
PO-Cables (34.5kV & 138kV)	"	$ 27,769,505	300dys
PO-Offshore Substation	"	$ 19,451,250	550dys
Installation Phase-Foundations			
Mob Vessel	"	$ 234,000	2dys
Foundation Transport	"	$ 10,968,750	
Install Foundations	"	$ 10,968,750	
Install Scour Protection	"	$ 6,581500	
Install Transition Piece, J Tubes	"	$ 10,968,750	
Installation Phase-Offshore Cables			
Plough Inter-Array Cables	"	$ 9,188,837	
Plough & Install Export Cable	"	$ 5,396,714	
Terminate Cables at Foundation	"	$ 10,530,000	
Demob Vessel	"	$ 234,000	2dys
Lay Onshore Cable	"	$ 1,186,910	
Tie-in Network		$ 50,505	100dys
Install Offshore Substation	"	$ 3,656,260	20dys
Mob/Demob Vessel	"	$ 468,000	
Wind Turbine (WTG) **Installation**			
Mob/Demob Vessel	"	$ 468,000	
WTG Transport	"	$ 3,656,250	
Install WTGs	"	$ 10,968,750	
Est. Contingency Cost	"	$ 3,900,000	
Total #1 as of 2006	DWL	**$323,861,284**	
(Alternative) as of 2006	(ODE)	**($423,192,684)**	

Reference Material:

Douglas Westwood Ltd [http://www.dw-1.com/sectors/energy/]

Location: Off Crosby, Liverpool Bay, Liverpool, UK
http://www.burbo.info/page.dsp?area=38

Status:	Construction; online-Dec/07
Capacity:	90 MW
Distance to Shore:	6.4 KM (roughly 4 miles)
Water depth:	8 Meters (26 feet)
Turbines:	Siemens
Number of Turbines:	25
Turbine type:	3.6 MW
Hub Height	
Total Height:	
Blade length:	44M
Turbine supply cost:	$69,600,000
Turbine installation cost:	$8,100,000
Foundation type:	Monopile
Manufacturer:	Sif Group B
Number of foundations:	25
Foundation supply cost:	24,830,000
Foundation installation cost:	23,910,000
Export Cable length:	22.5KM
Export cable type:	36kV
Cable Cost:	$34.5 million
Total Cost:	$193 million
Cost per turbine:	$7.7 million
Grid connection cost:	$19.3 million

Project name:	Arklow Bank, Phase 1,
Location:	Arklow Bank, off Ireland
Status:	Operational – Autumn/03
Capacity:	25.2 MW
Distance to Shore:	7 KM (roughly 4.35 miles)
Water depth:	15 Meters (roughly 50 feet)
Turbines:	GE
Number of Turbines:	7
Turbine type:	3.6 MW
Hub Height:	73.5 M (241 feet)
Total Height:	125.5 M (412 feet)
Blade length:	52 M (170 feet)
Turbine supply cost:	$16.3 million
Turbine installation cost:	$1.9 million
Foundation type:	Monopile
Manufacturer:	Sif Group BV

Number of foundations:	7
Foundation supply cost:	$5.8 million
Foundation installation cost:	$5.58 million
Export Cable length:	10KM
Export cable type:	35kV
Cable Cost:	$8.1 million
Total Cost:	$45 million
Cost per turbine:	$6.4 million
Grid connection cost:	

Project Name: Nysted Havmollepark
Location: Rodsand, Lolland, Denmark

Status:	Operational-Dec/03
Capacity:	165.6 MW
Distance to Shore:	6 KM (roughly 3.75 miles)
Water depth:	6-9 Meters (19-30feet)
Turbines:	Siemens
Number of Turbines:	72
Turbine type:	2.3 MW
Hub Height:	68.8 M (225 feet)
Total Height:	110M (360 feet)
Blade length:	41.2M (135 feet)
Turbine supply cost:	$94.9 million
Turbine installation cost:	$11.1 million
Foundation type:	Gravity Based Structure
Manufacturer:	Per Aarsleff A/S
Number of foundations:	72
Foundation supply cost:	$33.84 million
Foundation installation cost:	$32.58 million
Export Cable length:	10.5KM
Export cable type:	132kV
Cable Cost:	$47 million
Total Cost:	$262 million
Cost per turbine:	$3.6 million
Grid connection cost:	$32.8 million[1]

Facts about Horns Rev wind farm	
Item	**Data**
Wind turbine type	Vestas V80 - 2MW
Total output	160 MW
Expected annual output	600,000,000 kWh
Rotor diameter	80 m
Hub height	70 m
Weight, blade	6.5 ton
Weight, nacelle	79 ton

[1] http://www.dw-1.com/sectors/energy/

Facts about Horns Rev wind farm	
Item	**Data**
Weight, tower	160 ton
Weight, foundation	180-230 ton
Total weight per wind turbine	439-489 ton
Cut-in wind speed	4 m/s
Full power output from	13 m/s
Cut-out wind speed	25 m/s
Mean wind speed at 62 metres' height	9.7 m/s
Depth of water	6-14 m
Distance from shore	14-20 km
Distance between wind turbines	560 m
Wind farm site	20 km2
Project costs	DKK 2 billion/ EUR 270 million

http://www.vattenfall.com/www/vf_com/vf_com/365787ourxc/366203opera/555848newpo/557004biofu77761/557004biofu/index.jsp Vattenfall: 60% owner of Horns/cost= $361M('02)

Facts about Kentish Flats wind farm	
Item	**Data**
Wind turbine type (Vestas)	V90/3.0
Total output	90 MW
Expected annual output	280, 000, 000 kWh
Rotor diameter	90 m
Hub height	70 m
Weight, blade	6.6 tonne
Weight, nacelle	68 tonne
Weight, rotor	39.8 tonne
Weight, tower	108 tonne
Weight, foundation	247-292 tonne
Total weight per wind turbine	463-508 tonne
Length of monopile	38-44 m
Cut-in wind speed	4m/s
Full power output from	14 m/s
Cut-out wind speed	25 m/s
Mean wind speed at 70 meters height	8.7 m/s
Depth of water	5 m
Distance from shore	10 km
Distance between wind turbines	700 m
Wind farm site	10 km 2
Project costs (GBP)	105 million {$204.75M}>'05

http://www.vattenfall.com/www/vf_com/vf_com/365787ourxc/366203opera/555848newpo/557004biofu77761/599930kenti/index.jsp

[1]

STUDY OF THE COSTS OF OFFSHORE WIND GENERATION

A Report to the Renewables Advisory Board (RAB) & DTI

Contractor

Offshore Design Engineering (ODE) Limited

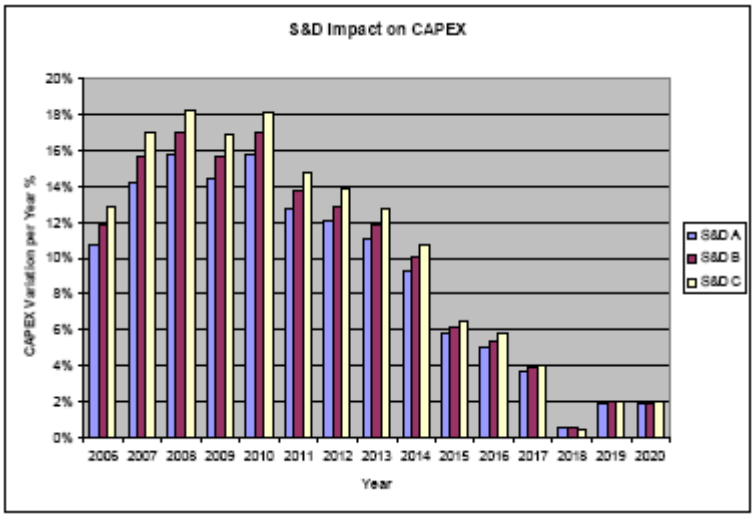
Fixed Parameters 2006

Fixed Parameters 2006		
Start Date	01/01/06	
Steel Fabrication Costs	£1,500	Tonne
Cable Costs	£270,000	km
Cable Laying Costs (Offshore)	£195,000	km
Cable Laying Costs (Onshore)	£125,000	km
Main Installation Vessel Day Rate	£75,000	Per Day
Secondary Installation Vessel Day Rate	£45,000	Per Day
Met Mast Installed Cost	£1,800,000	Each
Man Hour Cost	£60	Per Hour
Mob/De-Mob	£240,000	Rate
No days to transport each Foundation & WTG	0.5	Per Item
No of days to install foundations	1.5	Per Item
No of days to install transition piece	1.5	Per Item
No of days to install scour protection	1.5	Per Item
No of days to install turbine	1.5	Per Item
No of days to terminate cables in foundation	3.0	Per Item
Downtime	25.00%	%
Cable Lay Downtime	10.00%	%
Decommissioning Cost	£ 275,000.00	Per Turbine
Availability (Load Factor)	35.0%	%

*

Supply & Demand influence

Looking at trendline B on the graph below, the Supply and Demand (S&D) trend is predicted to inflate the CAPEX by about 12% from year 2006, this continues to rise and peaks at 17% in years 2008 and 2010 when the industry is predicted to be highly active.



Scoping Document - Forms part of ES	£150,000	**Fixed** - Team of 5 @ £50/hr for 80 days	80 days	**Fixed** - Duration from confidential **ode** source
Assess and Negotiate Grid Connection	£100,000	**Fixed** – Team of 4 @ £50/hr for 70 days	70 days	**Fixed** - Duration from confidential **ode** source
Environmental Statement	-	**Calculated** – This assumes that as the size of the Project increases there is an additional effort required for the ES, proportional to the square root of the increase in the size of the field. The baseline has been assumed as £350K for 30 turbines.	-	**Calculated** – This assumes that as the size of the Project increases there is an additional time required for the ES, proportional to the square root of the increase in the size of the field. The baseline has been assumed as 250 days for 30 turbines.
Contact Statutory Consultees	-	**Calculated** – This assumes that as the size of the Project increases there is an additional effort required for this activity proportional to the square root of the increase in the size of the field. The baseline has been assumed as £90K for 30 turbines.	-	**Calculated** – This assumes that as the size of the Project increases there is an additional time required for this activity, proportional to the square root of the increase in the size of the field. The baseline has been assumed as 250 days for 30 turbines.
Contact Non-statutory Consultees	-	**Calculated** – This assumes that as the size of the Project increases there is an additional effort required for this activity proportional to the square root of the increase in the size of the field. The baseline has been assumed as £45K for 30 turbines.	-	**Calculated** – This assumes that as the size of the Project increases there is an additional time required for this activity, proportional to the square root of the increase in the size of the field. The baseline has been assumed as 250 days for 30 turbines.
Preliminary Geotechnical/physical Surveys	£100,000	**Fixed** - From Titan Environmental Surveys Ltd webpage	15 days	**Fixed** - Estimated duration
Preliminary Bathymetric Survey	£30,000	**Fixed** - From Titan Environmental Surveys Ltd webpage	30 days	**Fixed** - Estimated duration
Procure & Install Met Mast	-	**Calculated** - Based on number of met masts with fixed cost of £1.8M per installed mast. From internet - SLP won £3.2M contract for EPIC of 2 met masts at Shell Flat and Docking Shoal & Race	120 days	**Fixed** - Duration from confidential **ode** source
FEED/Development of ITT	£750,000	**Fixed** - Cost of FEED is taken from confidential **ode** source.	250 days	**Fixed** - Duration from confidential **ode** source

Procurement Phase	-	**Calculated** – Sum of component parts below	-	**Calculated** – Based on difference between start date of first item and end date of last item
PO for WTG (WTGS + Blades + Tower)	-	**Calculated** – Based on trend line based on current market costs of turbine sizes	600 days	**Fixed** - Assumed duration, based on current lead times for turbines
PO for Foundations & Transition Piece	-	**Calculated** – Formula based on number of turbines (thus foundations), steel costs and foundation weight	180 days	**Fixed** - Assumed duration, based on current lead times for foundations
PO for SCADA	£1,000,000	**Fixed** - Cost is taken from confidential **ode** source.	270 days	**Fixed** - Assumed duration, based on current lead-time for SCADA systems.
PO for Cables (onshore and offshore)	-	**Calculated** – Based on £195/m material cost (information garnered from developers) and total onshore and offshore cable lengths.	300 days	**Fixed** - Assumed duration, based on current lead-time for cables.
PO for Onshore Substation	-	**Calculated** – Based on number of substations required multiplied by a fixed cost of £3M per substation (this is based on information from developers).	300 days	**Fixed** - Durations based on information from developers.
PO for Offshore Substation	-	**Calculated** – Based on number of substations required multiplied by a fixed cost of £7.5M per substation (this is based on information from developers).	550 days	**Fixed** - Durations based on information from developers.

Foundations	-	**Calculated** – Sum of component parts below	-	**Calculated** – Based on difference between start date of first item and end date of last item
Mob Vessel	£120,000	**Fixed** - Cost is taken from confidential **ode** source.	2 days	**Fixed** - Duration from confidential **ode** source
Foundation transport	-	**Calculated** – Number of foundations x installation vessel day rate (£75K/day – taken from Ref #19) x number of days transport per foundation (0.5 days/foundation – based on assumed boat speed and estimated distance from shore) + 25% weather downtime.	-	**Calculated** – Number of foundations x number of days transport per foundation (0.5 days/foundation – based on assumed boat speed and estimated distance from shore) + 25% weather downtime
Install Foundations (Q2 earliest)	-	**Calculated** – Number of foundations x installation vessel day rate (£75K/day – taken from Ref #19) x number of days to install foundation (1.5 days/foundation – based on information from installation contractors) + 25% weather downtime.	-	**Calculated** – Number of foundations x number of days to install foundation (1.5 days/foundation – based on information from installation contractors) + 25% weather downtime
Install Scour Protection (Q2 earliest)	-	**Calculated** – Number of foundations x secondary installation vessel day rate (£45K/day – taken from Ref #19) x number of days to install scour protection (1.5 days/foundation – based on information from **ode** Installation Vessel Report) + 25% weather downtime.	-	**Calculated** – Number of foundations x number of days to install foundation (1.5 days/foundation – based on information from **ode** Installation Vessel Report which states 1.5 months to install scour protection for 30 turbine OWF) + 25% weather downtime
Install Transition Piece, J-Tubes & ancillaries	-	**Calculated** – Number of foundations x installation vessel day rate (£75K/day – taken from Ref #19) x number of days to install foundation (1.5 days/foundation – based on information from installation contractors) + 25% weather downtime.	-	**Calculated** – Number of foundations x number of days to install foundation (1.5 days/foundation – based on information from installation contractors) + 25% weather downtime

Offshore Cables	-	**Calculated** – Sum of component parts below	-	**Calculated** – Based on difference between start date of first item and end date of last

Plough Inter-array Cables	-	**Calculated** – Distance of inter-array cable x cable laying costs/2 (£195/m – based on information from developer) + 10% weather downtime.	-	**Calculated** – Related to number of wind turbines. Doubling the number of turbines will not double duration as calculation is to power 0.5.
Plough and Install Export Cables	-	**Calculated** – Distance of export cable to shore x cable laying costs (£195/m – based on information from developer) + 10% weather downtime.	-	**Calculated** – Distance of export cable to shore x cable laying rate (fixed at 1.5 days per km) + 10% weather downtime
Terminate Cables at Foundations	-	**Calculated** – Number of turbines x number of days to terminate cables at each location (fixed at 3 days – based on information from developer) x secondary installation vessel day rate.	-	**Calculated** – Number of turbines x number of days to terminate cables at each location (fixed at 3 days – based on information from developer).
Shore End Pull In and Burial	£0	**Fixed** – Zero cost as included in laying.	15 days	**Fixed** – Estimated duration
Demob Vessel	£120,000	**Fixed** - Cost is taken from confidential **ode** source.	2 days	**Fixed** - Duration from confidential **ode** source
Onshore Cables/Onshore Substation	-	**Calculated** – Sum of component parts below	-	**Calculated** – Based on difference between start date of first item and end date of last item
Construct Onshore Substation	£0	**Fixed** – Zero cost as assumed included in PO.	180 days	**Fixed** - Duration from confidential **ode** source
Lay Onshore Cables	-	**Calculated** – Length of onshore cables x onshore cable laying costs (£125/m – based on information from developer) + 25% disruption downtime.	-	**Calculated**: Based on a pro-rata duration of 150 days for 10km onshore cable
Tie-in to Network	-	**Calculated** - £185K per MW of capacity. Adapted from information from ECONNECT website.	100 days	**Fixed** - Duration from confidential **ode** source
Offshore Substation	-	**Calculated** – Sum of component parts below	-	**Calculated** – Based on difference between start date of first item and end date of last item
Mob/Demob Vessel	£240,000	**Fixed** - Cost is taken from confidential **ode** source.	2 days	**Fixed** - Duration from confidential **ode** source
Install Substation	-	**Calculated** – Number of days to install substation(s) x main installation vessel day rate (£75K/day – taken from Ref #19) + 25% weather downtime	-	**Calculated** – Number of substations x number of days to install substation (fixed at 20 days – information from developer)
Connect Cables	£0	**Fixed** – Included in installation costs		**Fixed** - Duration from confidential **ode** source
WTG	-	**Calculated** – Sum of component parts below	-	**Calculated** – Based on difference between start date of first item and end date of last item
Mob Vessel	£120,000	**Fixed** - Cost is taken from confidential **ode** source.	2 days	**Fixed** - Duration from confidential **ode** source
WTG Transport	-	**Calculated** – Number of WTGS x main installation vessel day rate (£75K/day – taken from Ref #19) x number of days transport per WTGS (0.5 days/WTGS – based on assumed boat speed and estimated distance from shore) + 25% weather downtime	-	**Calculated** – Number of WTGS x number of days transport per WTGS (0.5 days/foundation – based on assumed boat speed

				and estimated distance from shore) + 25% weather downtime
Install WTG	-	**Calculated** – Number of WTGS x main installation vessel day rate (£75K/day – taken from Ref #19) x number of days to install each WTG (1.5 days/WTGS – taken from Ref #14 and Ref #19) + 25% weather downtime	-	**Calculated** – Number of WTGS x number of days to install each WTG (1.5 days/WTGS – based on information from Ref # 14, Ref #19, and experience from Round 1) + 25% weather downtime.
Demob Vessel	£120,000	**Fixed** - Cost is taken from confidential **ode** source.	2 days	**Fixed** - Duration from confidential **ode** source

Testing & Commissioning	-	**Calculated** – Sum of component parts below	-	**Calculated** – Based on difference between start date of first item and end date of last item
Commission Onshore/Offshore Substation	£0	**Fixed** – Zero cost as assumed to form part of substation PO.	30 days	**Fixed** - Duration from confidential **ode** source
Test Transmission Cables	£0	**Fixed** – Zero cost as assumed to form part of cable PO.	60 days	**Fixed** - Duration from confidential **ode** source
Commission WTG	-	**Calculated** – This assumes that as the size of the Project increases there is an additional effort required for this activity proportional to the square root of the increase in the size of the field. The baseline has been assumed as £2M for 30 turbines.	70 days	**Fixed** - Duration from confidential **ode** source
First Production from OWF	£0	**Fixed** – Zero cost	0 days	**Fixed** - Milestone, therefore zero duration

Other Costs	£2,000,000	**Fixed** – Estimated contingency cost	0 days	**Fixed** - Milestone, therefore zero duration

O&M	-	**Calculated** – Sum of component parts below, based on 23% over lifetime.	-	**Calculated** – Based on difference between start date of first item and end date of last item
O&M Activities Yr 0-5 (warranty)		This has been assumed as £1.3M per year for the first 5 years. – study data		**Fixed** – Initial 5 year period
O&M Activities Yr mid range		Assuming a mean of £1.2M pa for OPEX over the life of the field, this is the remaining sum after the first and last 5 years.		**Calculated** – Based on life of field and excludes initial and last 5 year periods.
O&M Activities Yr last 5		This has been assumed as £1.5M per year for the last 5 years		**Fixed** – Initial 5 year period

Decommissioning		**Calculated** – Sum of below	-	**Calculated** – Copy from below
Decommissioning	-	**Calculated** - Cost of decommissioning per turbine (fixed at £275,000 – based on information from developers) x number of turbines + 25% weather downtime.		**Calculated:** This is assumed as being directly proportional to the number of turbines, prorated on 150 days for 30 turbines.

Assumed Turbine Cost		
WTGS Capacity	Cost	Trended cost
2.0MW	£1,500,000	£1,426,030
2.5MW	£1,750,000	£1,836,945
3.0MW	£2,000,000	£2,247,860
3.6MW	£2,963,000	£2,740,958

Links:

http://www.clemson.edu/scies/wind/Presentation-Grimley.pdf - GE O%M

http://www.ceere.org/rerl/publications/published/2005/COW05_OWFLO.pdf - clem$on

North Hoyle: www.dti.gov.uk/files/file32843.pdf; www.dti.gov.uk/files/file32844.pdf
Scroby Sands report: www.dti.gov.uk/files/file32785.pdf

http://www.dti.gov.uk/files/file38125.pdf - ODE, Study of Offshore Costs

http://www.dtistats.net/energystats/dukes7_4.xls - load factor

http://www.ewea.org/fileadmin/ewea_documents/documents/publications/WETF/Facts_Volume_2.pdf - EWEA, "Wind Energy , The Facts – Costs & Prices", 2004

http://www.ieawind.org/GWEC_PDF/GWEC%20UK_DK%20presentation.pdf, RISO

http://www.iea.org/textbase/papers/2005/offshore.pdf - "Offshore Wind Experience"

http://www.bwea.com/pdf/OffshoreWindAtCrossroads.pdf -BWEA/BVG/Douglas-Westwood

http://www.windenergie.de/fileadmin/dokumente/statistiken/statisiken_englisch/ewea_2005statistics.pdf#search=%22wind%20power%20installed%20in%20europe%20by%20end%20of%202005%22

Exhibit A:

Main advantages

- Renewable
- Little to no emissions
- Low operating costs

Main disadvantages

- Is not a controllable source for electricity because it depends on the wind blowing, which leads to a low utilisation factor and high capital costs per kWh
- Has very high investment costs and often requires investment in new network capacity
- Requires flexible back-up capacity to generate energy when wind generation fluctuates
- Impacts the landscape and seascape

Did you know?

Vattenfall is the largest Nordic wind power generator, and one of the biggest in Europe. The 478 wind turbines in Denmark, Sweden and Finland currently generate about 870 GWh of electricity annually. With the builidng of the wind-power farm at Lillgrund in Öresund, Vattenfall will stand for 42 per cent of total Nordic wind power generation.

http://www.vattenfall.com/www/vf_com/vf_com/Gemeinsame_Inhalte/DOCUMENT/360168vatt/386254ener/P0272159.pdf