

OVERVIEW PAPER ON OFFSHORE WIND

ANKAN DATTA

SUB-GROUP 2 MEETING,

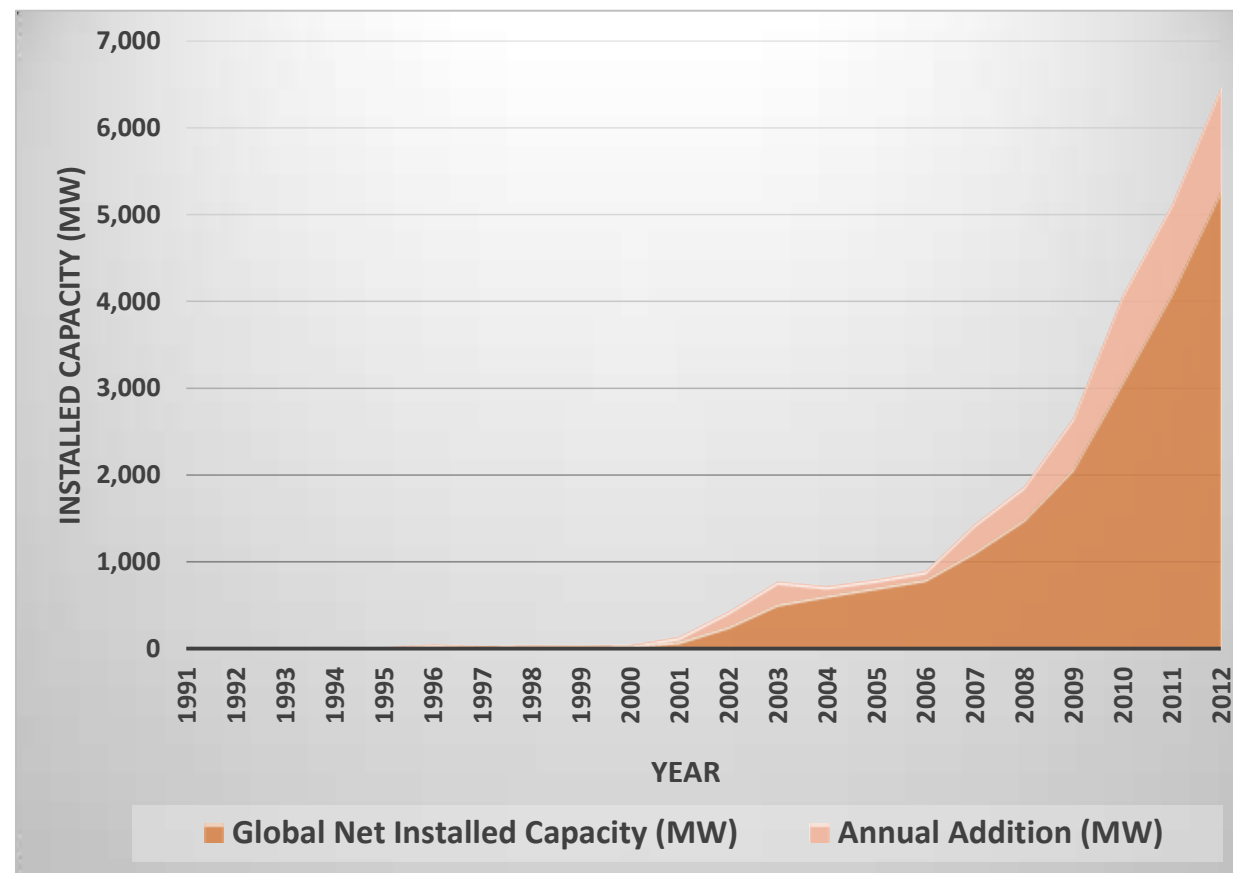
NEW DELHI, INDIA

7th MAY, 2014

GLOBAL SCENARIO AT THE END OF 2012

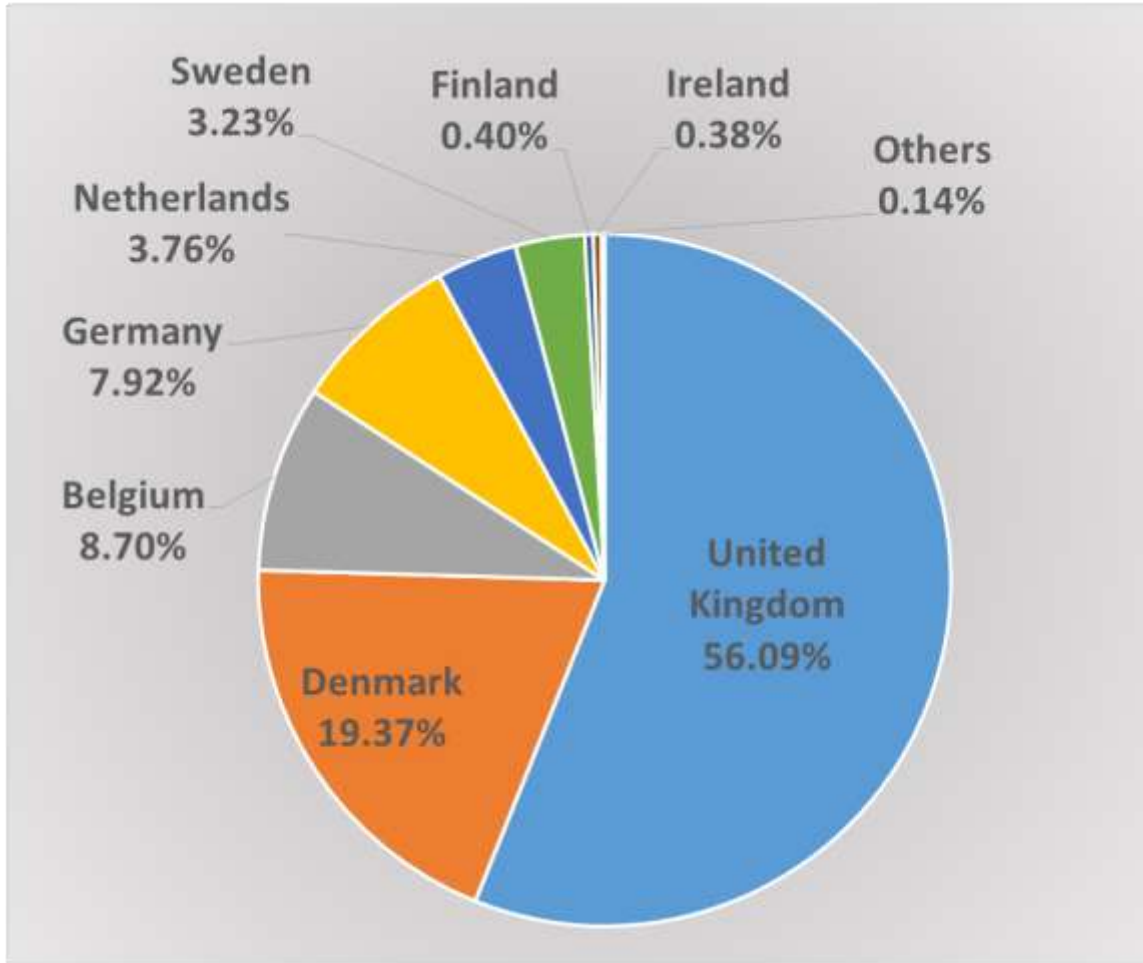
COUNTRY	TOTAL INSTALLED CAPACITY (MW)
Norway	2
Portugal	2
South Korea	5
Ireland	25
Japan	28
Finland	32
Sweden	164
Netherlands	247
Germany	286
China	365
Belgium	380
Denmark	875
United Kingdom	2874
TOTAL	5285

Source: Navigant Consulting, 2012

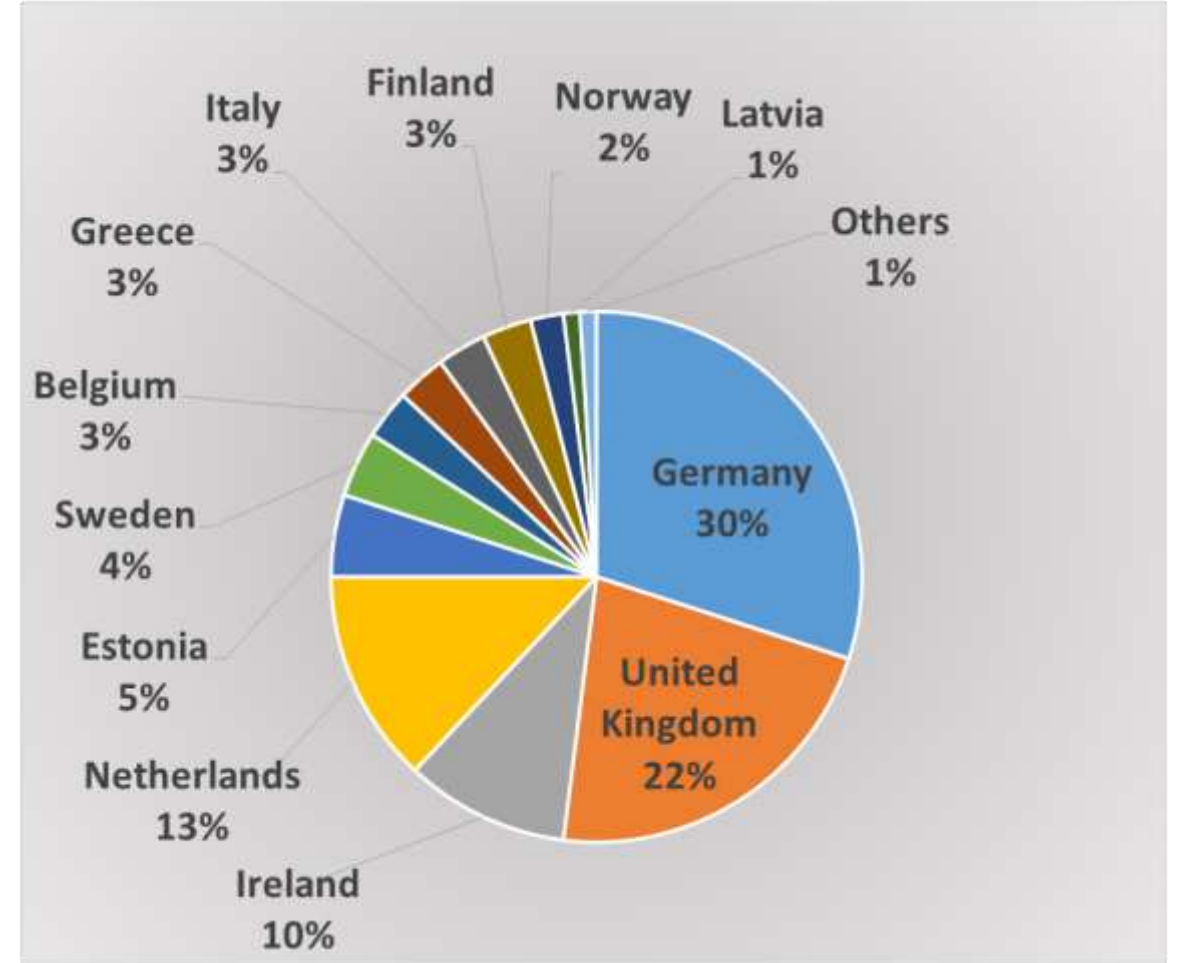


Source: Please see notes

EUROPEAN SCENARIO



TOTAL INSTALLED CAPACITY AT THE END OF 2013 – 6562 MW



CUMULATIVE CONSENTED CAPACITY – 22,000 MW

Source: European Wind Energy Association 2014

COUNTRY	NUMBER OF OFFSHORE WIND FARMS	NUMBER OF TURBINES ACROSS ALL FARMS	TOTAL INSTALLED CAPACITY (MW)	CAPACITY CONNECTED TO GRID IN 2013 (MW)	AVERAGE CAPACITY PER TURBINE (MW)
United Kingdom	23	1082	3681	733	3.40
Denmark	12	513	1271	350	2.48
Belgium	5	135	571	192	4.23
Germany	13	116	520	240	4.48
Netherlands	4	124	247	-	1.99
Sweden	6	91	212	48	2.33
Finland	2	9	26	-	2.89
Ireland	1	7	25	-	3.57
Spain	1	1	5	5	5.00
Portugal	1	1	2	-	2.00
Norway	1	1	2.3	-	2.30
TOTAL	69	2080	6562.3		

ALL COUNTRIES INCLUDED		AVERAGE SIZE OF NEW PROJECTS IN EUROPE
MEAN INSTALLED CAPACITY PER OFFSHORE WIND FARM IN EUROPE (MW)	95.11	
MEAN INSTALLED CAPACITY PER OFFSHORE WIND TURBINE IN EUROPE (MW)	3.15	2012 – 286 MW
ALL COUNTRIES EXCLUDING ONES WITH ONE PROJECT EACH		2013 – 482 MW
MEAN INSTALLED CAPACITY PER OFFSHORE WIND FARM IN EUROPE (MW)	100.43	
MEAN INSTALLED CAPACITY PER OFFSHORE WIND TURBINE IN EUROPE (MW)	3.15	

EUROPEAN MARKET SHARE OF TURBINE MANUFACTURERS AT THE END OF 2013

TURBINE MANUFACTURER	COUNTRY	TOTAL CAPACITY OF INSTALLED TURBINES (MW)	PERCENTAGE OF THE <u>TOTAL INSTALLED CAPACITY</u>	TOTAL NO. OF TURBINES INSTALLED	PERCENTAGE OF THE <u>TOTAL NO. OF TURBINES</u>
Siemens	Germany	3937	60 %	1249	60.05 %
Vestas	Denmark	1509	23 %	574	27.60 %
Senvion	Germany	525	8 %	92	4.42 %
BARD	Germany	394	6 %	80	3.85 %
WinWind	Finland	52	0.8 %	23	1.11 %
GE	USA	33	0.5 %	18	0.87 %
Others	Europe/USA	112	1.7 %	44	2.12 %
TOTAL		6562	-	2080	-

TURBINE MODELS AND SPECIFICATIONS

MANUFACTURER NAME		SIEMENS				SENVION		BARD	VESTAS		WINWIND		
COUNTRY OF ORIGIN		GERMANY				GERMANY		GERMANY	DENMARK		FINLAND		
SPECIFICATIONS	UNITS	SWT-3.6-120	SWT-4.0-120	SWT-4.0-130	SWT-6.0-154	6.2M 126	6.2M 152	BARD 5	V112-3.3 MW	V164-8.0 MW	WWD 1	WWD 3	WINWIND 3
RATED POWER	MW	3.6	4	4	6	6.15	6.15	5	3.3	8	1	3	2
CUT-IN WIND SPEED	m/s	3 – 5	3 – 5	3 – 5	3 – 5	3.5	3.5	3	3	4	3.6	4	3
CUT-OUT WIND SPEED	m/s	25	32 (applying HWRT)	32 (applying HWRT)	25	30	30	25	25	-	20	20 – 25	25
ROTOR SPEED	rpm	5 – 13	5 – 14	5 – 14	5 – 11	6.9 - 12.1	6.4 - 10.1	-	-	4.8-12.1	8 – 26	5 – 18	5 – 15
HUB HEIGHT	m	90 or site specific	90 or site specific	Site specific	Site specific	85 - 95	95 - 110	90	Site specific	Site specific	70	80/88	90/120
BLADE LENGTH	m	58.5	58.5	63.45	75	61.5	74.4	60	54.65	80	30	45/50/5 1.5/54.5	60

Source: Data sheets published by the companies and www.4coffshore.com

ALPHA VENTUS OFFSHORE WIND FARM

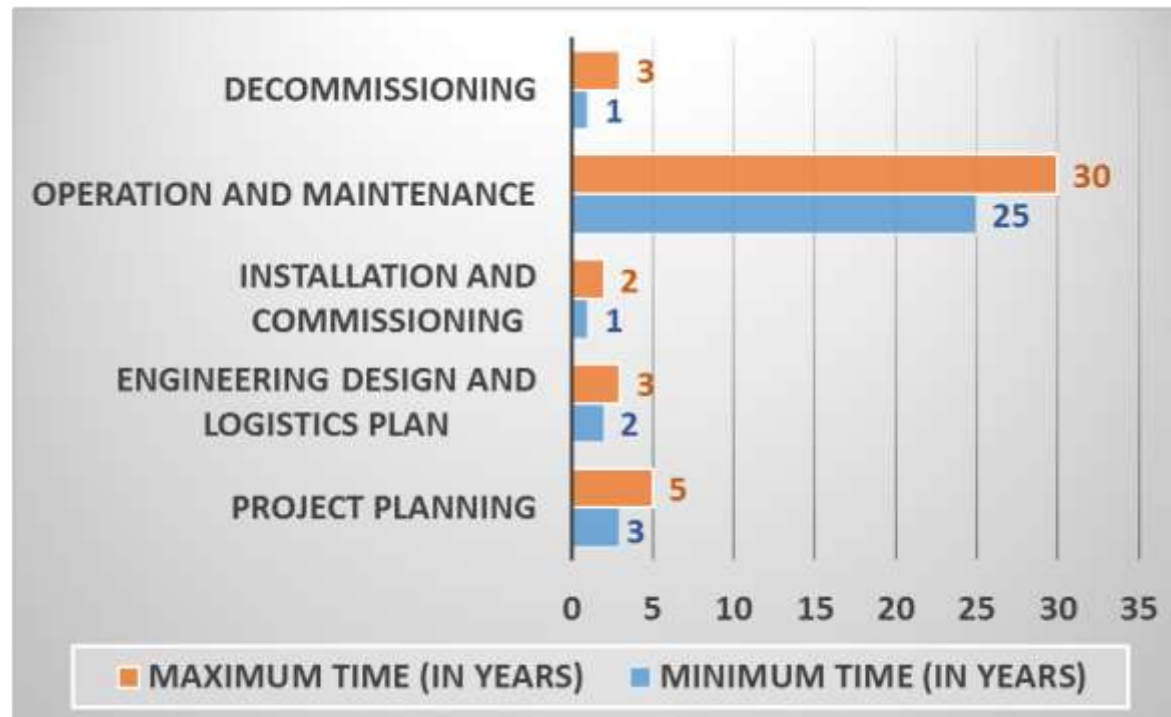
PROJECT FEATURES	TRADE-OFFs/DEVIATION FROM NORMAL
First German offshore wind plant & First terra-watt hour scale offshore project in the world	Large Commercial scale project than a smaller one to start with
	Higher than the average size of the projects in Europe
Employs multiple type of foundations – mostly jacket type	Chose jacket type over the monopiles that form about 80% of all foundations
Bathymetry of 30-45 nautical miles (~60 km) within the German EEZ with waves up to 10 metres (av. of 6-8 metres)	Very high depth while the norm is to locate farms within 30 nm
Located near the Wadden Sea World Natural Heritage site	No harm done to the nature
Two types of turbines used – 5 MW Senvion model and 5 MW Areva model	Chose the 5 MW turbines over the popular 3.6 MW ones
Power evacuation via an offshore sub-station on jacket type foundation	Very important to note that the infrastructure and the agreements for power evacuation was done long before the turbines were installed.



STAGES OF OFFSHORE WIND ENERGY PROJECT

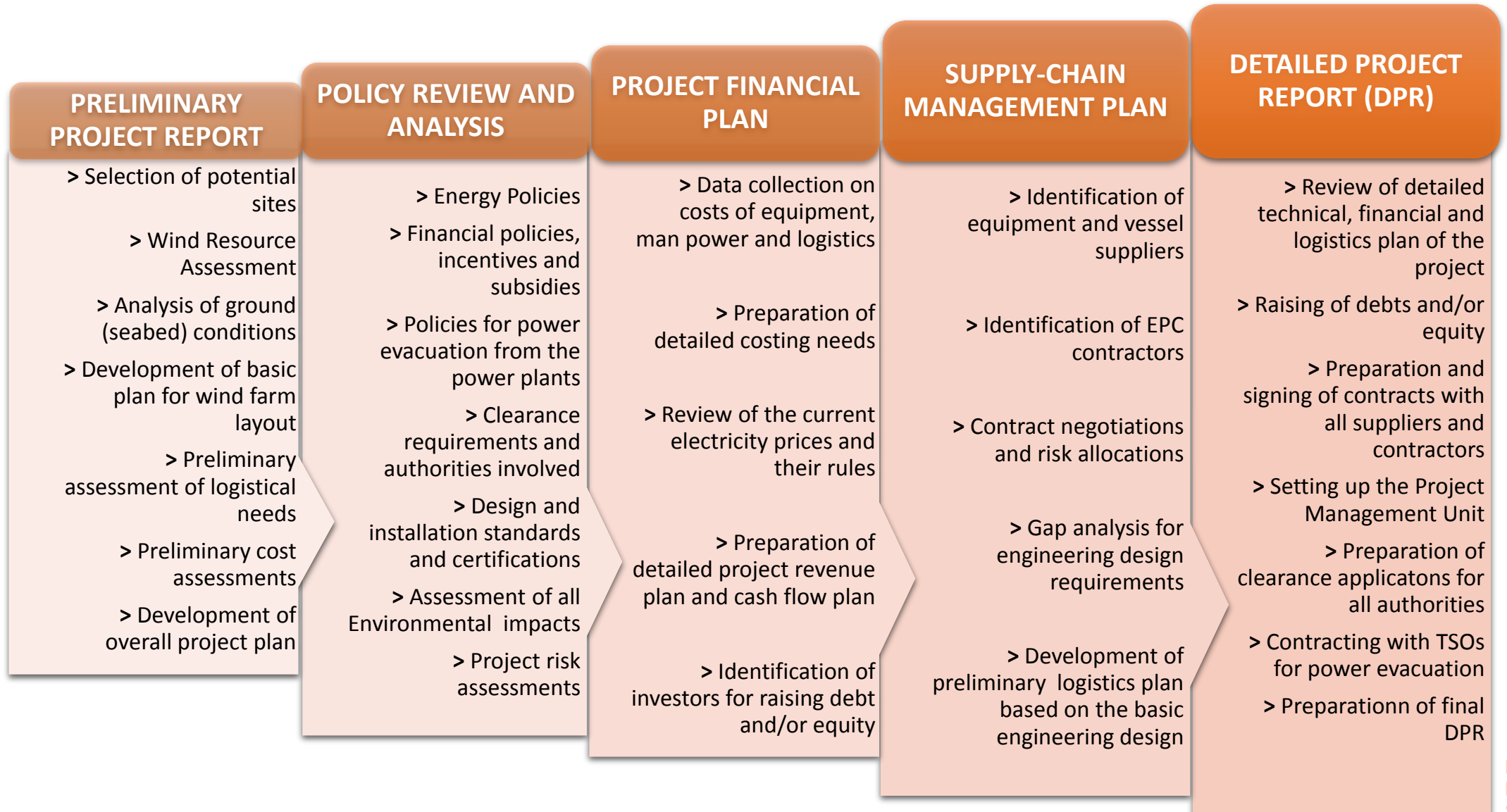


Offshore Wind Farm Life Cycle



Typical timelines of the stages in the life cycle of an Offshore Wind Farm

DETAILS OF THE PROJECT PLANNING STAGE



PROPOSED ACTIVITIES UNDER THE IGEF–SO

- Overarching study on the development of an offshore wind project in India
- One study tour of key Indian stakeholders to Germany covering the following topics:-
 - Various types of turbines, foundations and the offshore sub-stations
 - Power evacuation into the grid
 - Fabrication/Assembling facilities for foundations and turbines at the ports
 - Port infrastructure and characteristics
 - Vessel and Vessel Components involved
 - Meeting investors/project developers and/or the offshore wind association
 - Meeting with technology providers, equipment manufacturers and other stakeholders within the supply-chain management
- Exploring the possibility of associating with the FOWIND consortium on the European Union project in India – in kind support in the form of joint publications, workshops/roundtables and study tours

THANK YOU