


GLOBAL WIND ENERGY SHIPPING AND LOGISTICS

CHANGING BUSINESS MODELS FOR SHIPPING AND LOGISTICS IN OFFSHORE WIND

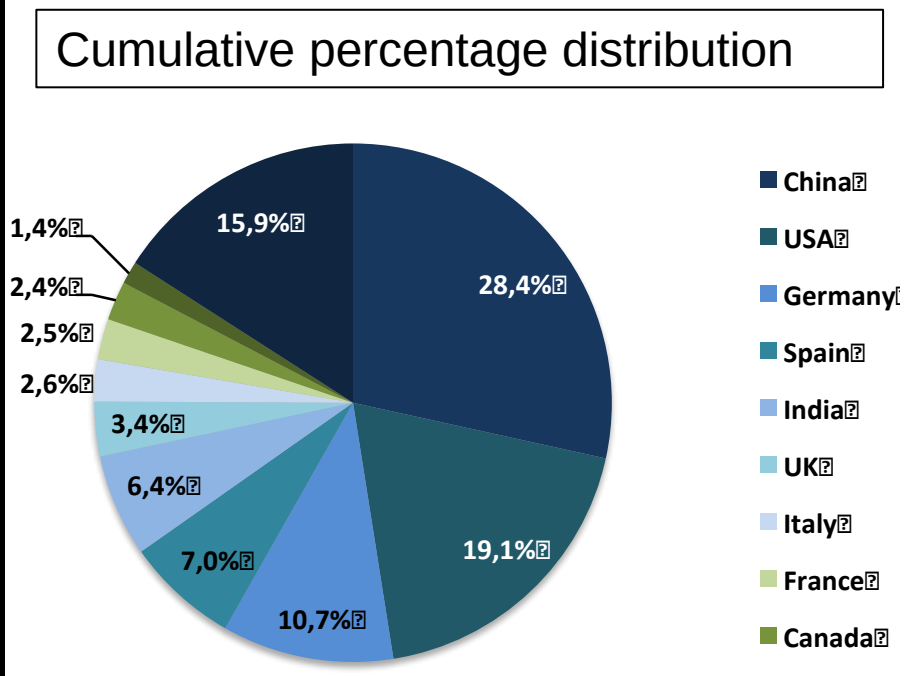
MARCH 17, 2015, GÅ-HJEM MEETING, PER AARSLEFF, HVIDOVRE

March 17, 2015

AALBORG UNIVERSITY
DENMARK

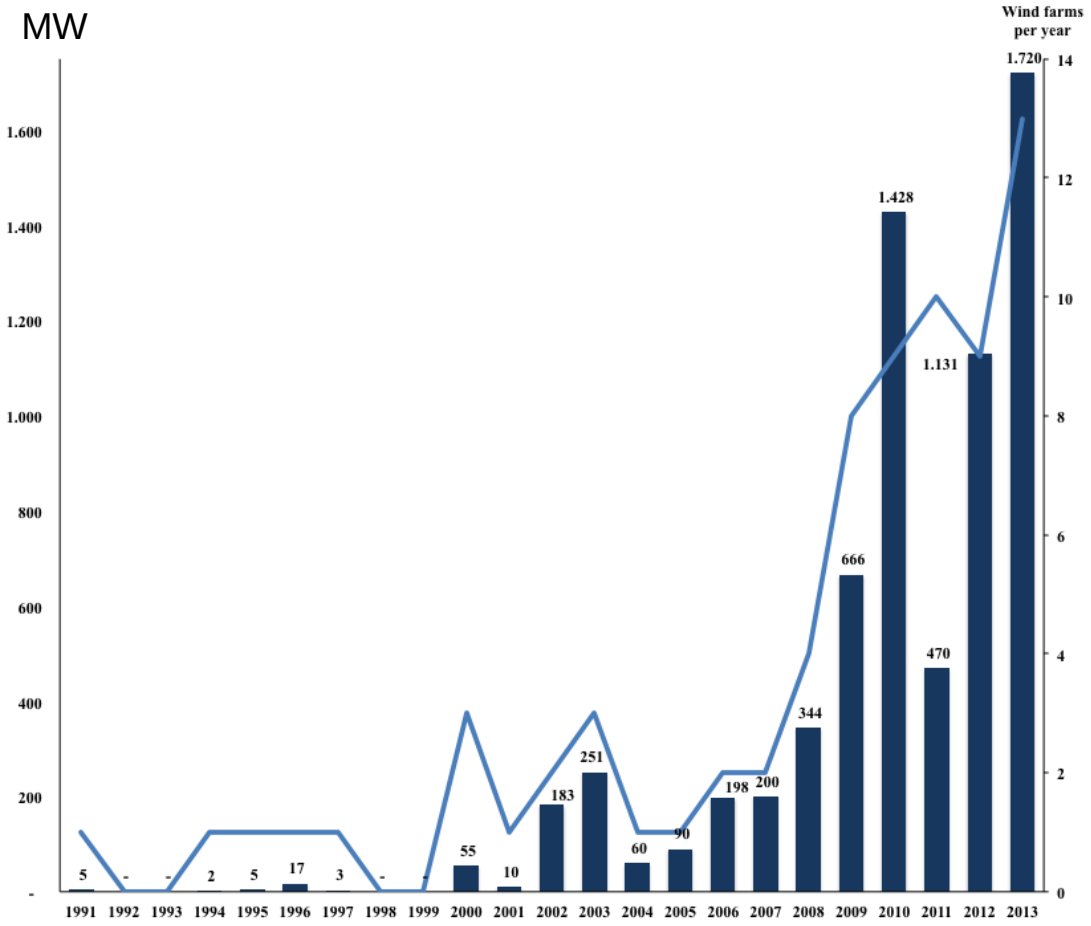
10 largest onshore wind markets - up until 2013

Top 10 global onshore markets			
Ranking	**Country**	**Cumulative**	**2013 new**
1	China	91460	16052
2	USA	61292	1084
3	Germany	34468	2729
4	Spain	22637	175
5	India	20589	1987
6	UK	10946	1028
7	Italy	8448	450
8	France	8128	535
9	Canada	7813	1599
10	Portugal	4557	196
Rest-of-the-world		51221	10299
Grand total		321559	36134



Source: BTM Consult part of Navigant (2013) and own construction

Number of offshore annual MW and wind farms installed up to and including 2013

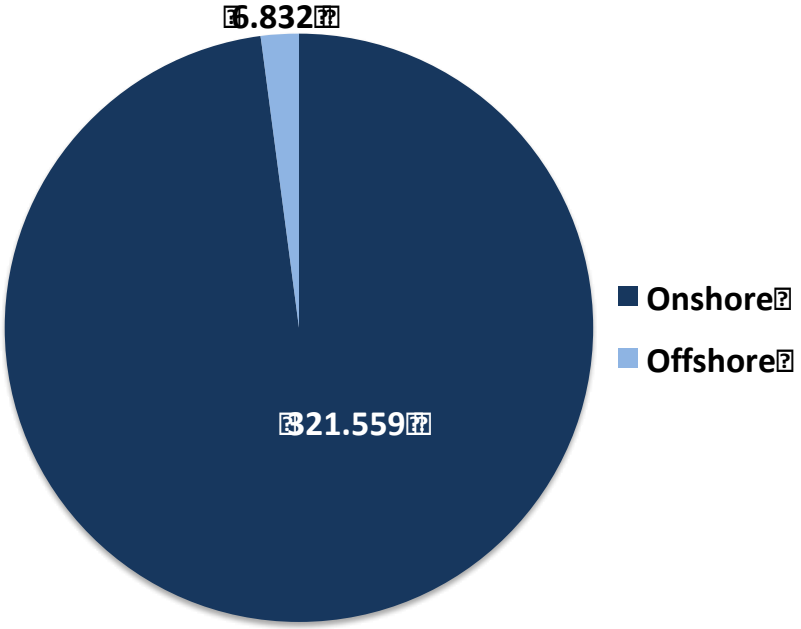


Year	MW installed	Number of wind farms
1991	5	1
1992	-	0
1993	-	0
1994	2	1
1995	5	1
1996	17	1
1997	3	1
1998	-	0
1999	-	0
2000	55	3
2001	10	1
2002	183	2
2003	251	3
2004	60	1
2005	90	1
2006	198	2
2007	200	2
2008	344	4
2009	666	8
2010	1.428	9
2011	470	10
2012	1.131	9
2013	1.720	13

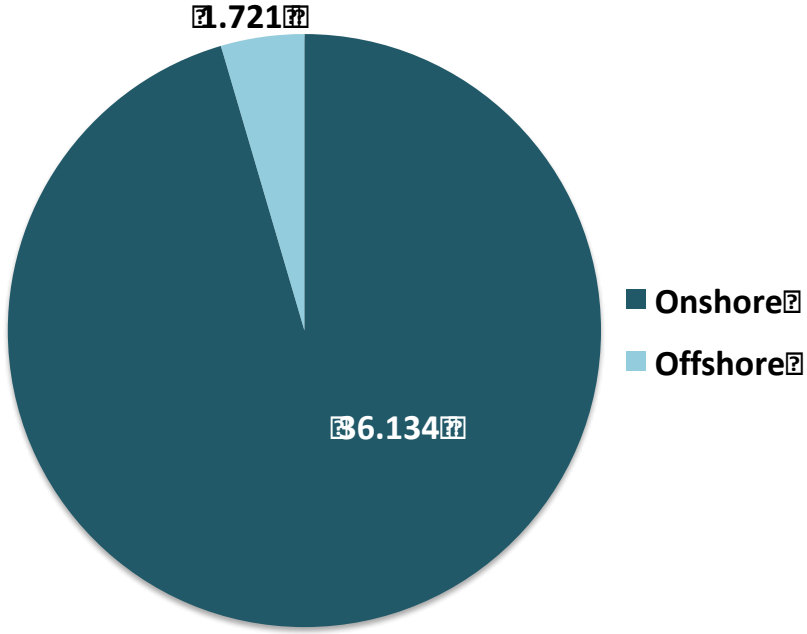
Source: BTM Consult a part of Navigant (2014a) and own construction

Onshore and offshore distribution

Cumulative distribution ultimo 2013 (MW)

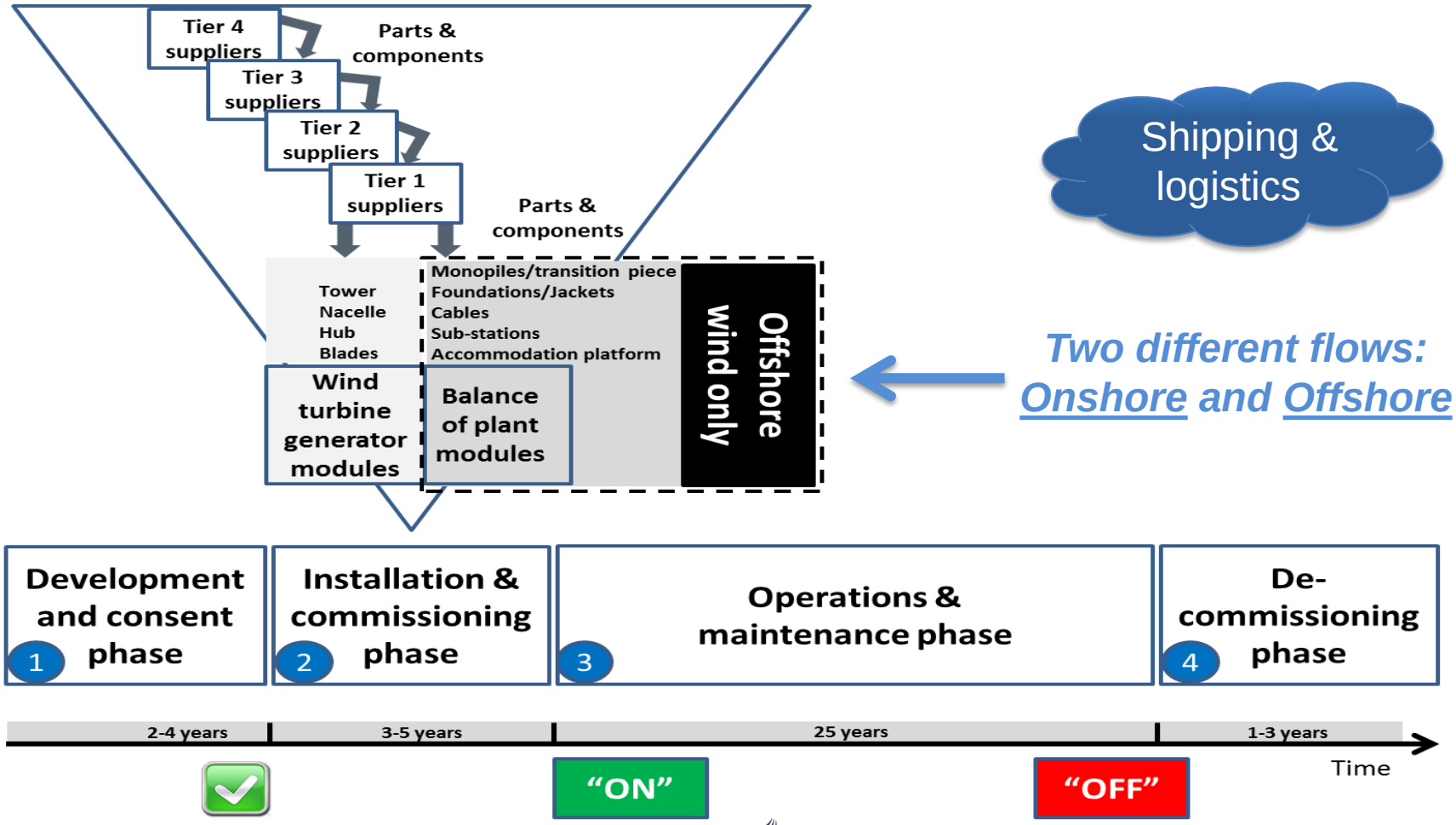


Installed distribution in 2013 (MW)



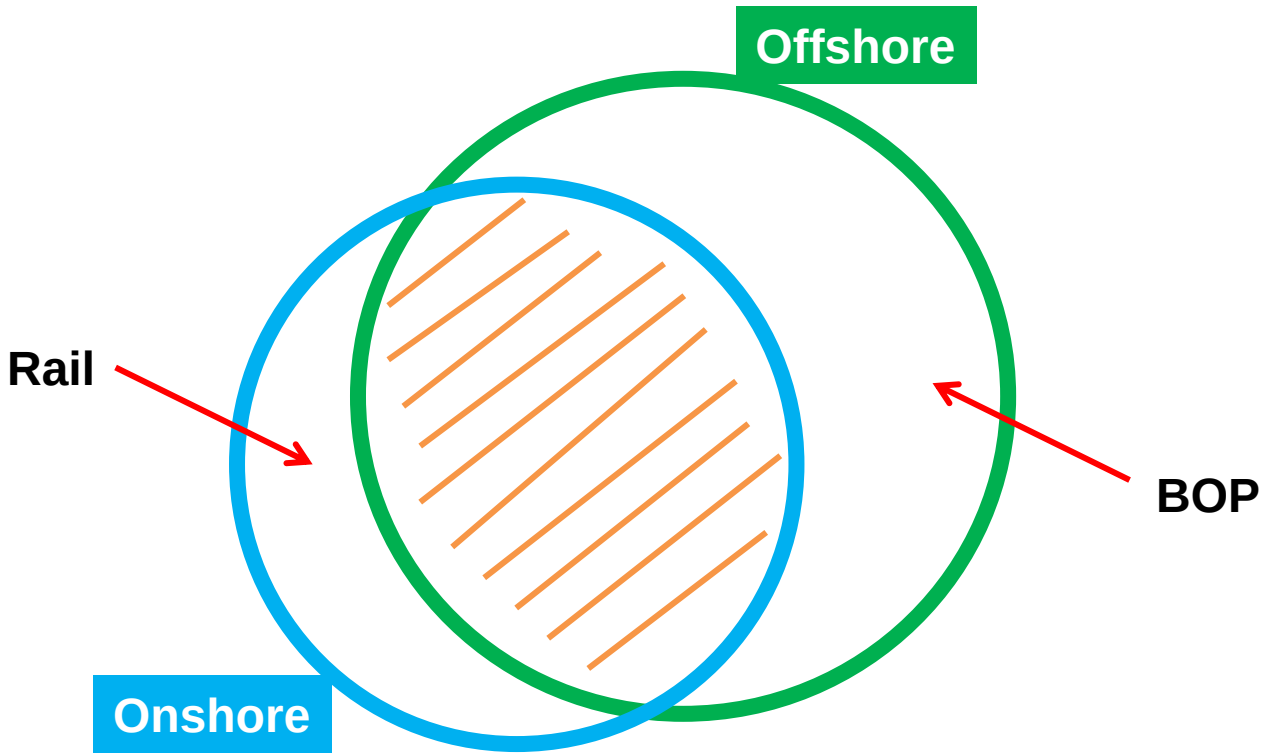
Source: BTM Consult a part of Navigant (2014a) and own construction

End-to-end life-cycle focus



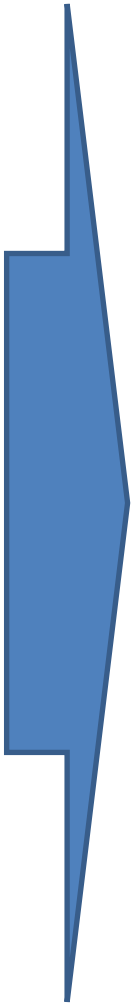
Source: LogMS conference paper, 2013, Singapore 2013, Poulsen et.al.

Onshore and offshore - logistics



Key differences offshore/onshore

- Bigger WTG output
- Bigger size
- Heavier weight
- Quality (corrosion, wind, water)
- Balance of plant modules (foundation, cables, substation, etc.)



Offshore wind is more costly

Case study efforts

Number of companies

Time spent

Extent of case study scope

Depth

Width

Europe — *Offshore, simple and easy cases*

Asia — *Offshore, one case*

Americas — *Onhore, rail focus*

Case study – OW base case Anholt Offshore wind farm

Fact box

- Operator: DONG Energy
- Ownership: DONG Energy, PKA, and PensionDanmark in JV
- Construction cost: DKK 11.5B
- Number of positions: 111 WTG's
- WTG type: 3.6 MW geared Siemens Wind Power
- Foundation type: MP/TP
- Total windfarm output: 400 MW
- Area covered: 88 km2
- Distance from installation / service port (Grenå): 15 km
- Water depth 15.5 – 18 meters

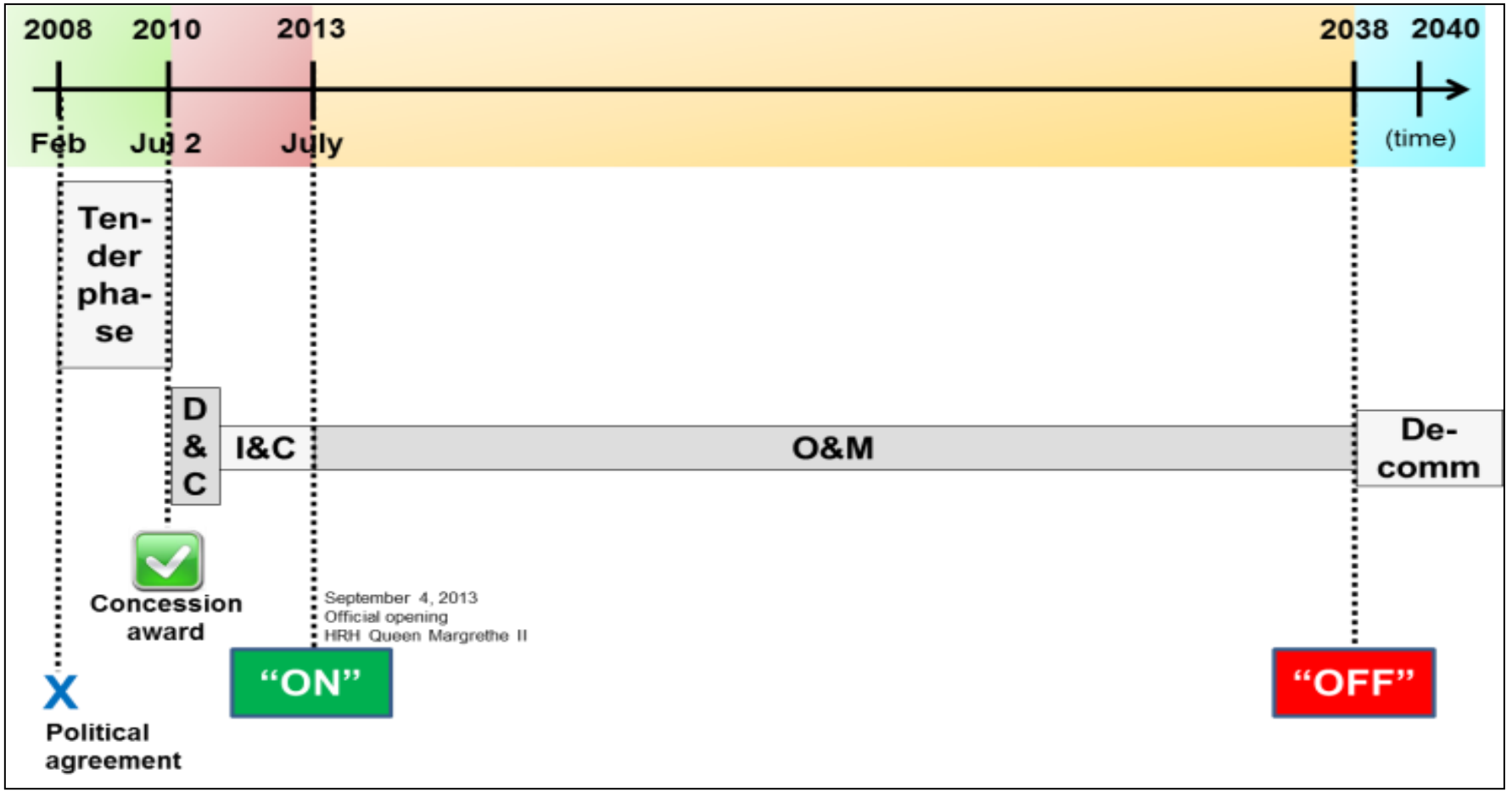
Source: DONG Energy, MTH, AAU research (meetings and site visits), EAWE conference paper, 2013 (Poulsen et.al.)

Main supply chain constituencies

Phase	Contract party	Product/service	Country
Development & consent	Geo	Geotechnical and geophysical investigations	Denmark
Installation & commissioning	Siemens Wind Power	Nacelles/hubs	Denmark
Installation & commissioning	Siemens Wind Power	Towers	Denmark
Installation & commissioning	Siemens Wind Power	Blades	Denmark
Installation & commissioning	Siemens	Substation control systems	Denmark
Installation & commissioning	Siemens	Offshore substation electrical equipment	Denmark
Installation & commissioning	Nexus	Array cables	Germany
Installation & commissioning	MTH/Bladt Industries	MP and TP	Denmark
Installation & commissioning	MTH/Ballast Nedam	MP installation - HLV "Svanen"	Holland
Installation & commissioning	MTH/Jumbo Shipping	TP installation - HLV "Jumbo Javelin"	Holland
Installation & commissioning	Visser & Smit Marine	Array cable installation	Holland
Installation & commissioning	A2SEA	Wind turbine installation	Denmark
Operations & maintenance	Hvide Sande Skibs- & Baadebyggeri	Service vessels	Denmark
Operations & maintenance	Port of Grenaa and misc. companies	35-50 jobs over coming 25 years	Denmark

Source: DONG Energy, MTH, AAU research (meetings and site visits), EAWE conference paper, 2013 (Poulsen et.al.)

Anholt offshore wind farm timeline



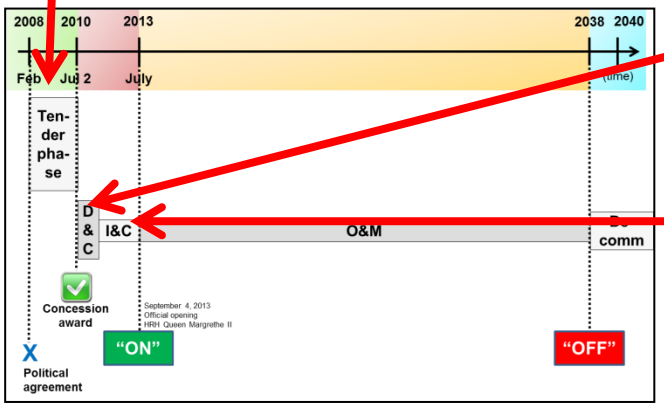
Source: DONG Energy, MTH, AAU research (meetings and site visits), EAWE conference paper, 2013 (Poulsen et.al.)

Initial phases - A closer look...

Tender phase:

- April 2009: Release of tender specifications
- April 2010: Tender submission
- July 2, 2010: DONG Energy concession confirmed

D&C	= development & consent
I&C	= installation & commissioning
O&M	= operations & maintenance
Decomm	= decommissioning

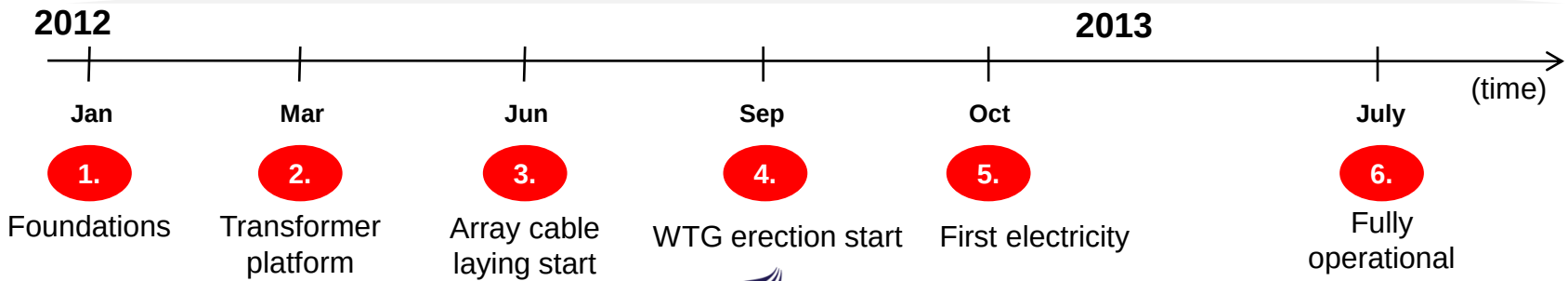


Development & consent phase:

- July 2010: Geological surveys commenced

Installation & commissioning phase:

- Autumn 2011: Shore landing cables (export cables) commenced
- January 2012: Offshore construction commenced



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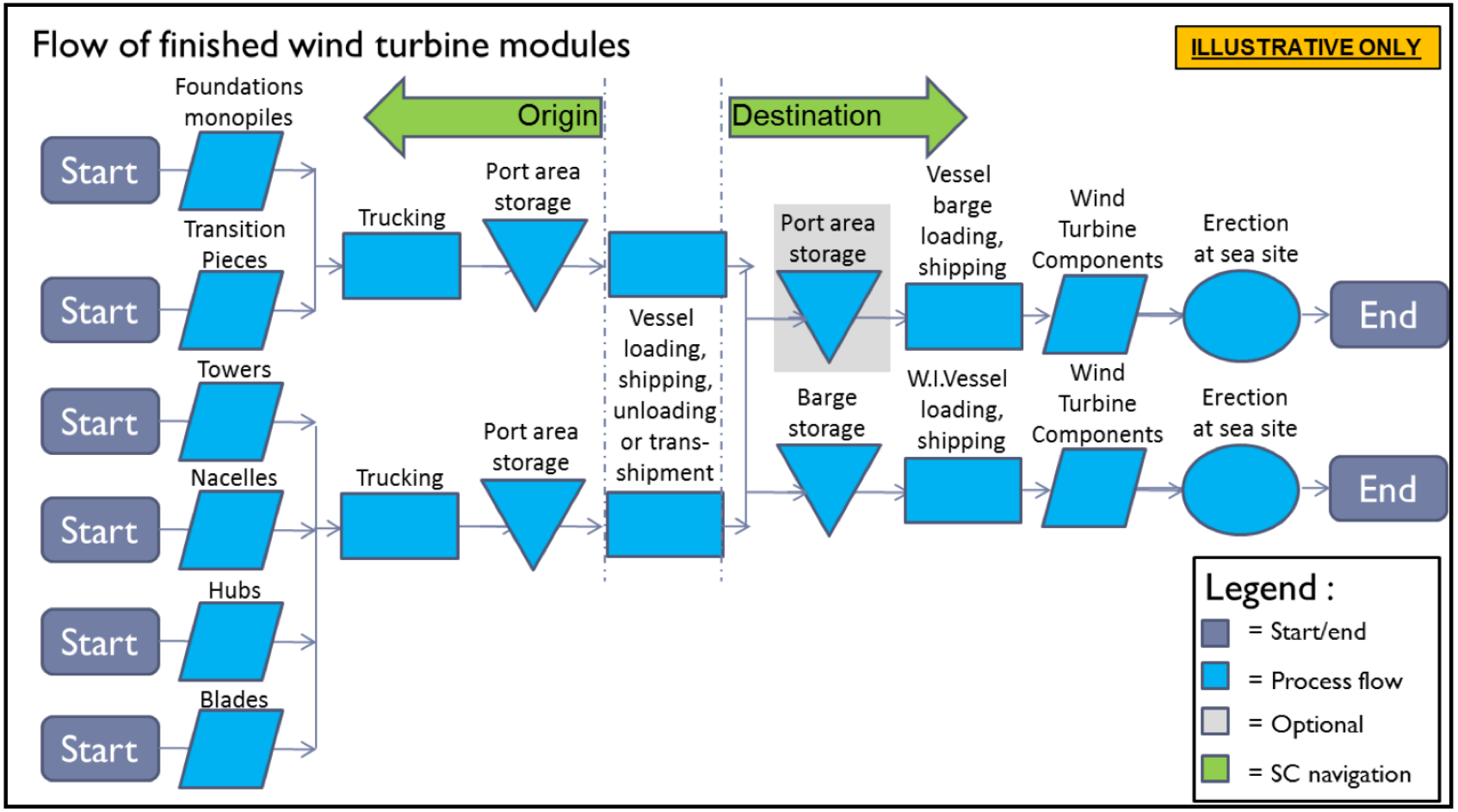
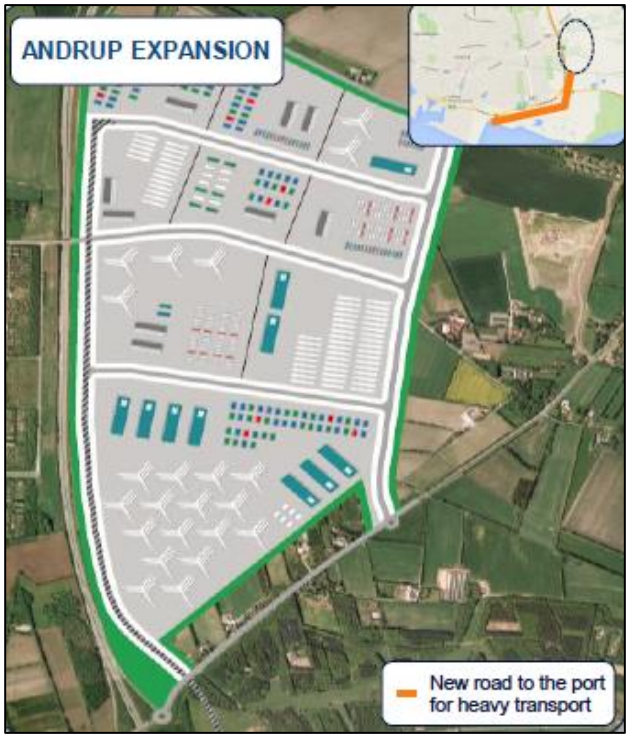
Source: DONG Energy, MTH, AAU research (meetings and site visits), EAWE conference paper, 2013 (Poulsen et.al.)

Outbound I&C offshore double-port supply chain set-up



Source: Own construction using Chambers et al (2010) framework

“Build it and they may come?!”



Port of Esbjerg is a lone example of an industry player that has been ahead of the industry and is now harvesting the benefits from this strategy

Source: Port of Esbjerg

Race for larger WTG output
- and importance of shipping/logistics/SCM

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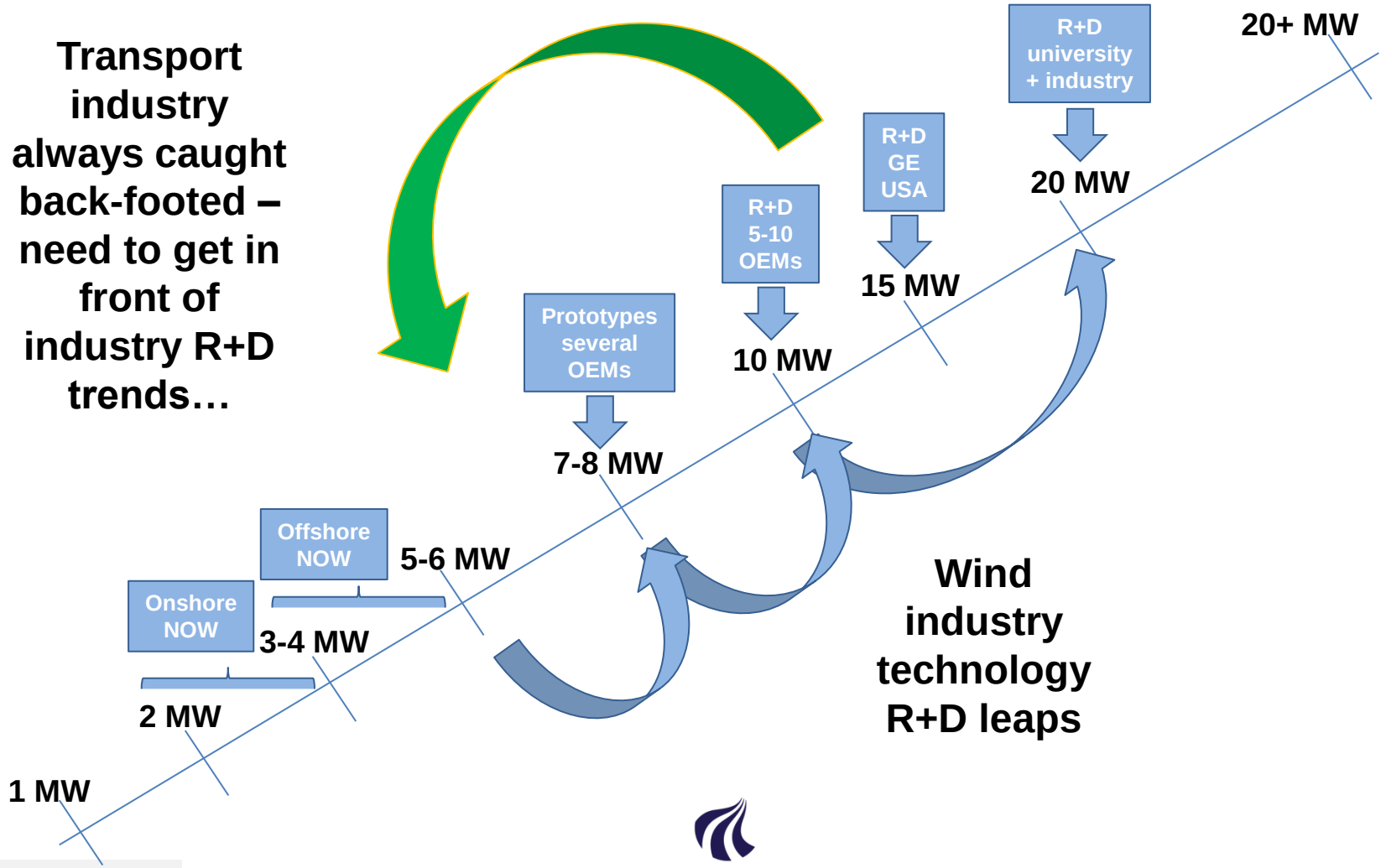
Source: Upwind Project (design limits and solutions for very large wind turbines) and Aalborg University Copenhagen photos

Research and development (R+D)



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Weight & Dimensions	Nacelle weight (t)	Blade Length (m)
Siemens 2.3 MW	82	45
Repower 6.15 MW	325	61
Siemens 6 MW	364	75
Samsung 7.5 MW		83
Vestas 8 MW	390	80

Wind R+D

Implications on:

- **Transport equipment**
- **Assets**
- **HSSEQ**

Transport Equipment

Trucks, trains, roads, bridges, storage facilities, lifting equipment, ports, vessels…

Makers of wind turbines (OEMs):

The pioneers

N·E·G MICON Powerful Simplicity Vestas

NASA

BONUS Energy A/S SIEMENS

GE

The "other" Europeans

ENERCON ENERGY FOR THE WORLD

AREVA

NORDEX We've got the power.

ALSTOM

Gamesa

Examples of the Asian "newcomers"

金风科技 GOLDWIND

SINOVEL 华锐风电

联合动力 United Power

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

SAMSUNG

UNISON

SENVION wind energy solutions

SUZLON POWERING A GREENER TOMORROW

AALBORG UNIVERSITY DENMARK

Source: AAU research, DHL Global Forwarding, Renewable Energy Solutions

Dimensions – Logistics challenges

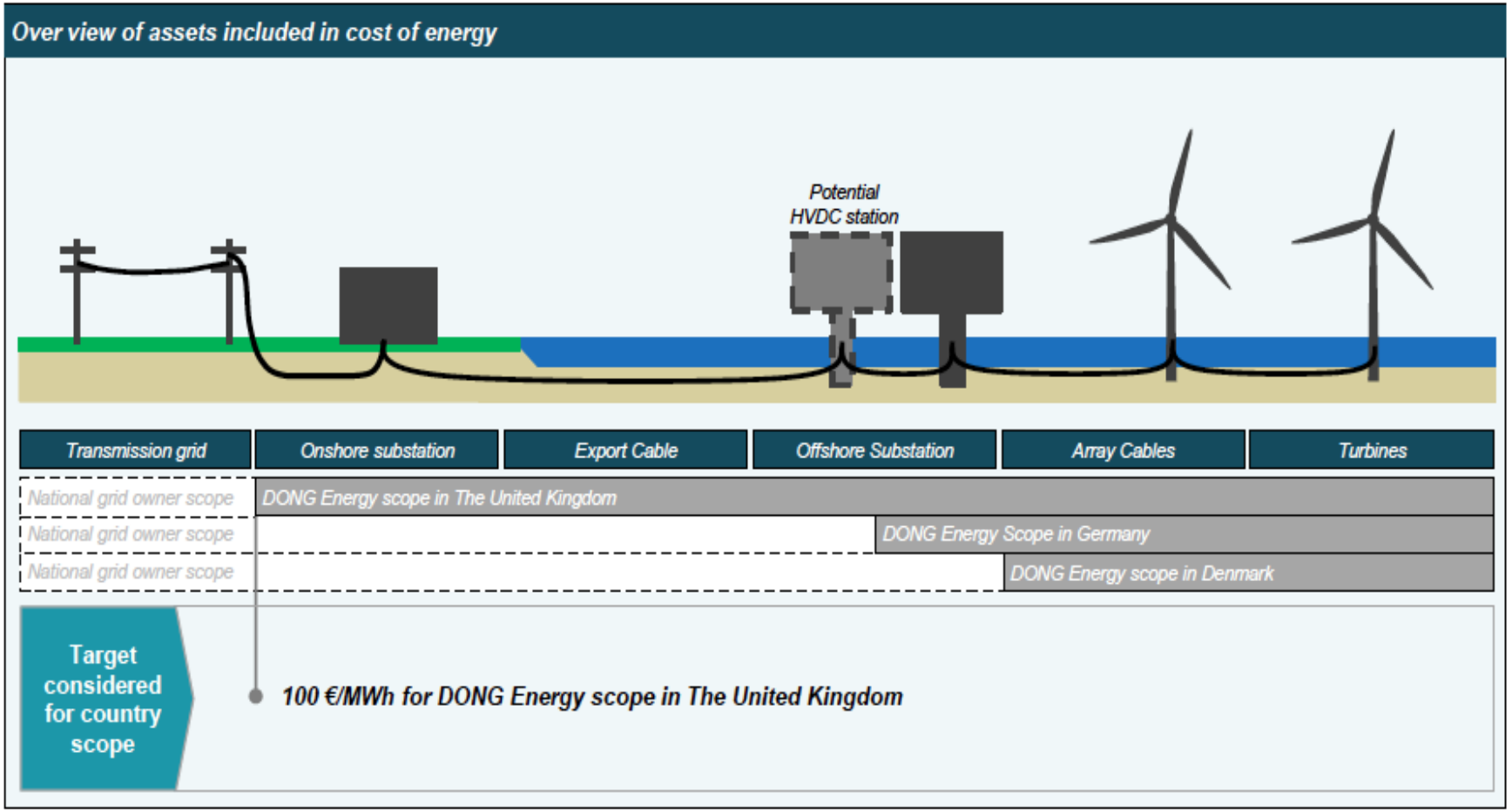
Source: Danish Shipowners' Association, courtesy Siemens Wind Power

5 critical offshore wind factors

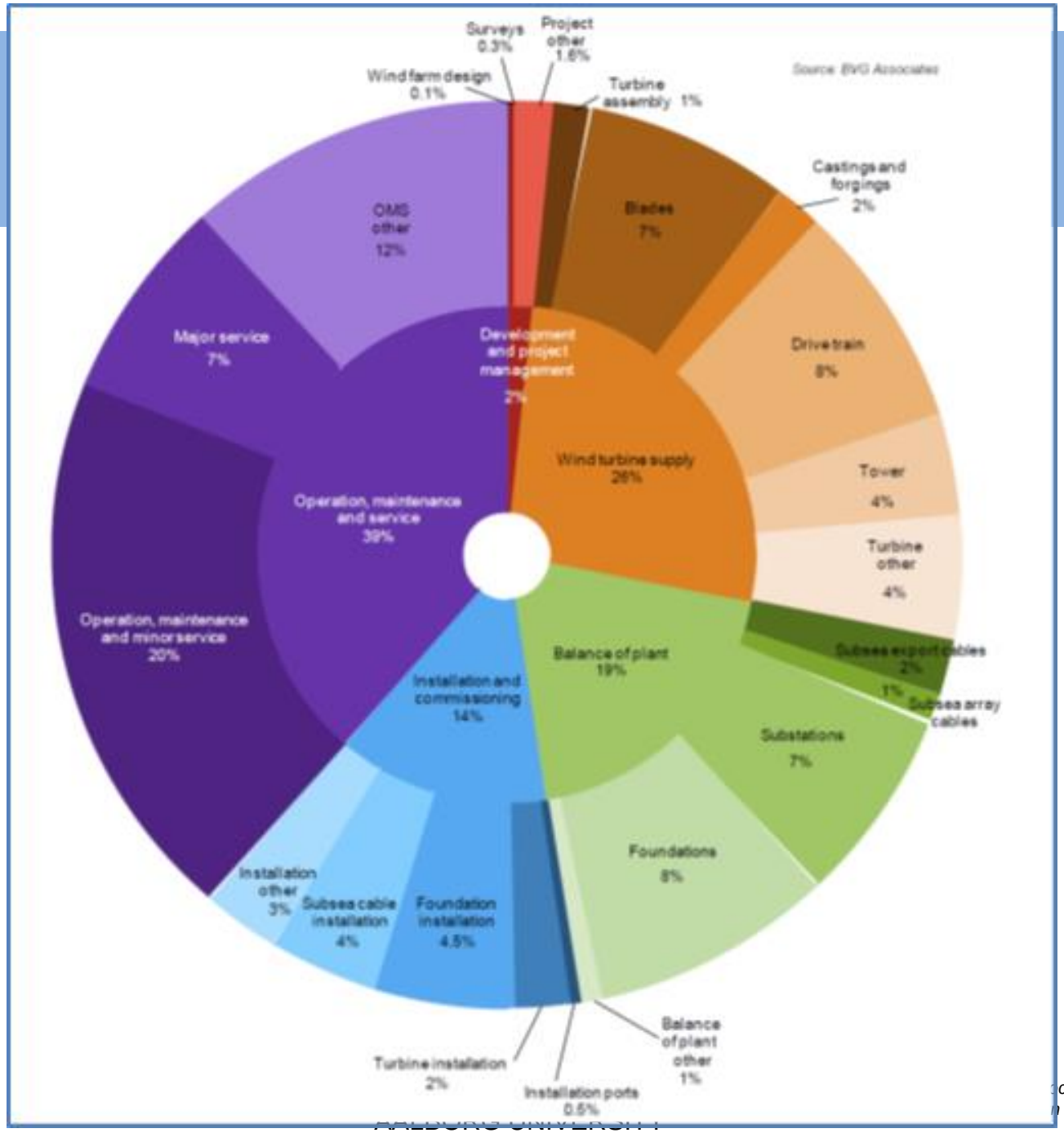
1. Distance to shore
2. Water depth
3. Number of wind farm turbine positions
4. Weight and dimensions of WTG and foundation
5. Seabed conditions

- ✓ Near shore
- ✓ Offshore
- ✓ Far offshore

Different ways to estimate LCoE



Source: DONG Energy



ciates for the Estate, 2014

Involved parties...

Freight forwarders:
- Global
- Regional
- Local

Ocean transportation and related:
- RO/RO ("Roll-on/Roll-off")
- LoLo ("Lift-on/Lift-off")
- Short-sea/regional operators
- Tug/barges and landing crafts ("LCTs")
- Multi-purpose vessels ("MPV")/Floating cranes
- Container vessel operators
- Safety vessels, work boats, and crew/hotel vessels
- Special vessels like offshore wind turbine installation and cable laying vessels

Ports

Storage:
- Warehouses
- Yards
- Storage areas

Rail

Specialty trucks

Land based cranes

Utilities | **Operators** | **OEM's** | **EPC companies** | **SWF**

Extent of services

M&A is picking up

- **DSV** - Acquired Baltship / Seatainers:
- **Mammoet** - Acquired KR Wind (cranes) and subsequently Brande Maskintransport (trucking):
- **Marubeni** - Acquired Sea Jacks:
- **Beluga** - Company was restructured by private equity Oak Tree (US) into Hansa Heavy Lift, many Beluga vessels taken over by banks and given to Döhle and Oldendorff to manage on behalf of the banks
- **Mitsubishi** - Joint venture with Vestas

M&A changes the landscape

- **Hochtief** – Beluga joint venture with Hochtief dismantled and Belgian firm GeoSea took over Beluga's shares and formed new company with Hochtief called HGO IntraSea Solutions:

- **A2SEA** – Acquired by DONG Energy who subsequently sold 49% to Siemens Wind Power

- **Swire** – Acquired Danish Blue Ocean and formed Swire Blue Ocean

- **Aarsleff** – Joint venture with German shipping company Bilfinger Berger called AB-JV:

Pure play Danish constituencies

PORTS	SHIPPING	CRANE	TRUCKING	FREIGHT FORWAR-DERS	EPC
LORC	A2SEA powered by knowhow	FANØ KRAN-SERVICE A/S	GIVE GOODWIND	DSV BALTSHIP	AARSLEFF
ESBJERG HAVN Gateway Scandinavia	NT Offshore Marine & Offshore services	BMS	TORBEN RAFN & CO. A/S INTERNATIONALE SPECIALTRANSPORTER	BLUE WATER SHIPPING	RAMBØLL
Aalborg Havn Port of Aalborg	ESVAGT		VST VAMDRUP SPECIALTRANSPORT A/S	cargo service	MTHøjgaard
Grenaa Havn A/S	MAERSK LINE			MARTIN BENCHER	
AARHUS HAVN PORT OF AARHUS	THORCO			NIELSWINTHER in shipping since 1931	
	Combi Lift DEFINES HEAVY LIFT				

Acquired Danish companies

Mergers & Acquisitions

DANBOR → NorSeaGroup, Wilh. Wilhelmsen

BLUE OCEAN → SWIRE

KR Wind, BRANDE MASKINTRANSPORT → MAMMOET

Joint Ventures

A2SEA powered by knowhow → SIEMENS *(49%)*

J. Poulsen Shipping A/S → CombiLift DEFINES HEAVY LIFT *(50%)*

abjv (Aarsleff Bilfinger Berger Joint Venture) → BILFINGER BERGER *(50%)*

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Foreign operators in Denmark

DHL GLOBAL FORWARDING

DB SCHENKER

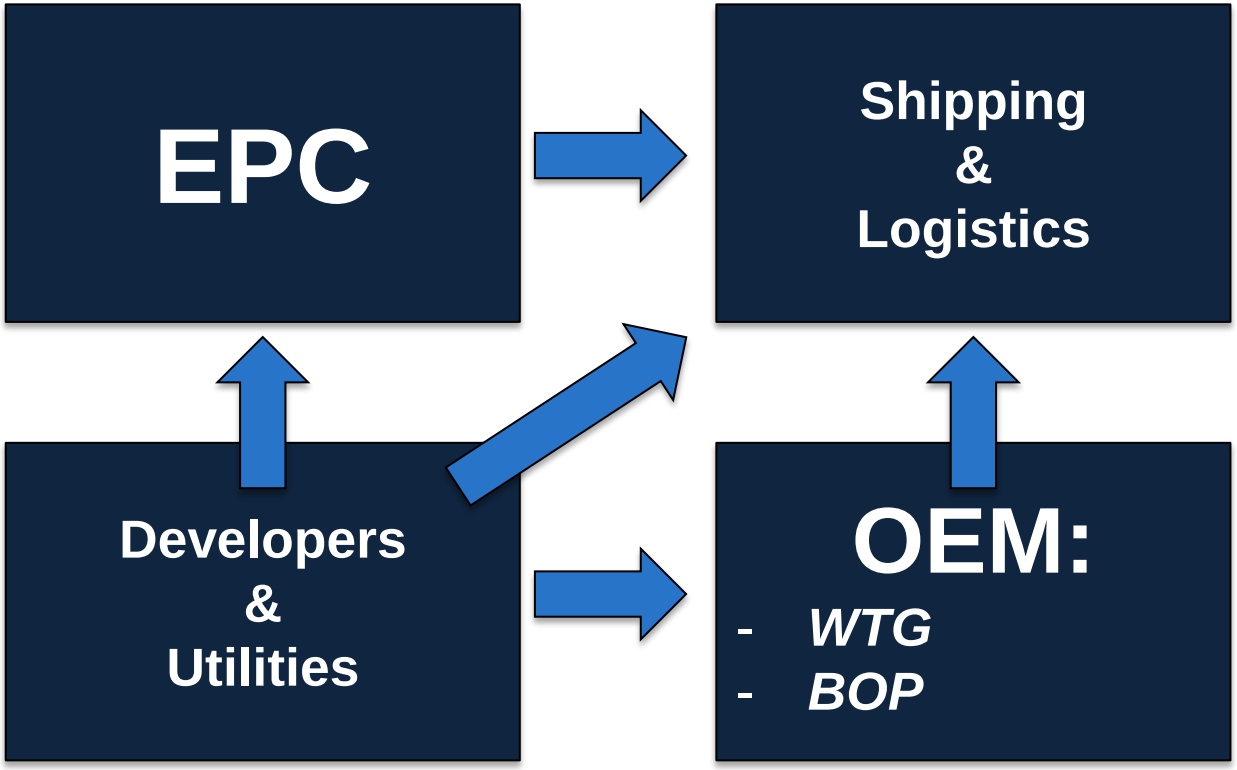
GEODIS

KÜHNE+NAGEL

Agility
A New Logistics Leader

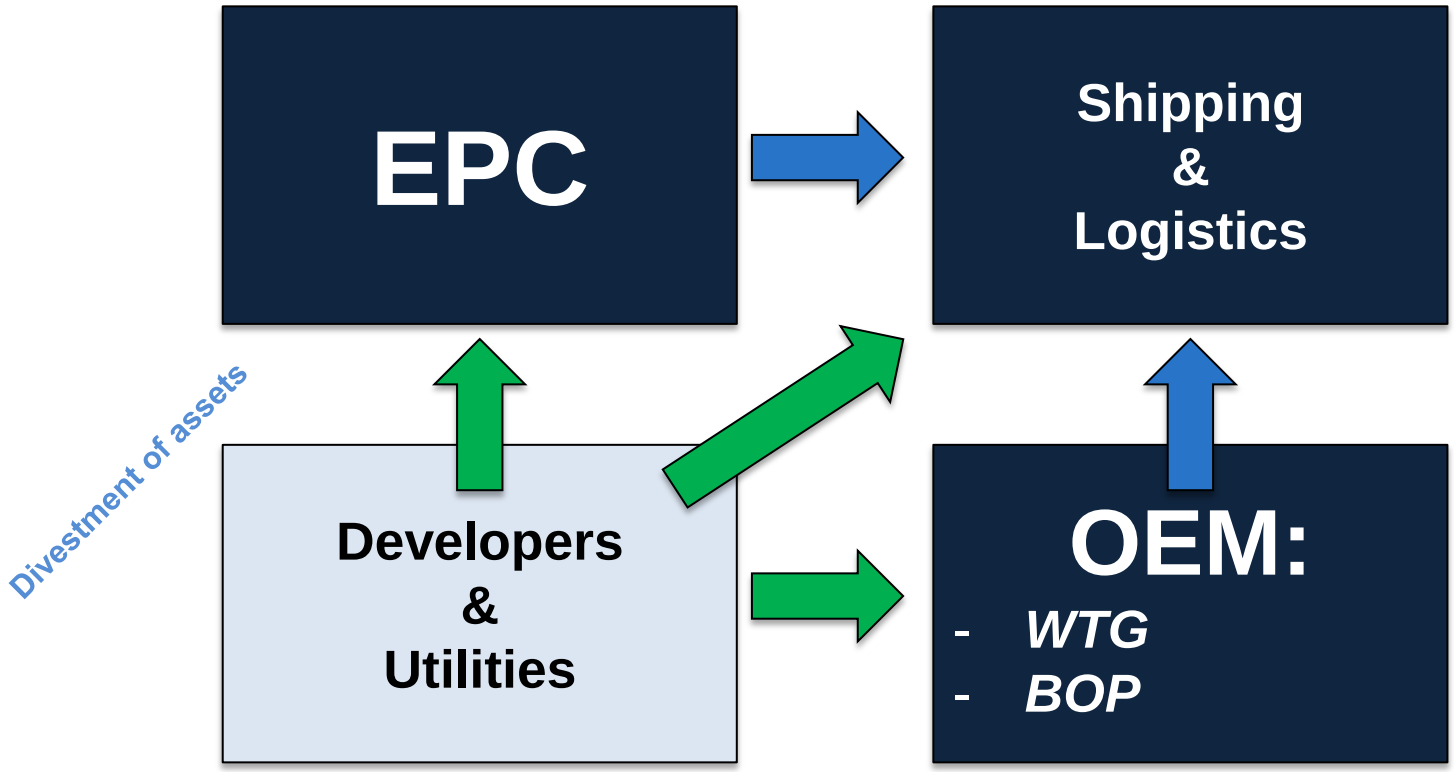
Shipping/logistics order flow 2015

Hypothesis: Europe



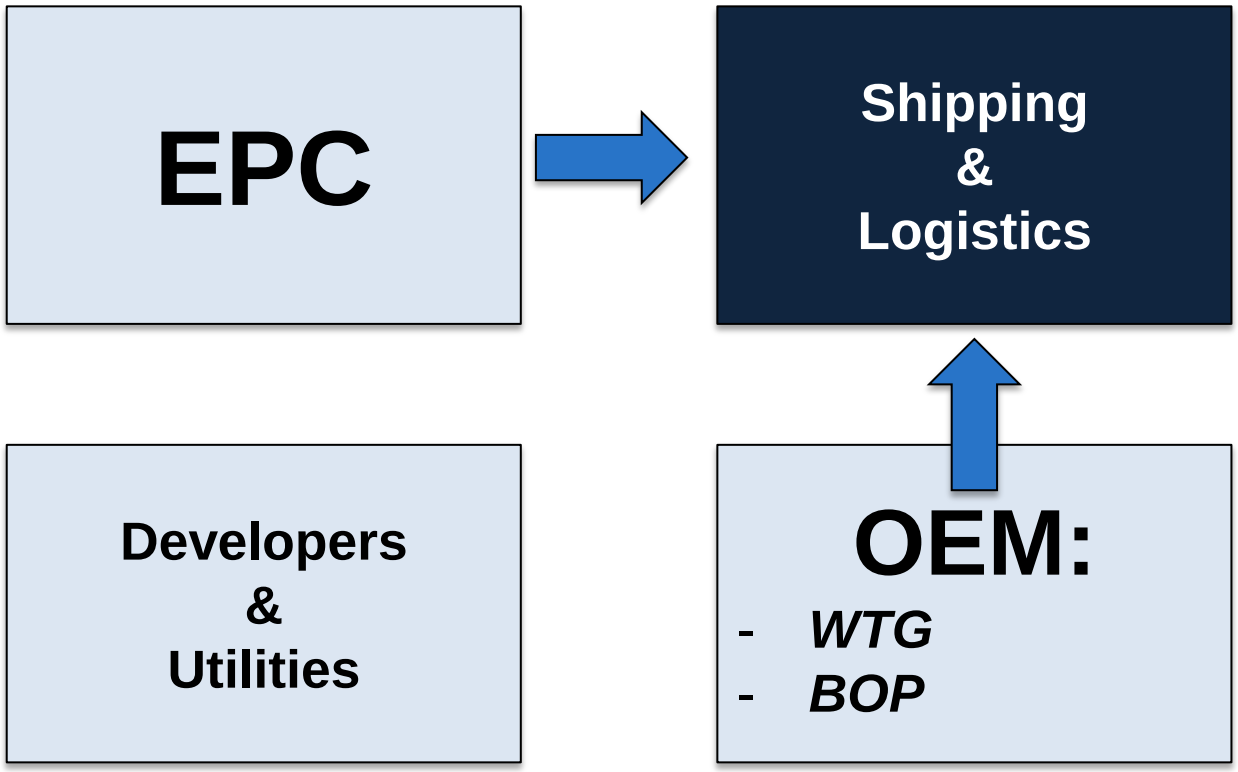
Shipping/logistics assets 2020

Hypothesis: Europe



Continued divestment 2030

Hypothesis: Europe

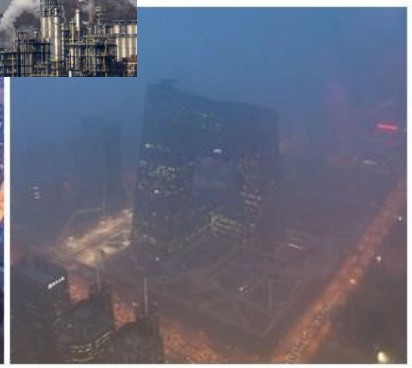


China offshore wind – the need is adamant







Offshore wind
- official 12th 5 year plan targets

Cumulative MW in 2012

320 MW

Cumulative target for 2015

2 GW

5 GW

Cumulative target for 2020

10 GW

30 GW

Wind resource map of China

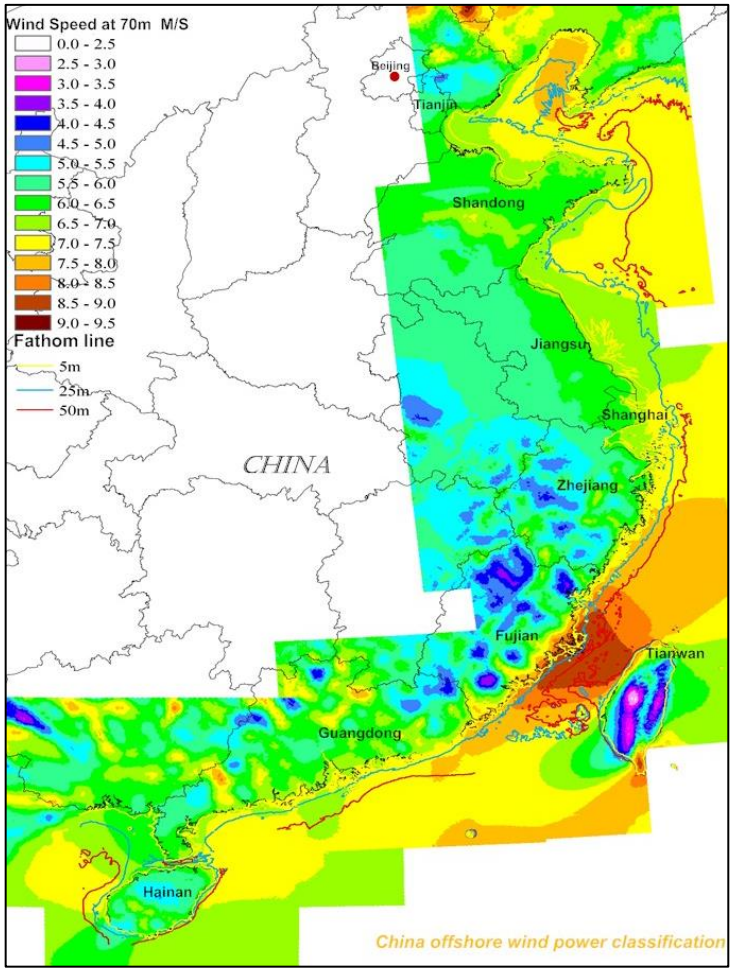
- **18.000 km long coastline**
- **From shoreline to water depth of 20m = 157.000 km²**
- **Assuming only 10%-20% is suitable for offshore wind and the use of an average 5 MW WTG´s**

→ 100-200 GW offshore capacity

Offshore resources in China are spread across:

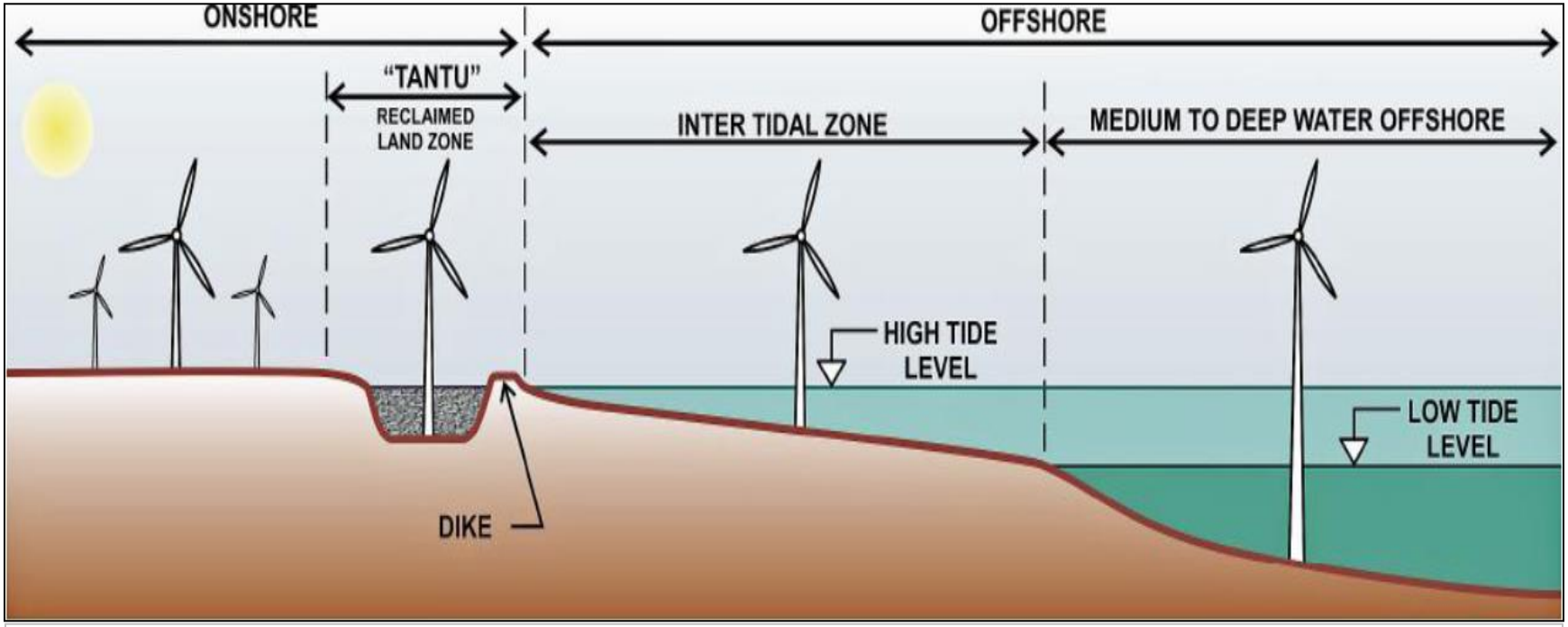
- **Jiangsu**
- **Zhejiang**
- **Fujian**
- **Shandong**
- **Guangdong**
- **Shanghai**

2020 target: 30 GW offshore wind



Source: Own analysis, BTM Navigant and data from National Climate Center of the China Meteorological Administration, June 2010

Example of unique China offshore-inter-tidal wind farm outbound I&C challenges

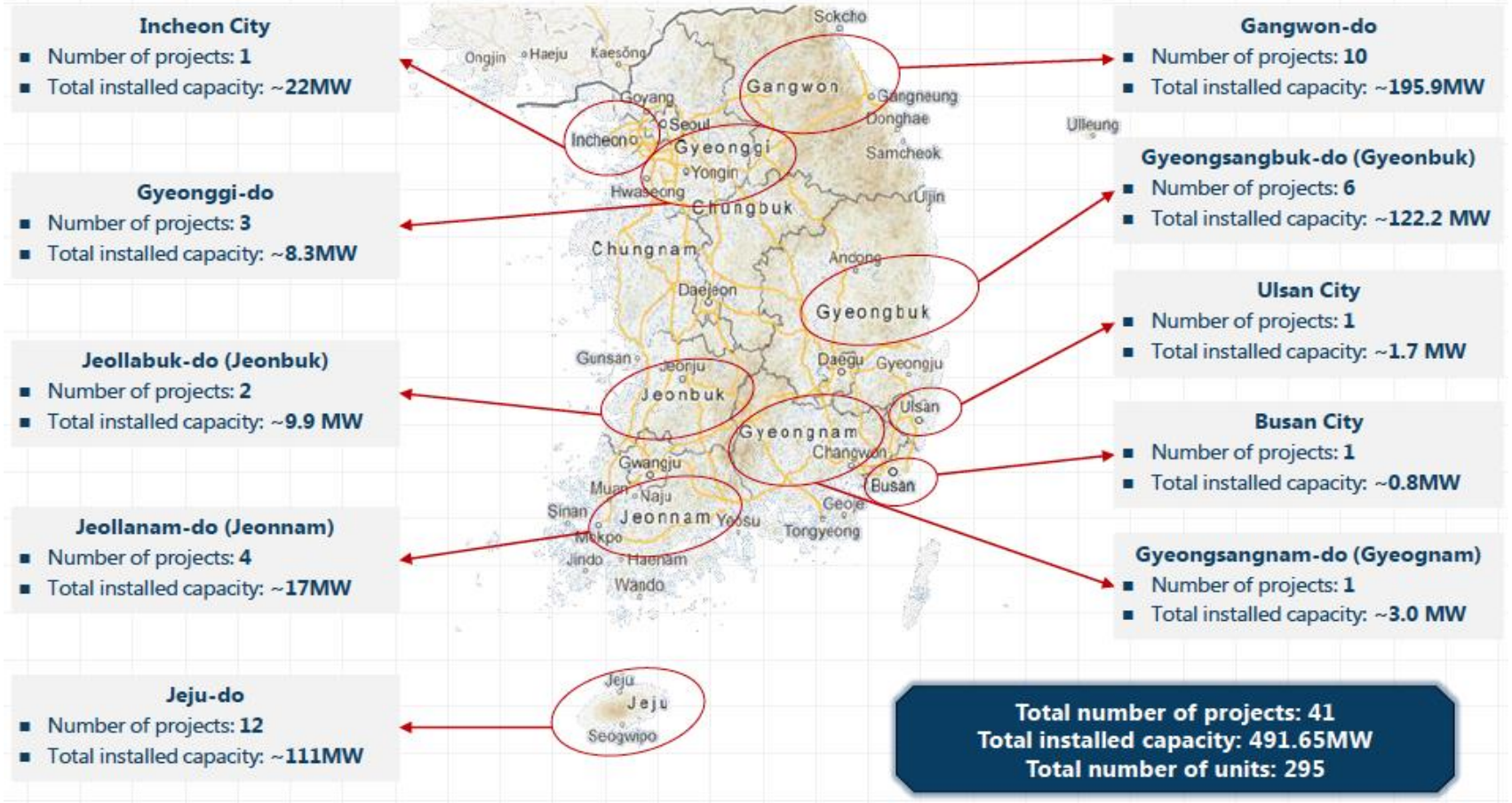


Example Jiangsu Dafeng project (installation by Guodian/CCCC JV):

- 30 km from shore, Western part of farm will have riverbed exposed during low tide
- Eastern part of farm will need WTIV's to be permanently jacked up out of the water
- Requires different kinds of vessels than in Europe

Source: NEA & World Bank (2010), BTM Consult part of Navigant & Poulsen (2012), and first author research

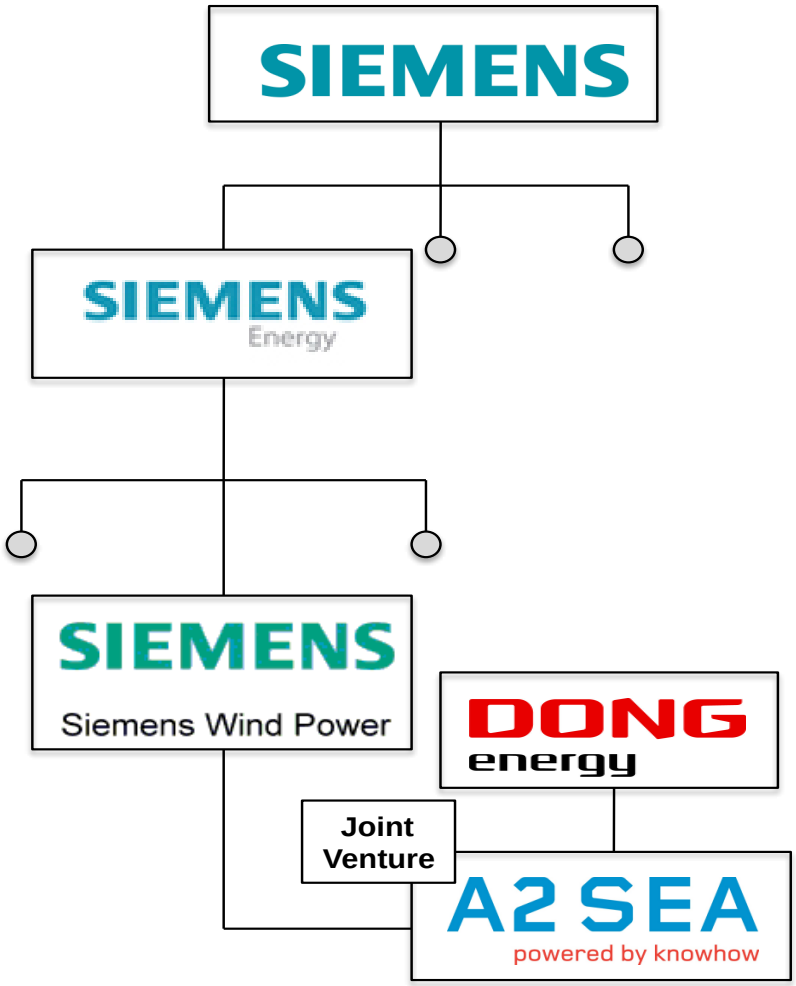
South Korea wind status - as of February, 2013 (onshore and offshore)



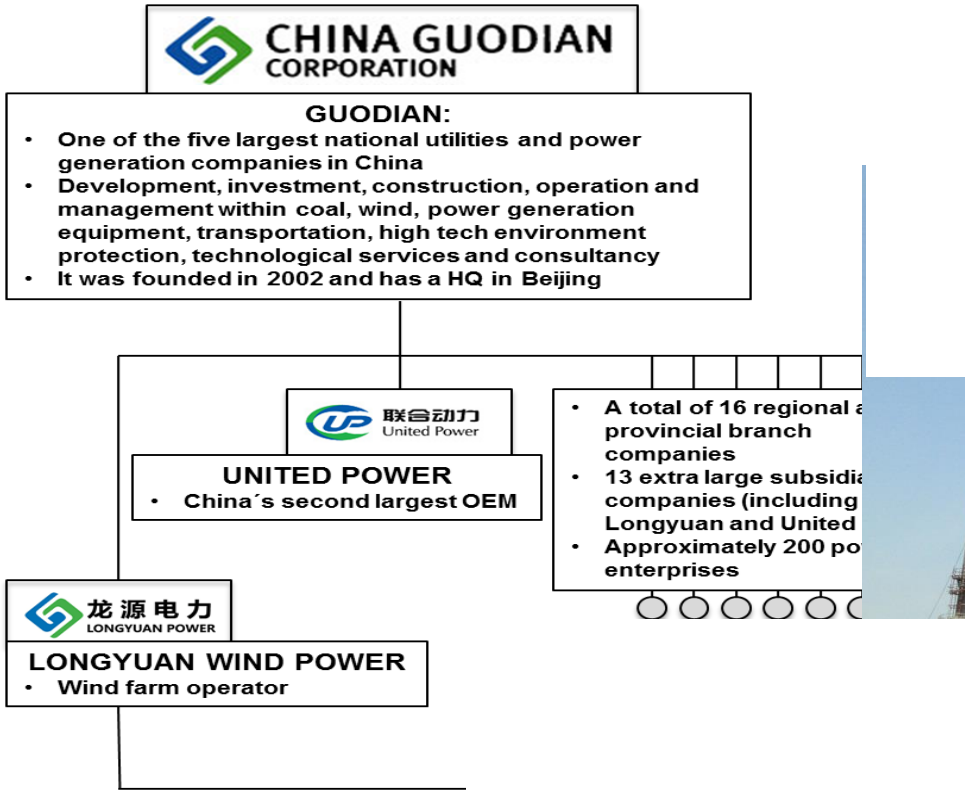
7.5 GW home market offshore wind target by 2030

Source: Korea Wind Energy Association (2013)

Business Model in Denmark

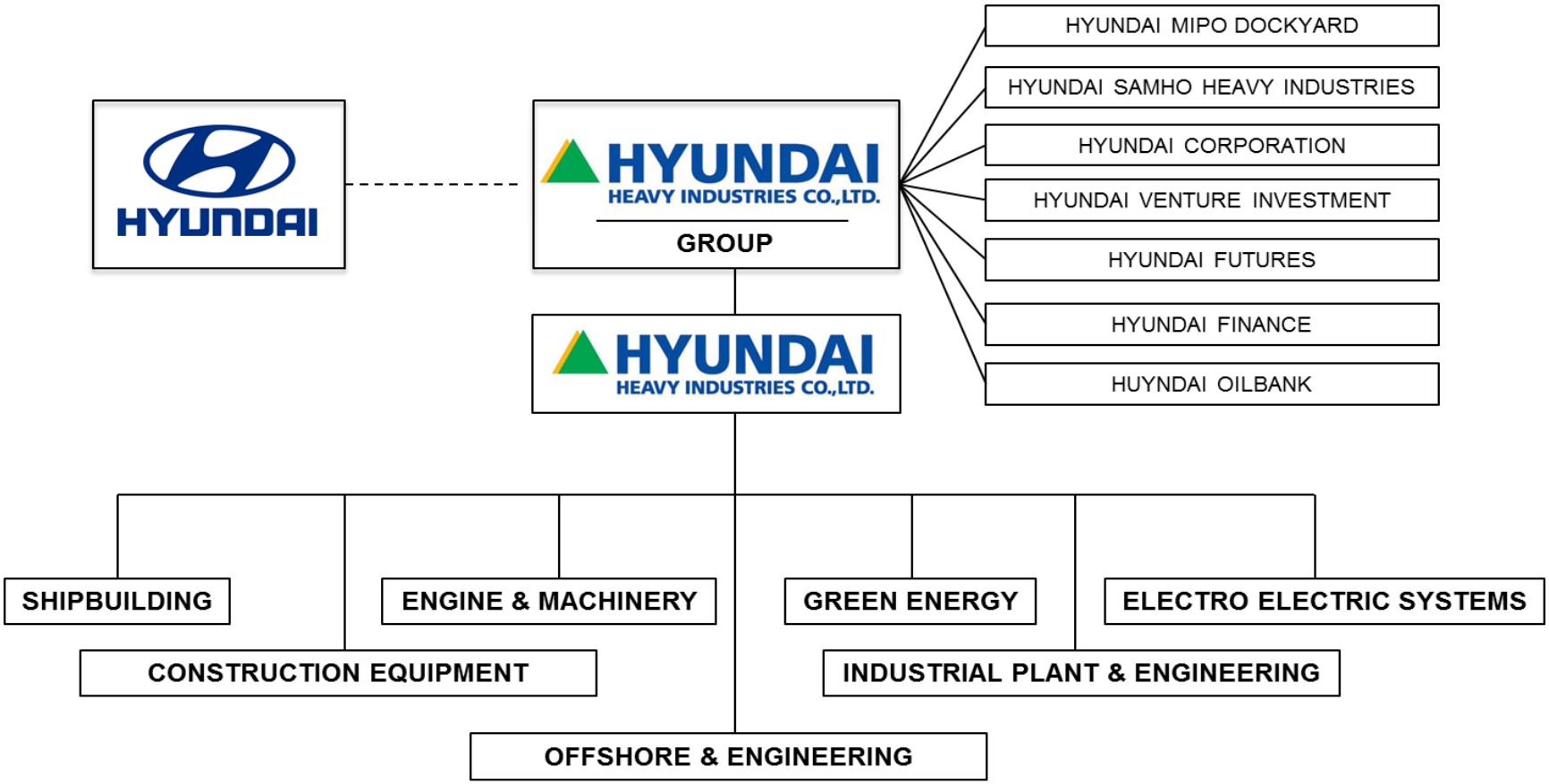


Vertically and horizontal integrated business model China



Top South Korean Chaebol….

Horizontal and vertical integration



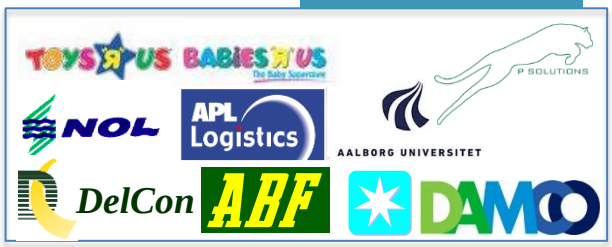
Key points of today

- Shipping/logistics/SCM is an important support function for the wind market
- Especially offshore wind is driving the step-change in technology development
- Different strategies and business models are being applied – in Europe and globally
- The market is changing
- M&A is on the rise

Thank you – Thomas Poulsen

Aalborg University, Copenhagen Campus
Department of Mechanical and Manufacturing Engineering

Past employers



Select consulting clients

Contact info

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Research interest:

Global wind energy shipping and logistics

Background:

25 years of global shipping, logistics, and SCM experience having lived in 8 different countries working at practical, strategic, general management, and consulting level

Discussion

Does the Danish heritage matter?

Can Danish firms keep up?

Does country of origin matter?