


GLOBAL WIND ENERGY SHIPPING AND LOGISTICS

LOGISTICS AND SHIPPING INNOVATION IN THE GLOBAL WIND INDUSTRY - SPECIAL FOCUS ON OFFSHORE WIND

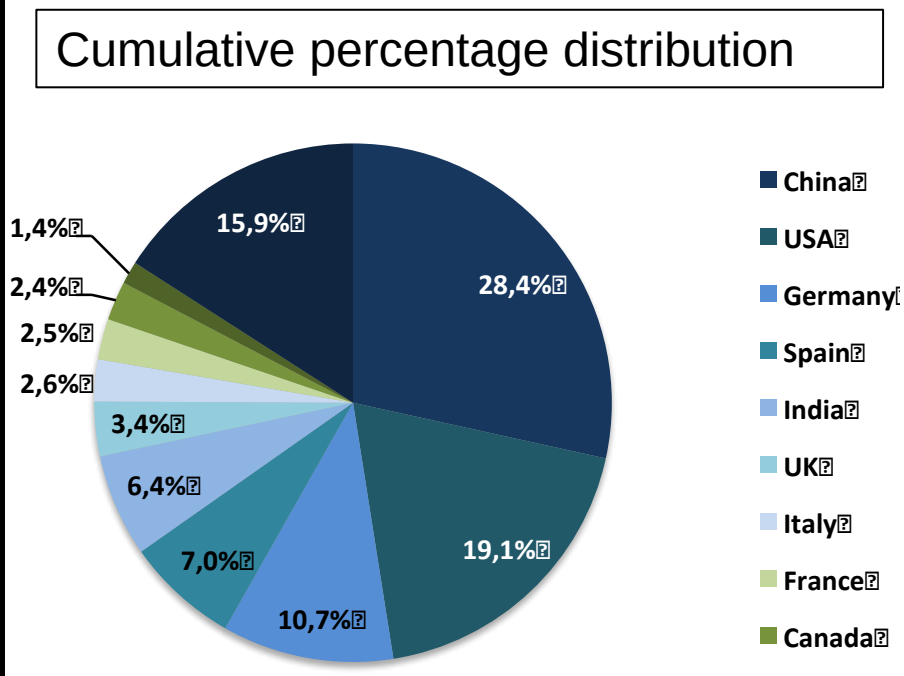
GÅ-HJEM/"GO HOME" MEETING, SIEMENS WIND POWER, BRANDE

September 2, 2015

AALBORG UNIVERSITY
DENMARK

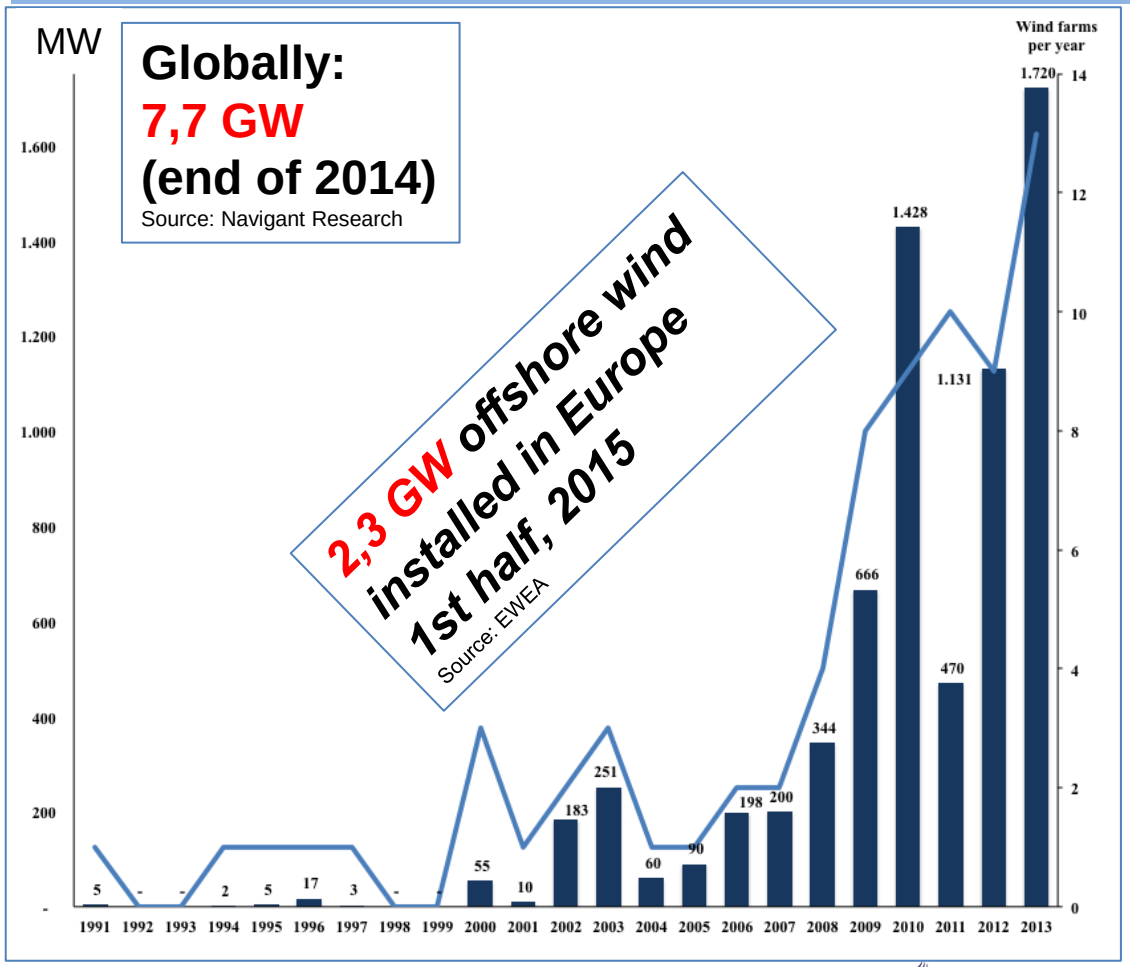
10 largest onshore wind markets - up until 2013

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

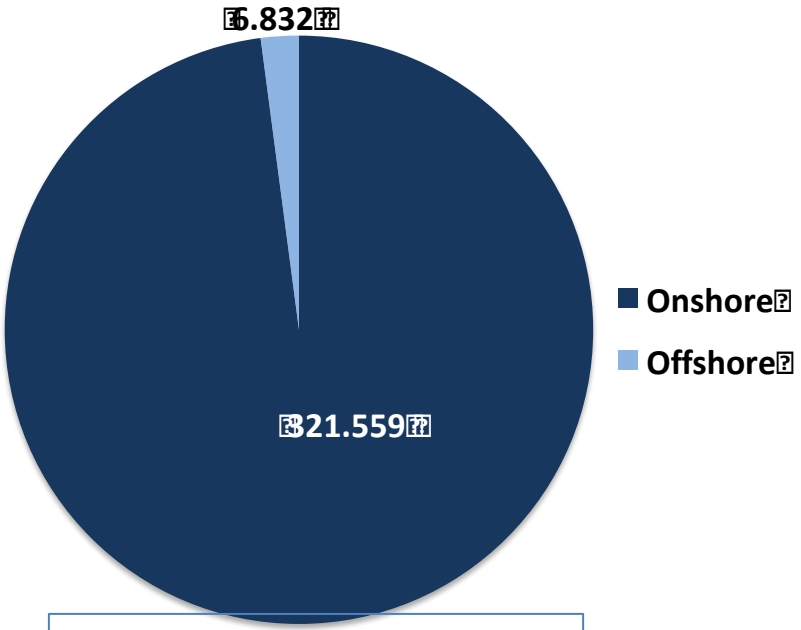


Year	MW installed	Number of wind farms
1991	5	1
1992	-	0
1993	-	0
1994	2	1
1995	5	1
1996	17	1
1997	3	1
1998	-	0
1999	-	0
2000	55	3
2001	10	1
2002	183	2
2003	251	3
2004	60	1
2005	90	1
2006	198	2
2007	200	2
2008	344	4
2009	666	8
2010	1.428	9
2011	470	10
2012	1.131	9
2013	1.720	13

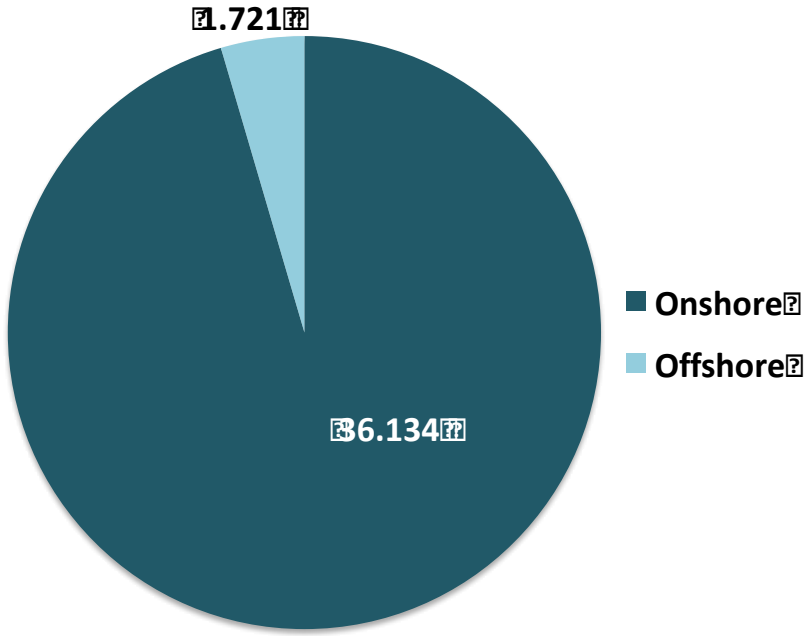
Source: BTM Consult a part of Navigant (2014a) and own construction

Onshore and offshore distribution

Cumulative distribution ultimo 2013 (MW)



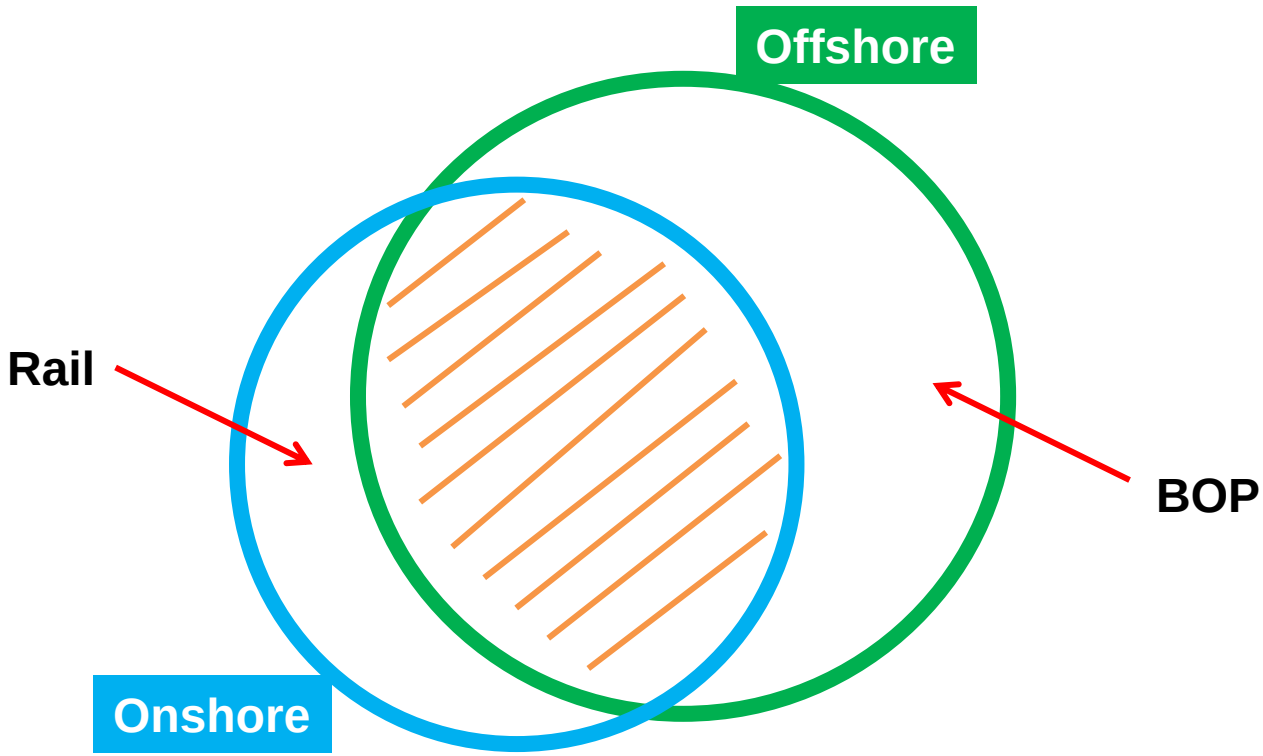
Installed distribution in 2013 (MW)



372 GW end 2014
7.7 GW offshore wind
Source: Navigant Research

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

Onshore and offshore - logistics



Source: AAU research

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*

Logistics defined by industry

The leading industry practitioner definition:

- The US has the largest independent network of industry practitioners in Council of Supply Chain Management Practitioners (CSCMP)
- CSCMP defines logistics as:

"That part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements"

Source: CSCMP

Shipping, logistics, SCM, end-to-end: *What does it really mean?*

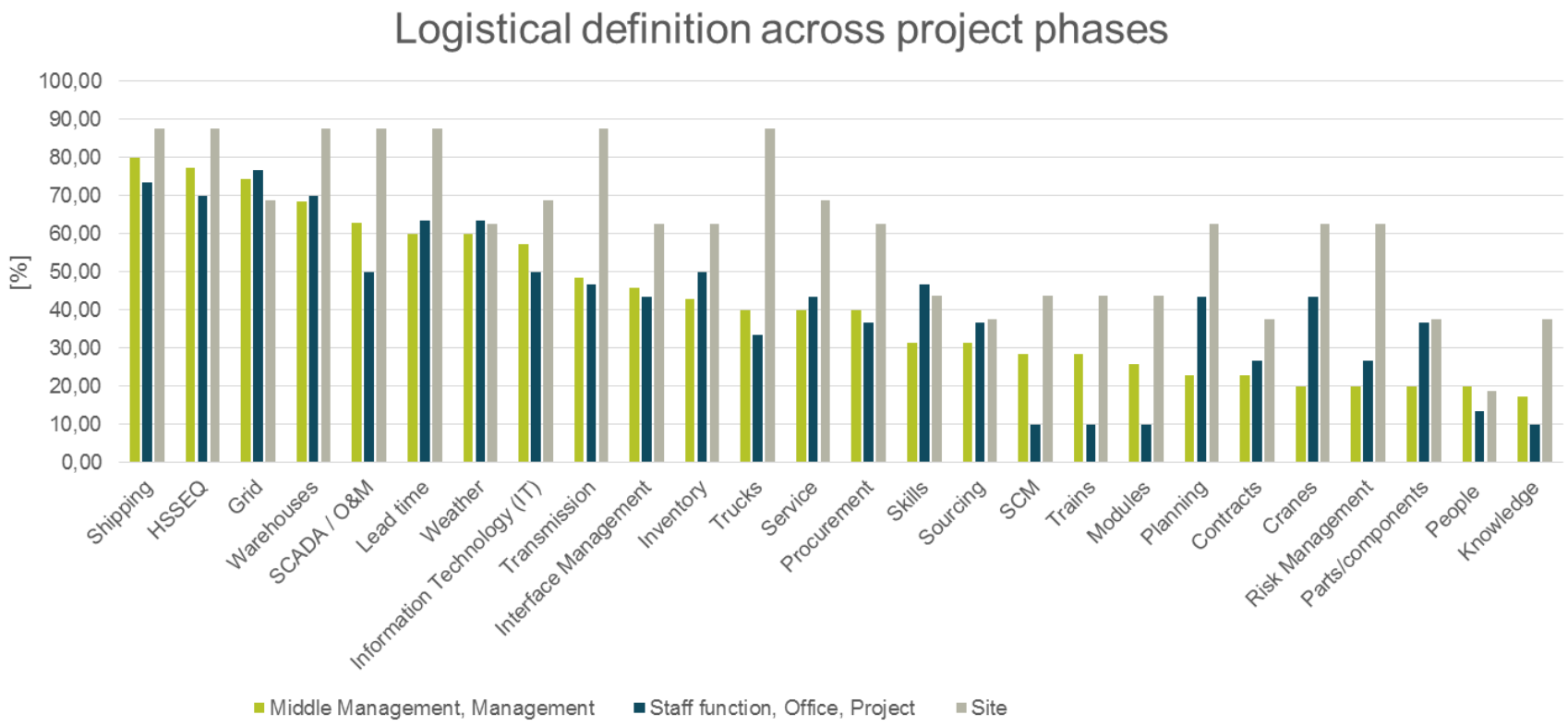
Conclusion:

"The inbound to manufacturing assembly supply chain consists of "standard transportation" mainly by ocean and some air. This part of the end-to-end supply chain was therefore considered less interesting for the project to review than installation & commissioning, operations & maintenance, and decommissioning"

Theory / Practice linkage	Support / Lobby	Challenges /Solutions
Learn biz	Convey info	Practical and relevant / correct
Chinese market network sharing	Investments going forward (vessels, financing, etc.)	Practical background → tools
Reducing LCoE	Project timelines	Academia vs. consulting
Applied research	Offshore wind knowledge	Capture change
Good quality research	Case studies	Look at change in future
Scope: Narrow, realistic, big, complex, crystalize, etc.	Continuous "smart" goals: Concrete, specific, look ahead, value	Moving research target (in time)
On-time project	E2E wind supply chain	Bridge more industries

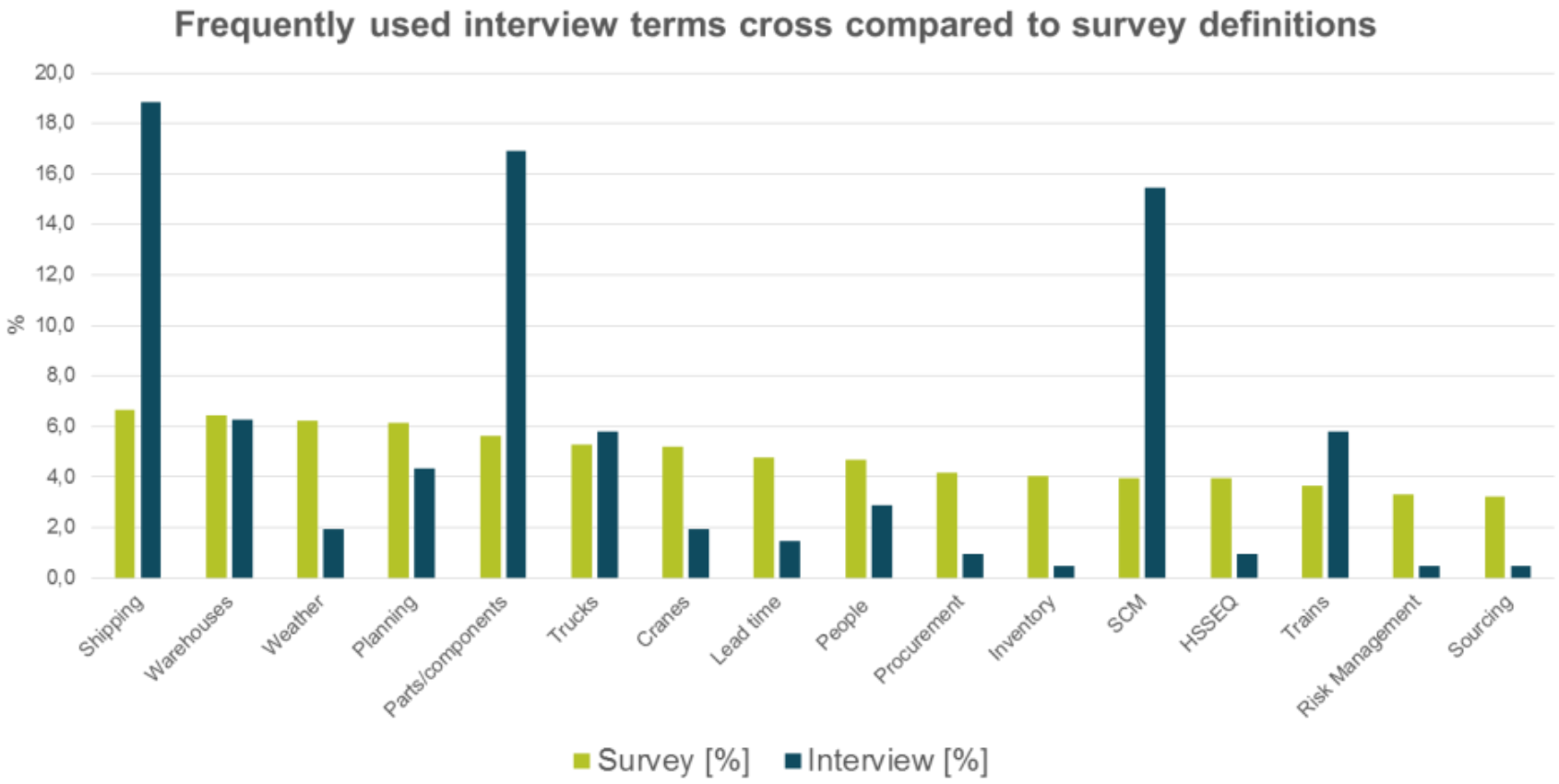
Source: First Reference Group meeting

One of our recent case studies



Source: AAU research, survey results 2015

Firm vs industry language



Source: AAU research, survey and interview results 2015

Case study deep-dive: Firm lingo

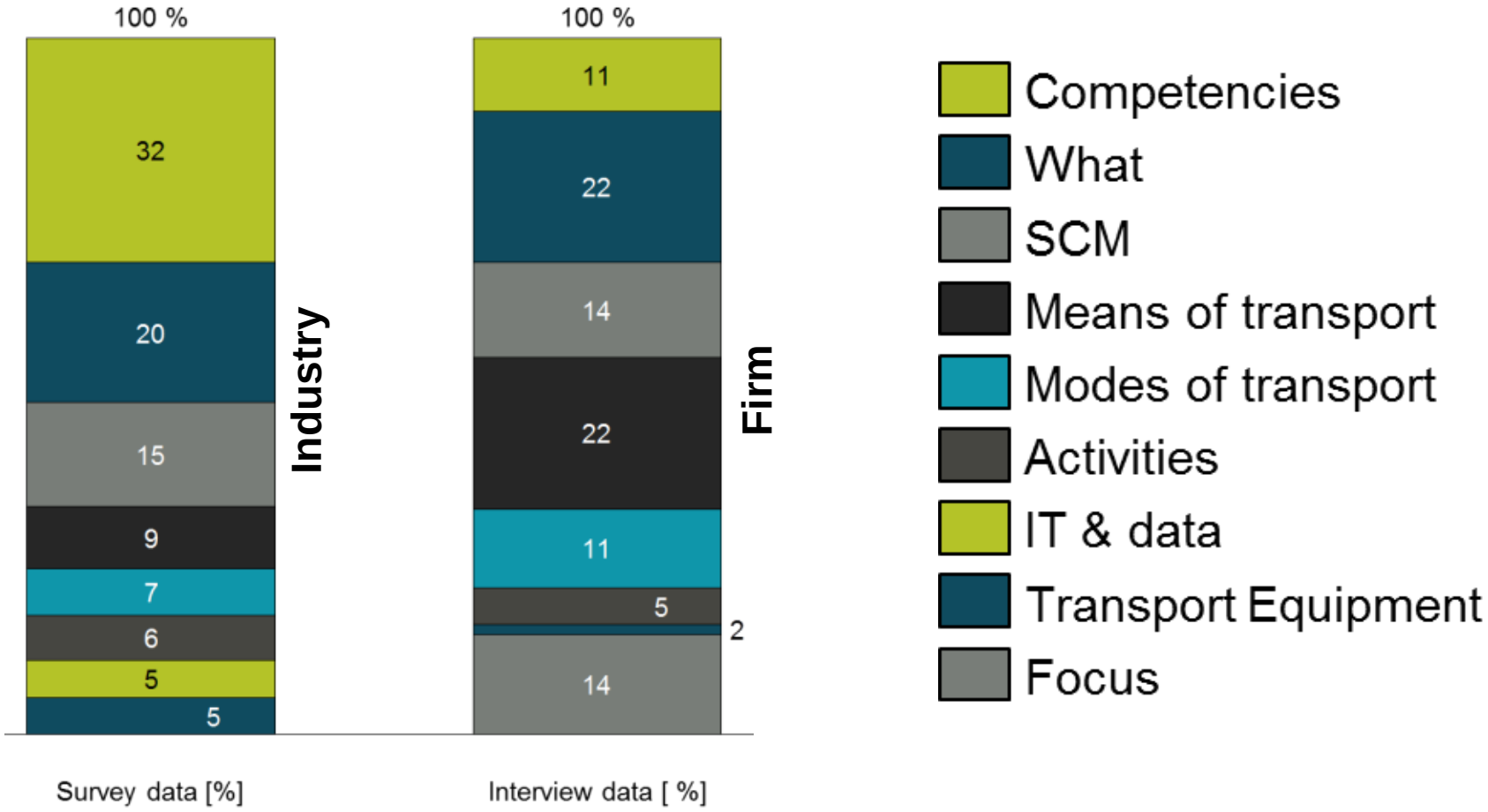
Shipping
Transport
Vessel
Crew transfer vessel
Helicopters
Transportation as part of installation
Accomodation vessels
Survey vessels
Other vessels
Offshore
Transportation with installation vessel
Personel logistics
Execution
Installation vessel
Unloading
Prepare for shipping
Sailing

Parts/components
Foundations
Turbines
Cable
Goods/components
Towers
Building materials
Spare parts
Equipment
Suppliers
Survey equipment
Fixed platform
Life vests
Tools
Installation vessel
Onshore activity
Transition assets
Return of faulty component
Distribution
Unloading
Logistics concepts
Traffic

SCM
Delivery
Reduce delivery time
Setup around transportation
Preparation prior to execution
Coordinate logistics activities
Aligned flow of components
Installation
Logistics in O&M
Transport
Starts at production
End-to-end
Between different countries
Tier one customer
Idea to project handower
Quay site
Build a wind park
Supply
Onshore projects
Knowledge re transportation process quality

Source: AAU research, interview results 2015

Case study: Categories



Source: AAU research, survey and interview results 2015

OW innovation: Siting is crucial

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

- ✓ Near shore
- ✓ Offshore
- ✓ Far offshore

Source: AAU research

In Europe…

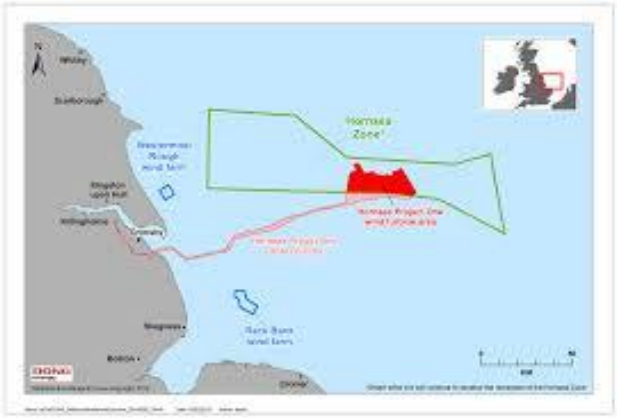
- Similar wind conditions:

➢Horns Reef III

VATTENFALL

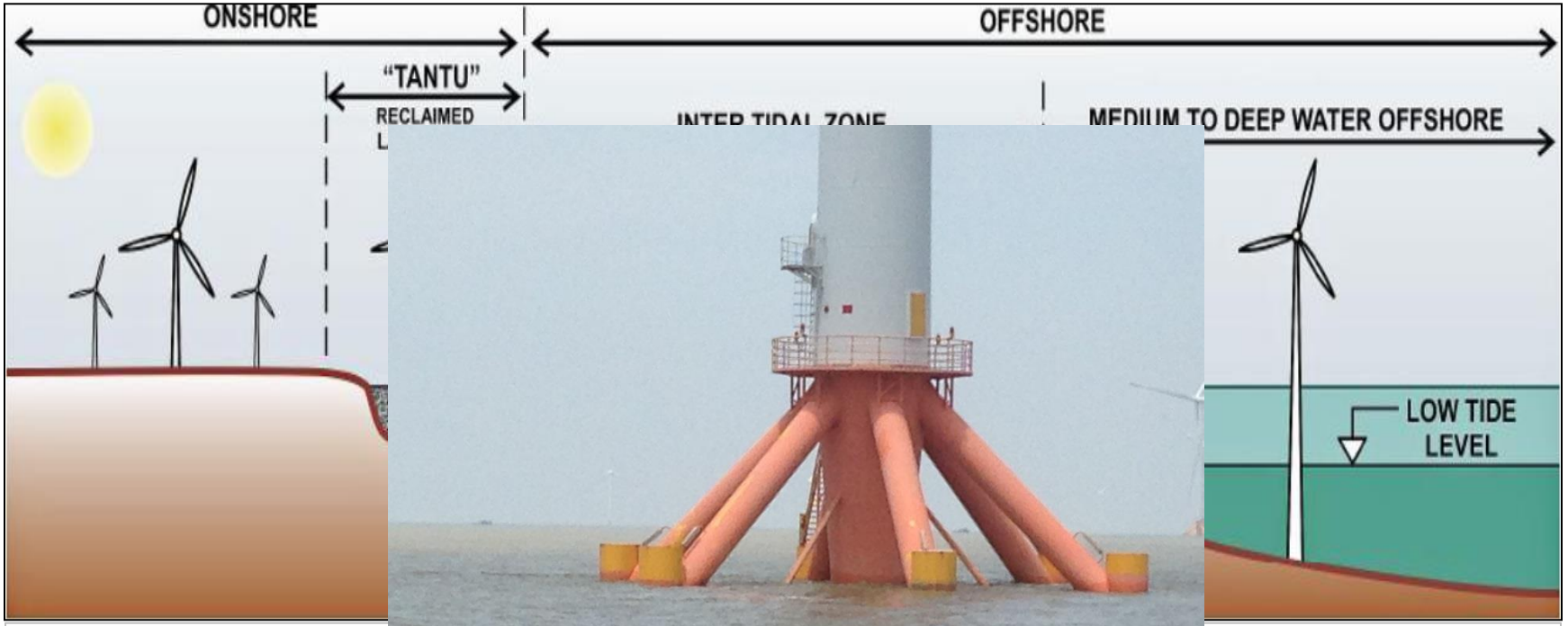
➢Hornsea

DONG energy



Source: AAU research and case study interview findings, 2015

And in China…



Example Jiangs Zhenhua JV):

- 30 km from shore, 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 AAU research

Where the market is picking up…

Cumulative MW in 2012

320 MW

Cumulative target for 2015

2 GW

5 GW

Cumulative target for 2020

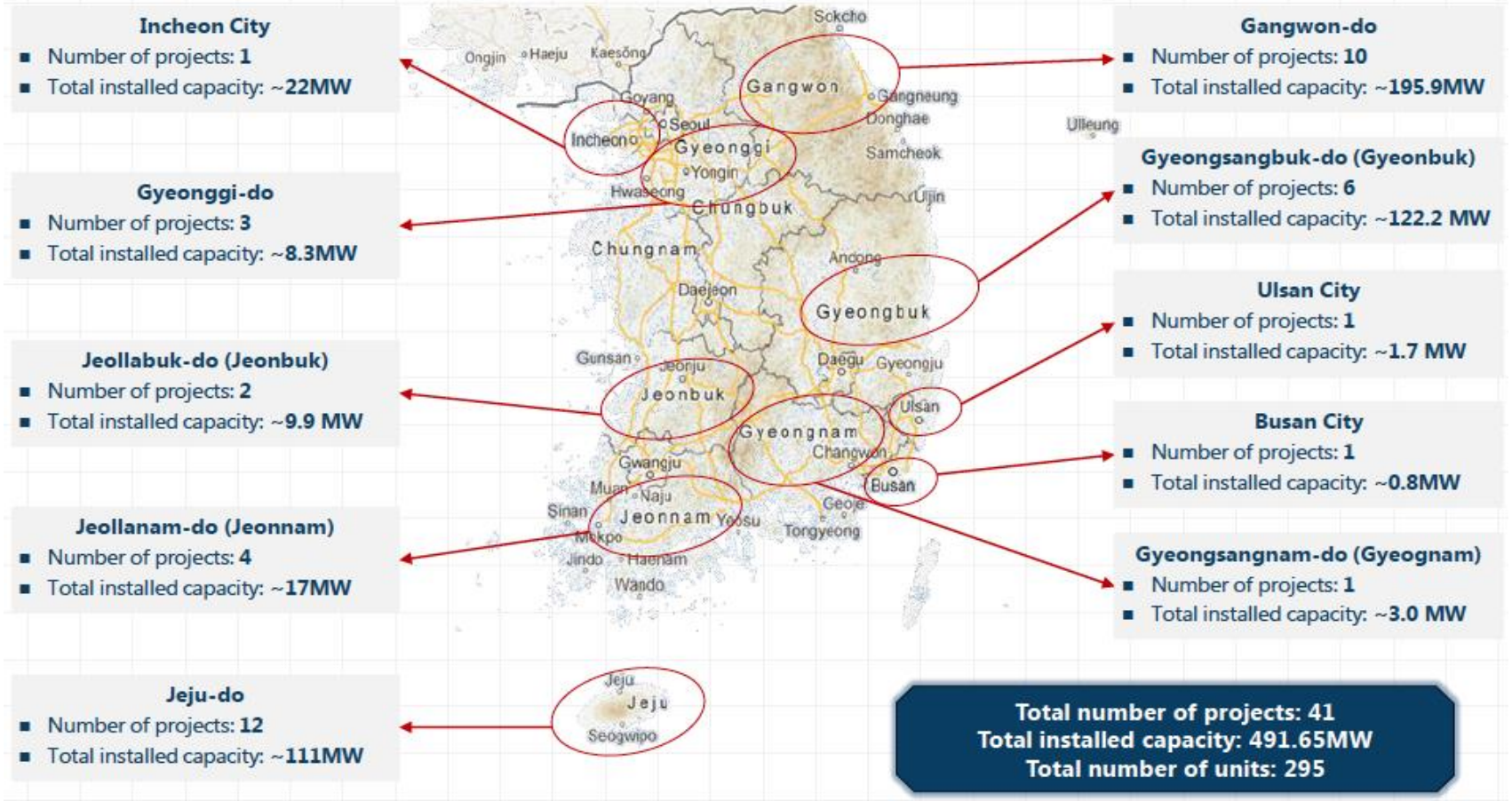
10 GW

30 GW

Source: AAU research and case study interview findings, 2015

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING
- SHIPPING & LOGISTICS

And South Korea



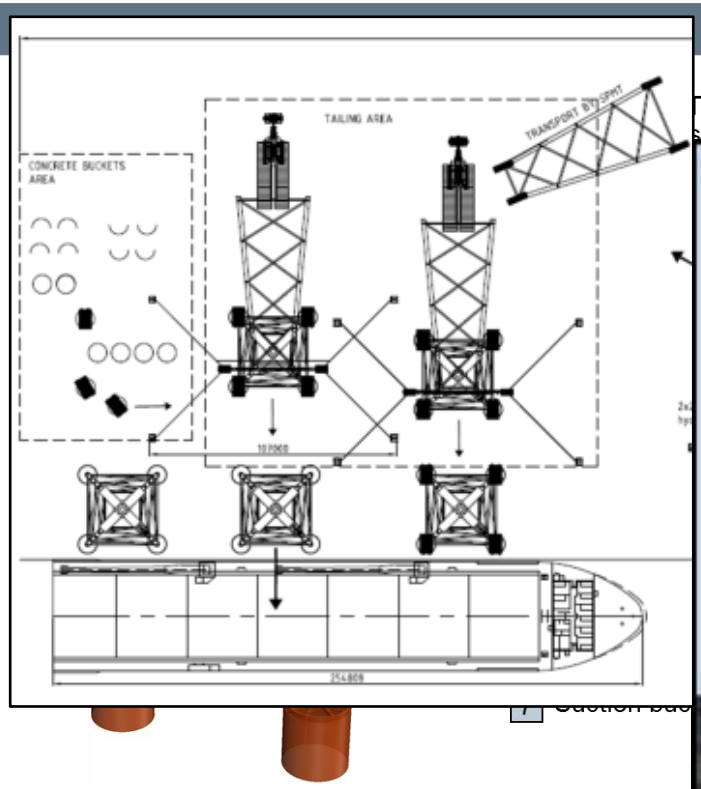
7.5 GW home market offshore wind target by 2030

Source: Korea Wind Energy Association (2013)

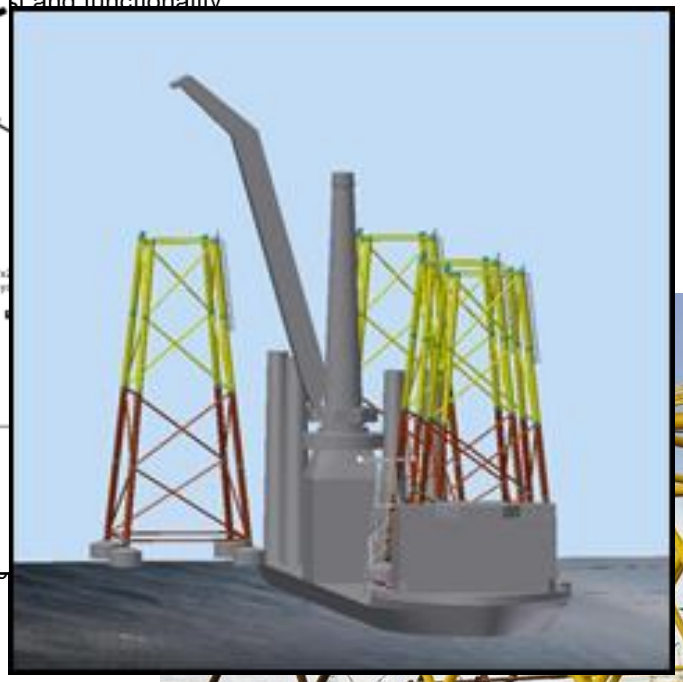
The 6 MW (7 MW) SWP WTG

Source: Henrik Stiesdal, Siemens Wind Power, 2014

Foundations need to catch up…



TP design with focus on simplicity,
st and functionality



Source: Henrik Stiesdal, Siemens Wind Power, 2014

The race is on 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

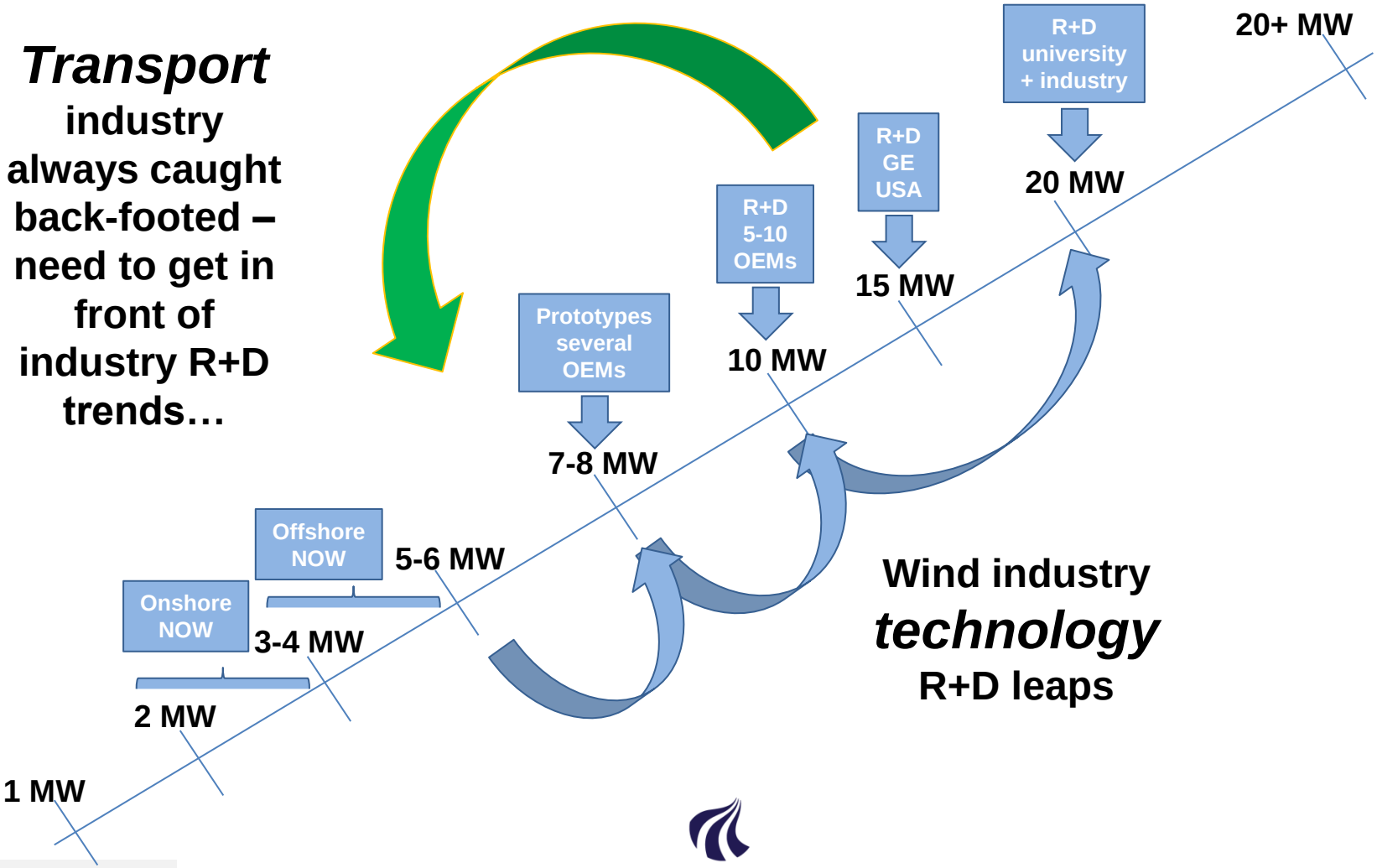
About knowing one's place

The tail does NOT wag the dog

We in transport know that we are basically considered coolies that just make things work...

Innovation – what comes first?

Transport
industry always caught back-footed – need to get in front of industry R+D trends…



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

R+D - logistics

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

NORDEX We've got the power.

ALSTOM

Gamesa

AREVA

Adwen AN AREVA GAMESA COMPANY

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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

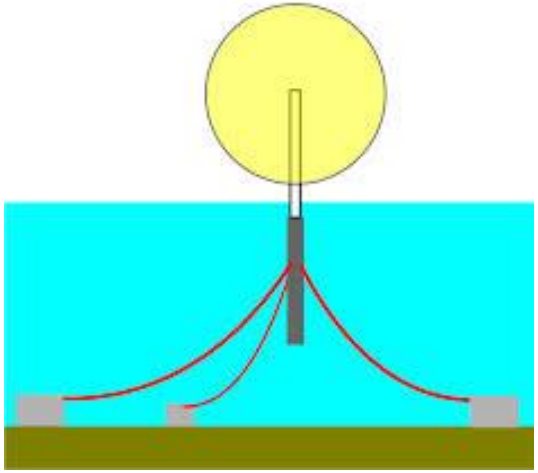
ENVISION

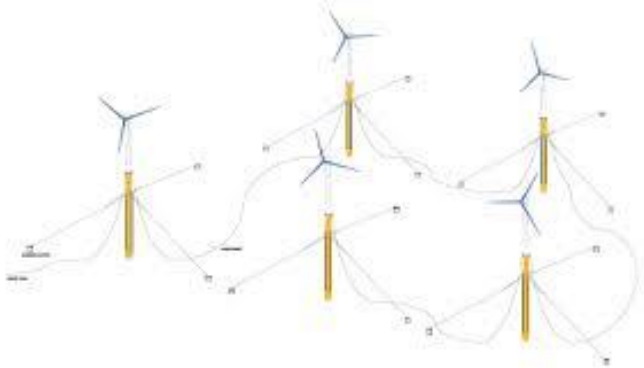
Source: AAU research, DHL Global Forwarding, Renewable Energy Solutions

And what about…?

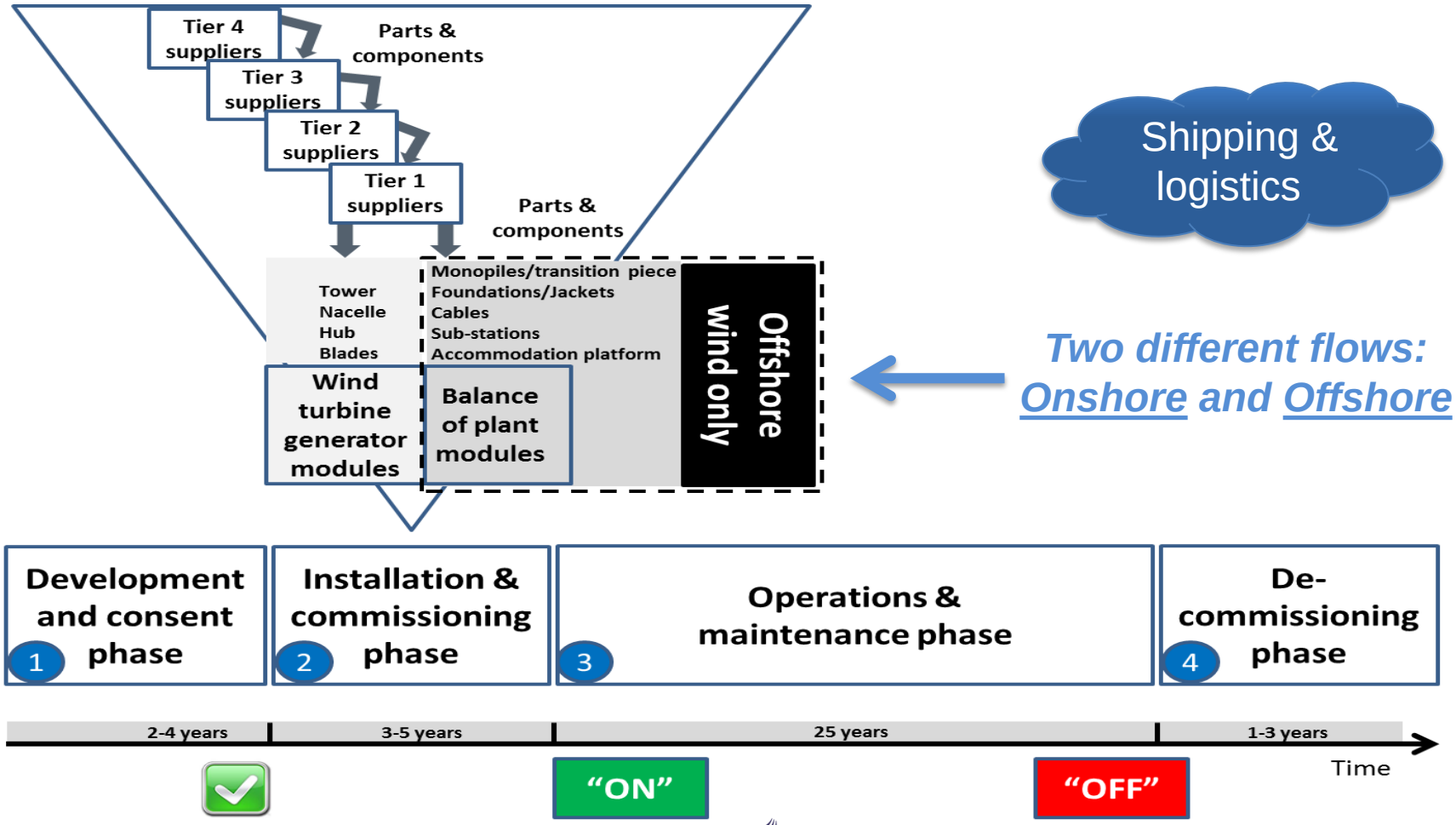
Floating turbines…

- Installation?
- O&M?





End-to-end life-cycle focus



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

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

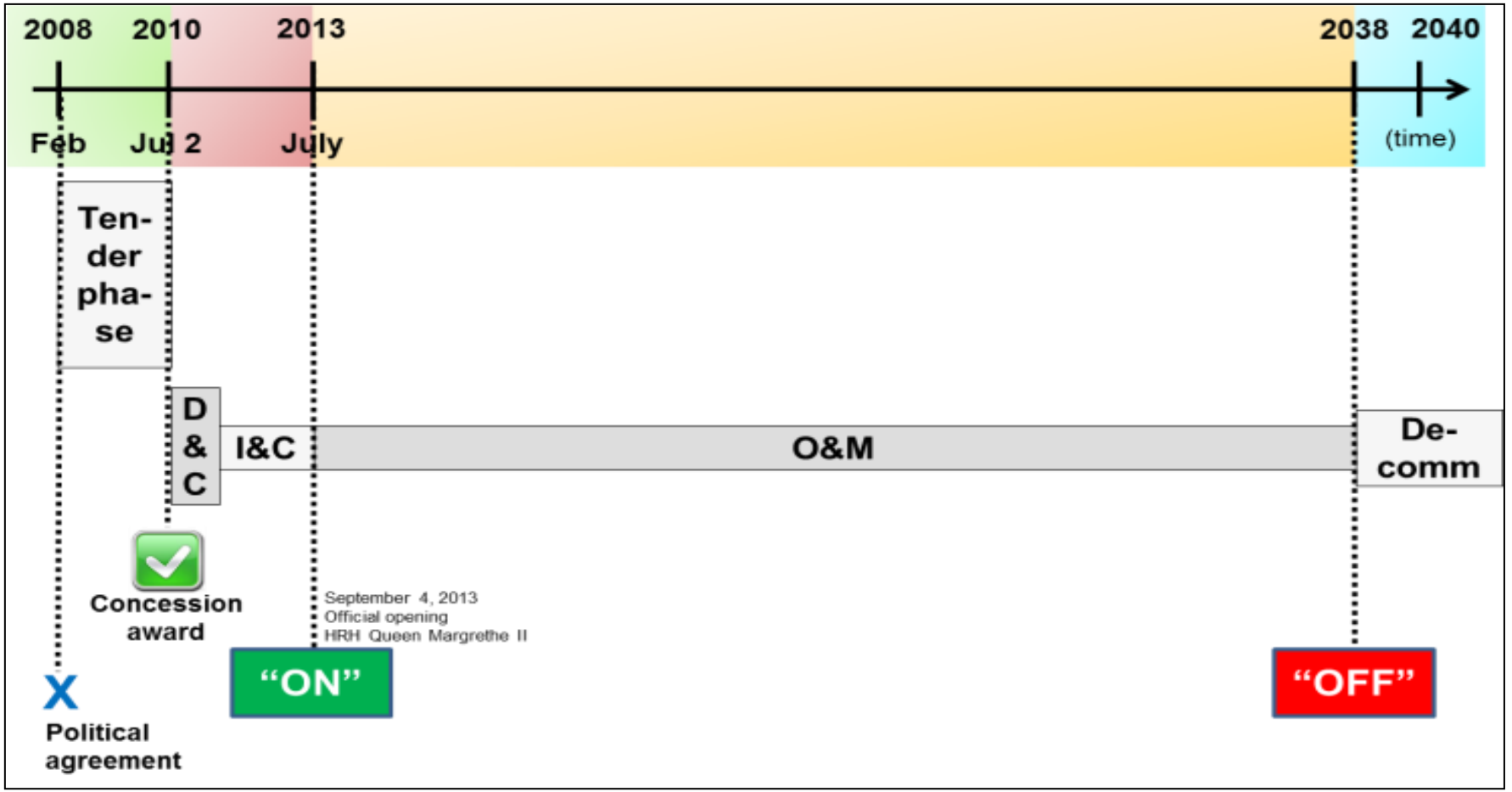
Source: DONG Energy, MTH, AAU research (meetings and site visits), EAWE conference paper, 2013 (Poulsen et.al.)

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



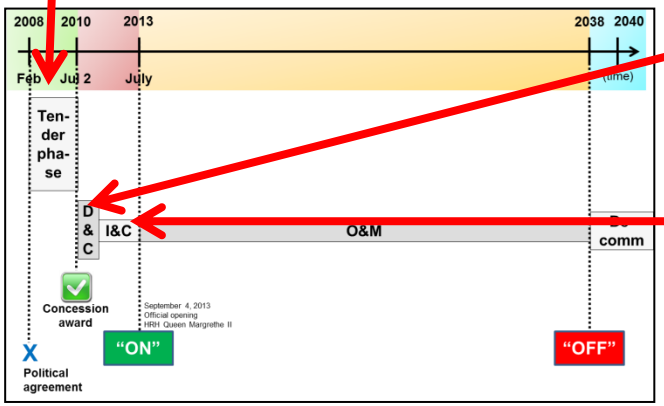
Source: DONG Energy, MTH, AAU research (meetings and site visits), EAWE conference paper, 2013 (Poulsen et.al.)

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

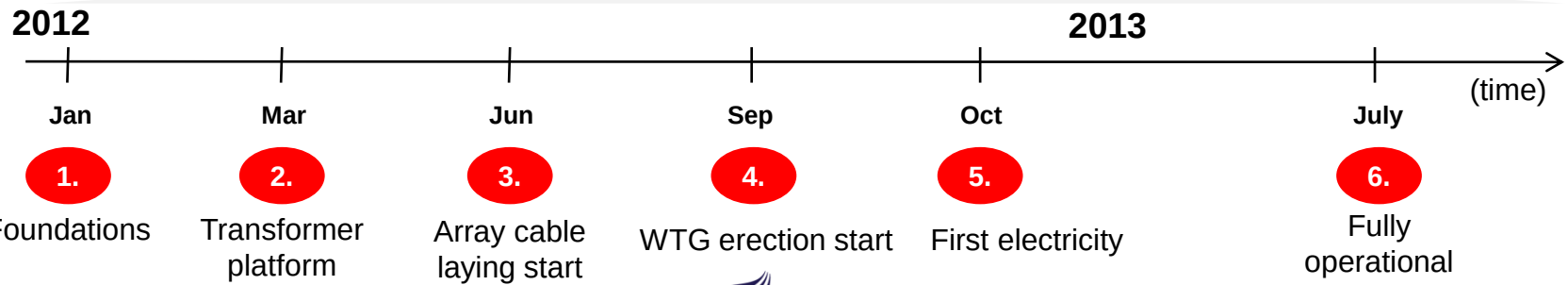


Development & consent phase:

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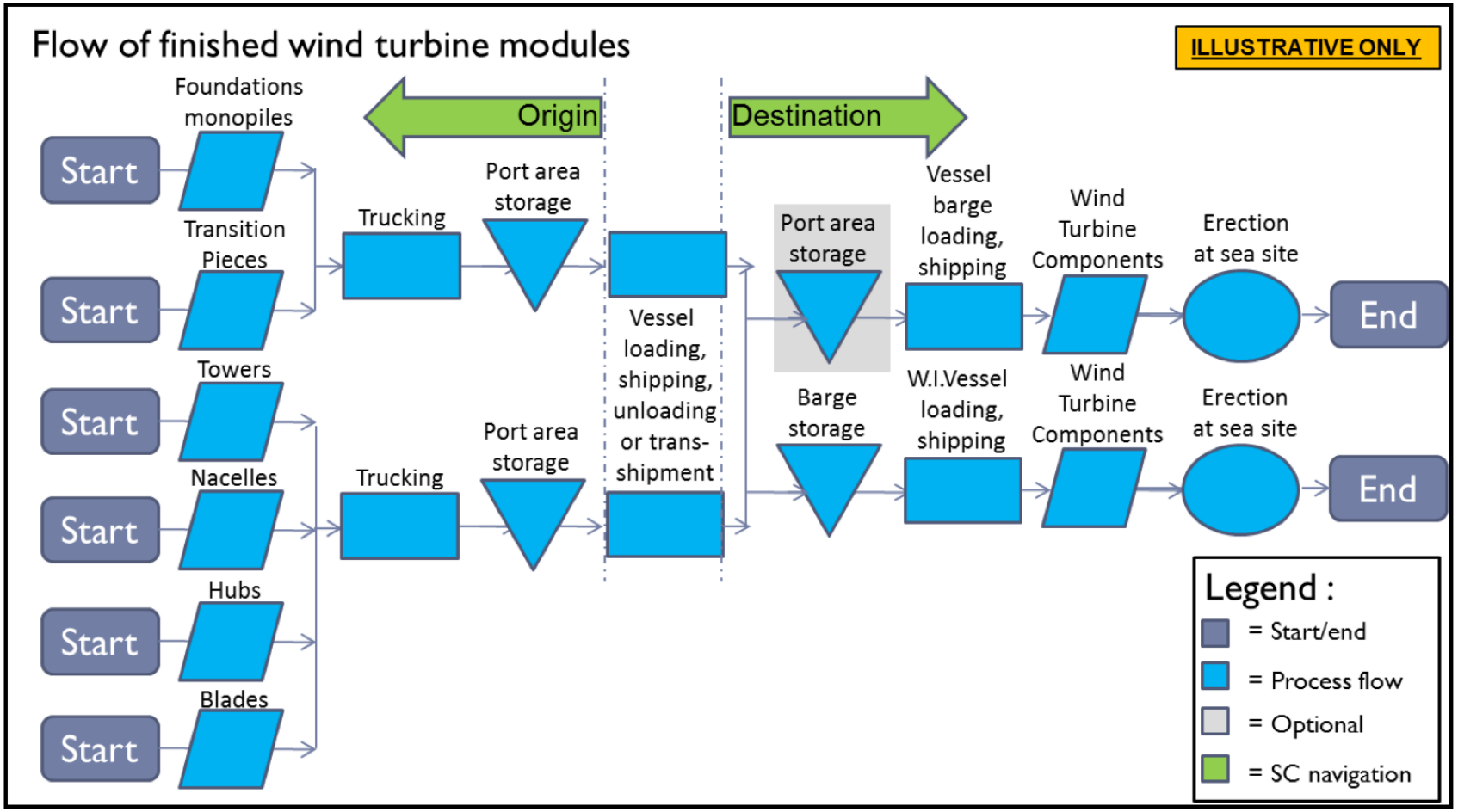
Source: DONG Energy, MTH, AAU research (meetings and site visits), EAWE conference paper, 2013 (Poulsen et.al.)

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

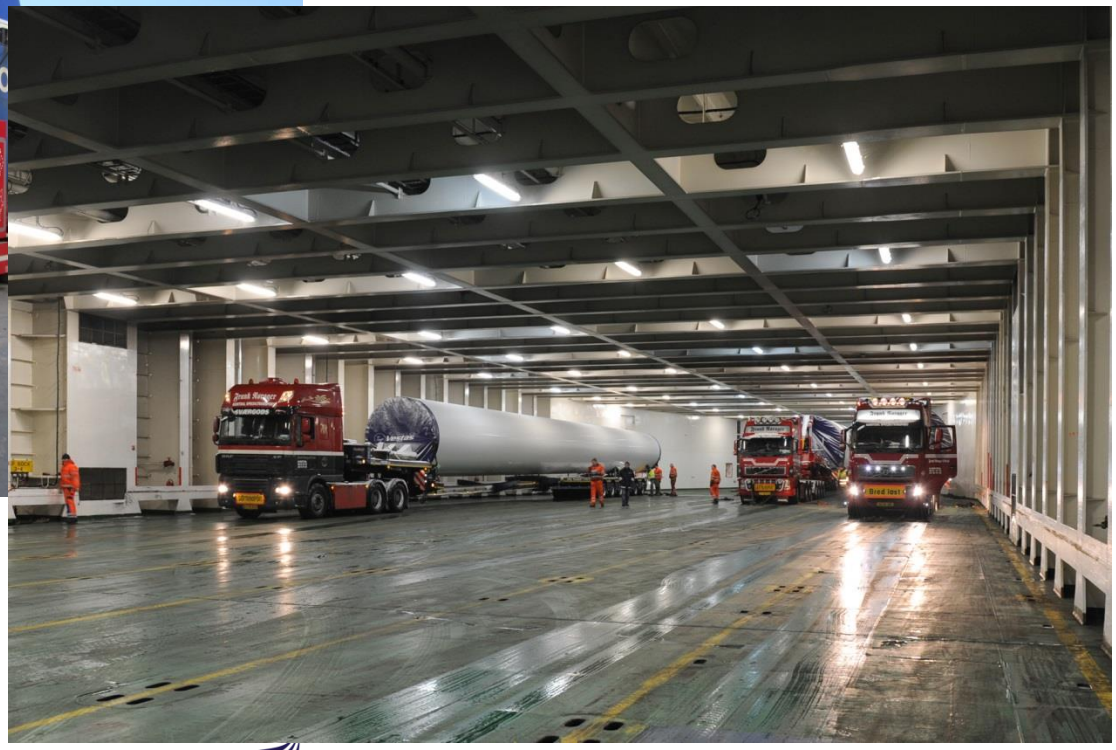


Source: Own construction using Chambers et al (2010) framework

RO/RO safety

Source: Siemens Wind Power internal newsletter

RO/RO safety



Source: DFDS

But also D&C and O&M…

Latest in wind O&M
(SOV)

Surveys

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DENMARK

Source: CT Offshore

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

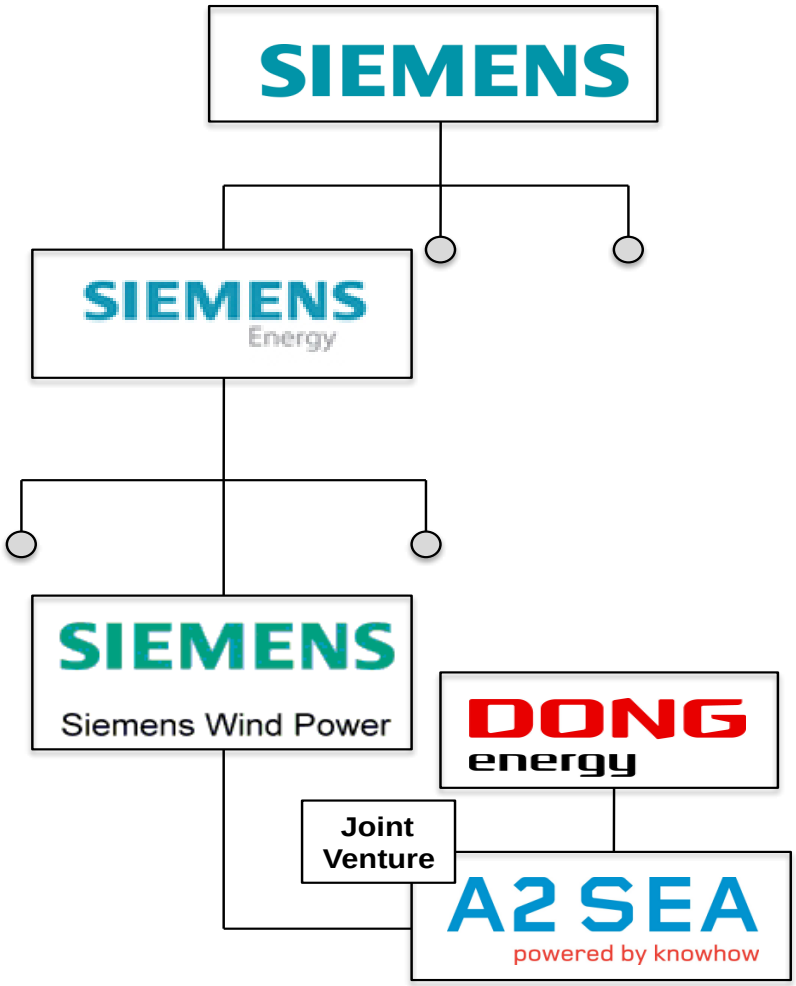
Specialty trucks

Land based cranes

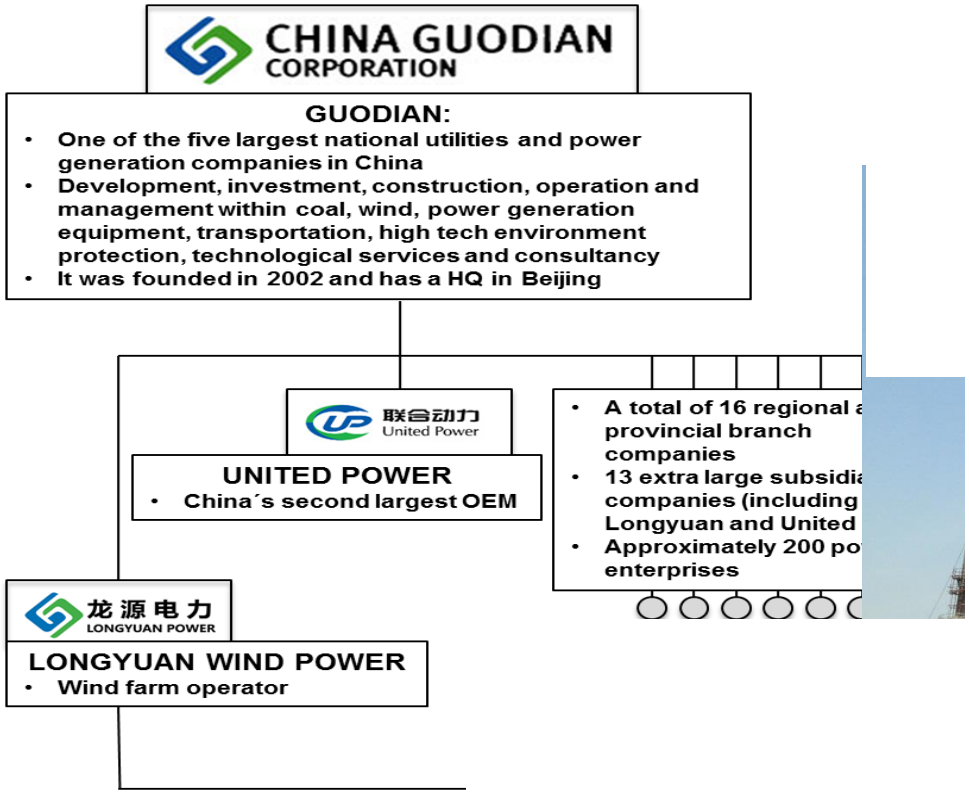
Utilities | **Operators** | **OEM's** | **EPC companies** | **SWF**

Extent of services

Business Model in Denmark

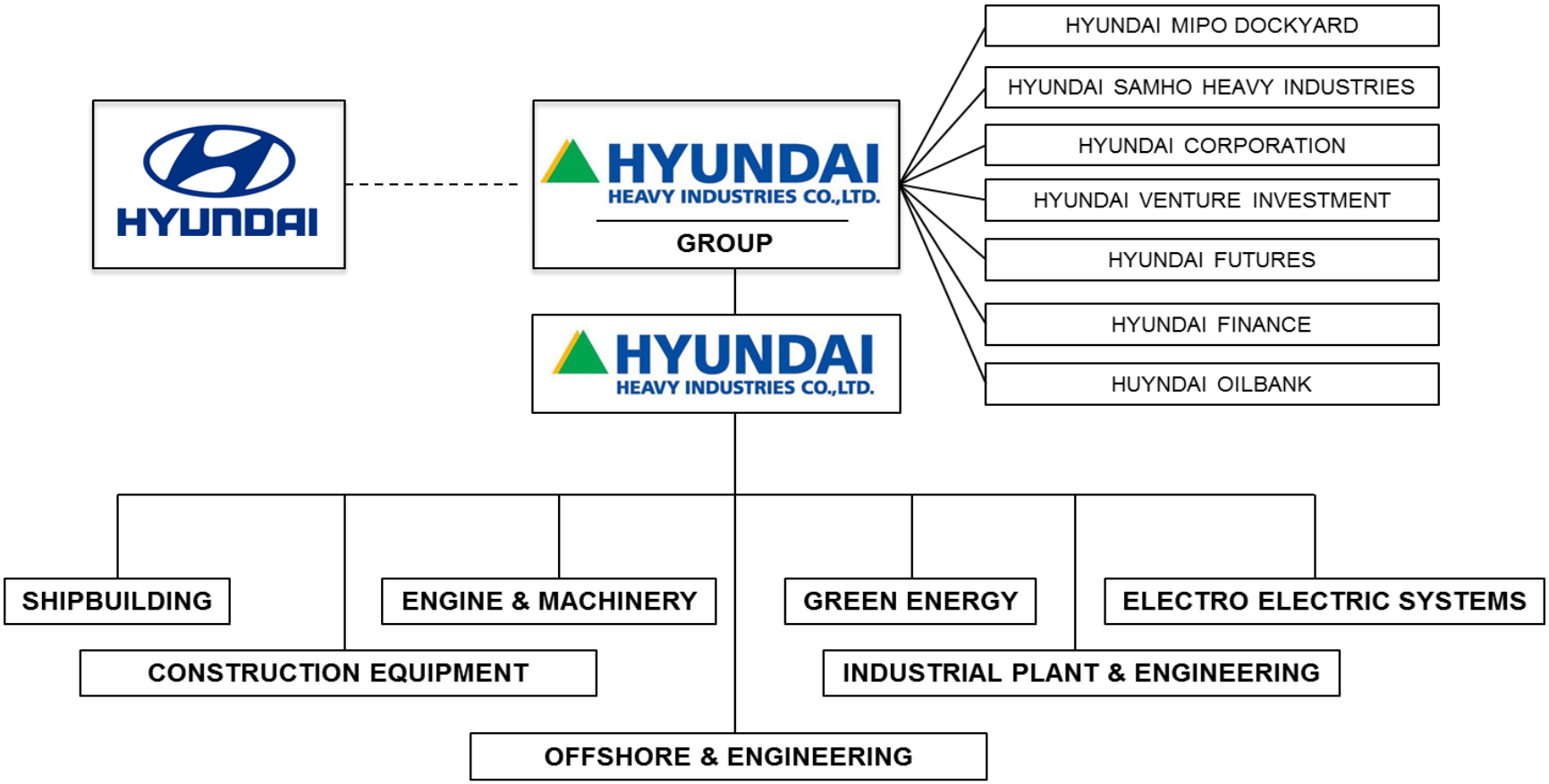


Vertically and horizontal integrated business model China



Top South Korean Chaebol….

Horizontal and vertical integration



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:

Latest M&A activity

- **Shipping.dk** – acquired Maersk Broker Agency from the Danish/Swedish Mærsk family

- **Deme** - acuired Hochtief Offshore via GeoSea subsidiary

- **Van Oord** - acquired Ballast Nedam Offshore

Pending deals

- **Mærsk**
  - Danish based A. P. Møller-Mærsk wants to sell their 75% stake in Esvagt subsidiary

Sold!!!

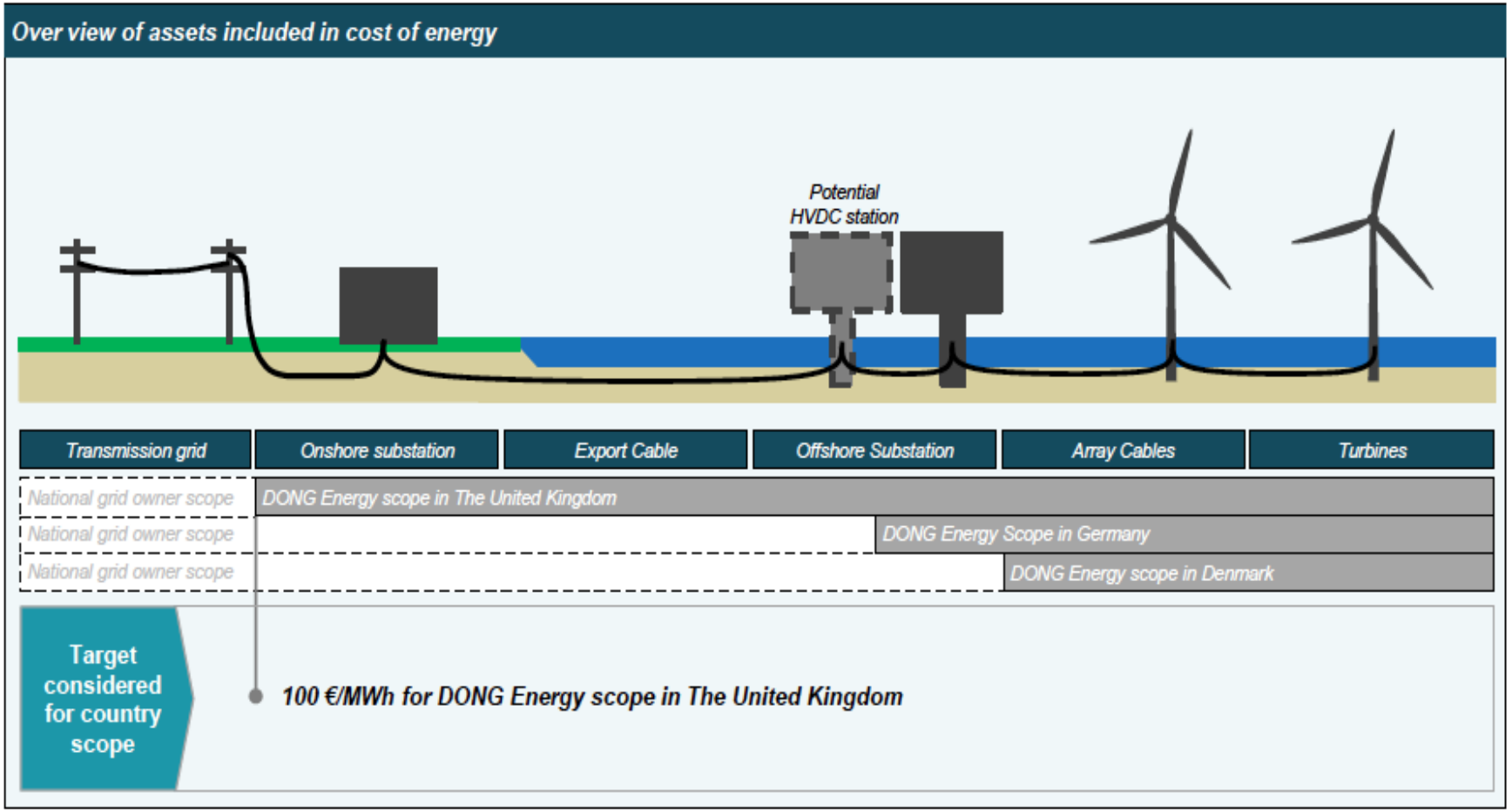
- **DONG Energy**
  - Danish based DONG Energy wants to sell their 51% stake in A2SEA subsidiary including tag-on acquisition CT Offshore

- **Bilfinger**
  - German based Bilfinger wants to sell their Bilfinger Offshore division

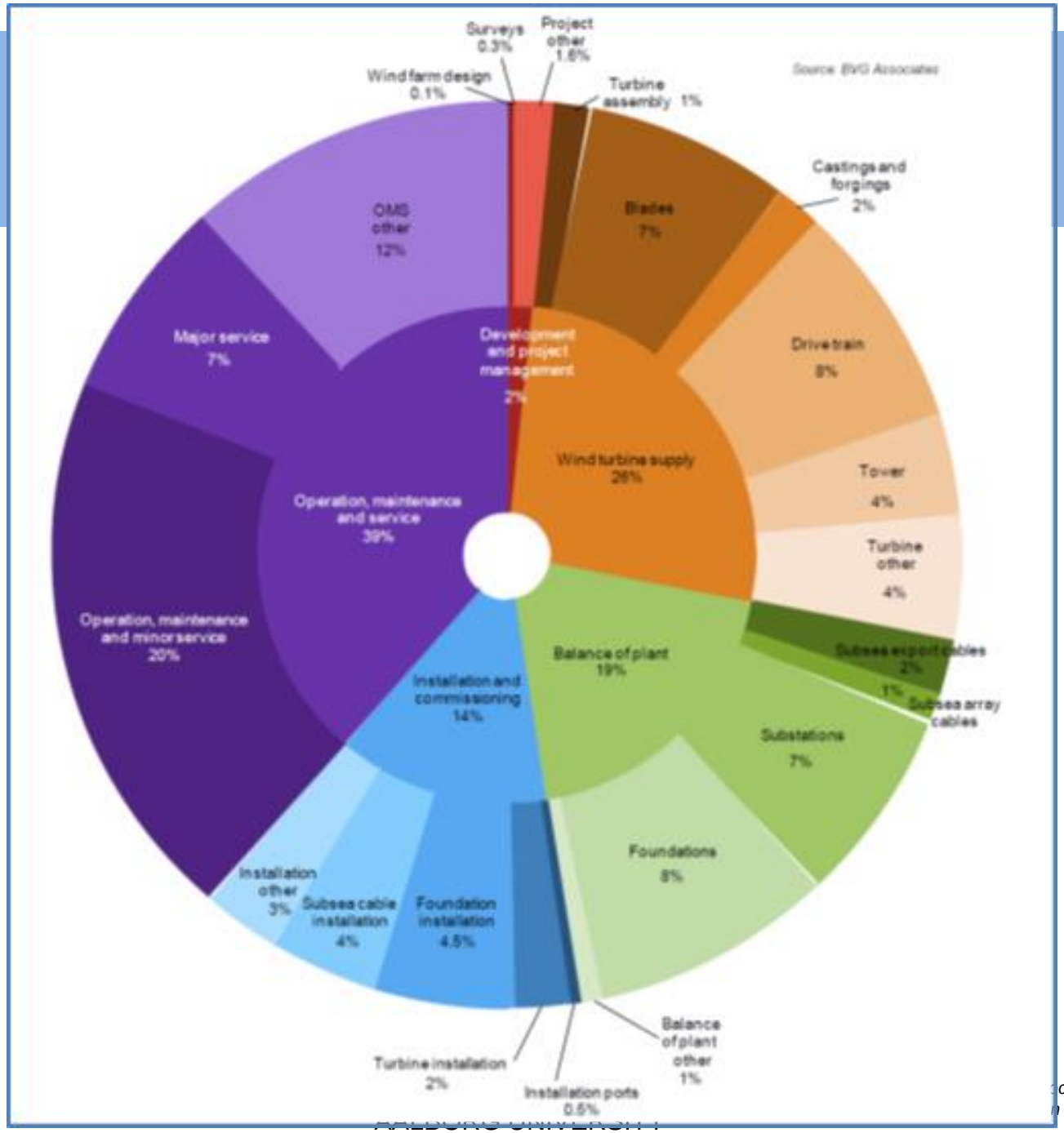
- **RWE Innogy**
  - German based RWE Innogy subsidiary of RWE wants to sell their OLC assets

Sold!!!

Different ways to estimate LCoE

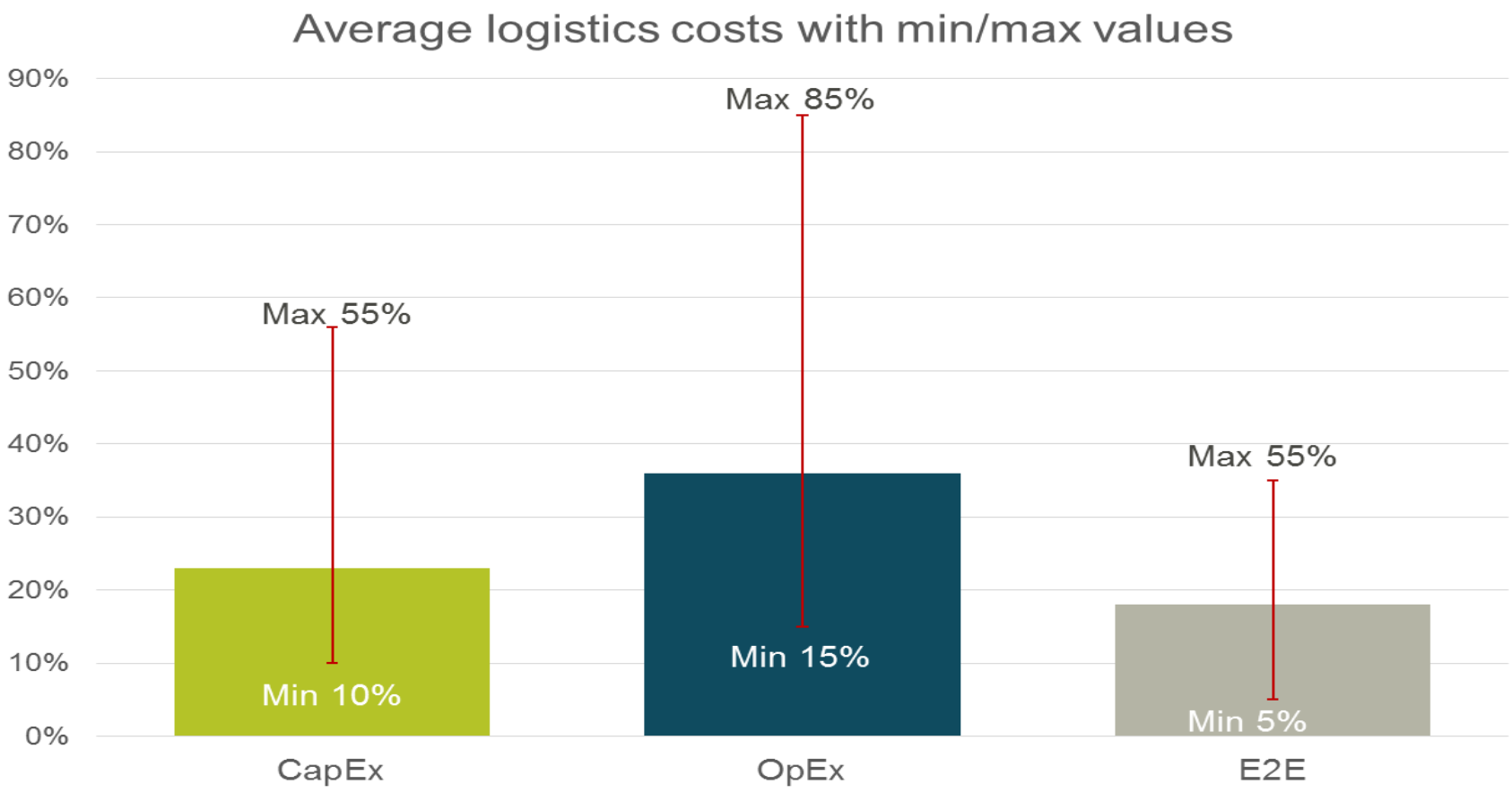


Source: DONG Energy



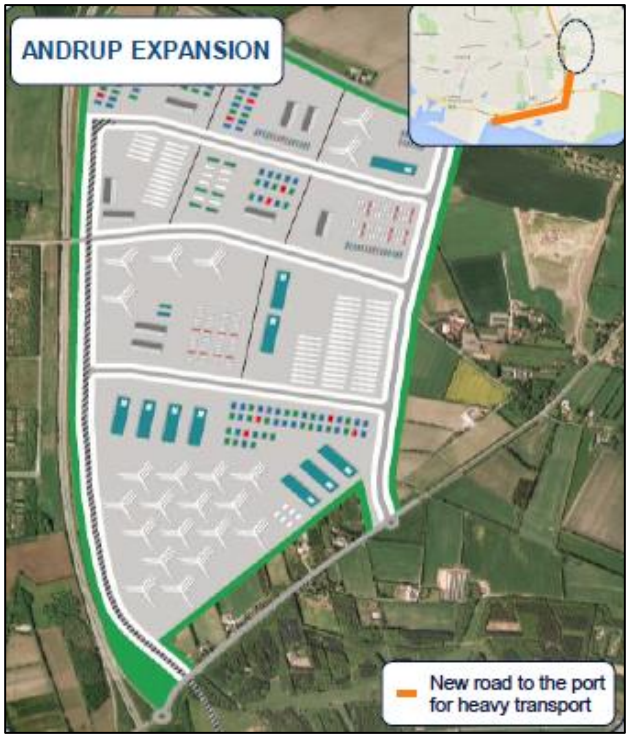
ciates for the Estate, 2014

The money: Recent case study



Source: AAU research, survey and interview results 2015

“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

Key points of today

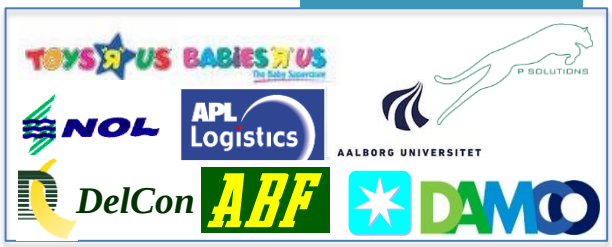
- Logistics and shipping innovation is key for the wind industry
  - Especially offshore wind is on the rise and very challenging
- To deal with logistics innovation, we must be able to
  - Define what we talk about
  - Consider different dimensions such as:
    - ✓ Geography
    - ✓ The different wind components
    - ✓ The life-cycles
    - ✓ The different supply chains
    - ✓ Modes of transport
    - ✓ Involved parties / constituencies
    - ✓ Business models
    - ✓ Market access (organic / M&A)
  - The money
- What drives innovation in logistics?

Should the tail wag the dog?

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

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DENMARK

Discussion

Should technological development drive innovation?

When should logistics and shipping get involved in the innovation process?

Do we need government funding for testing and R+D?