Hybrid Spar

OCEAN RENEWABLE ENERGY DIV.

TODA CORPORATION

TAKASHI HARADA

Agenda

- Who We Are
- Demonstration Project of Hybrid Spar Floating Wind
- Challenge to reduce cost of Hybrid Spar
- Our Perspective for the ScotWind and the Future

History and Heritage of Toda Corporation

1880

▽1881, Founded as Toda-kata

Rihei Toda, Founder
1852-1920

Started as Shrine Carpenter

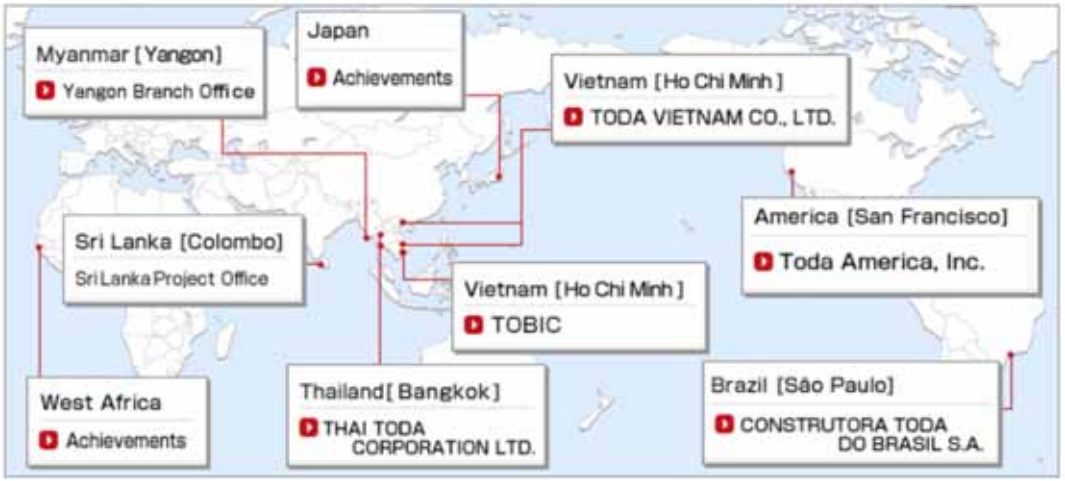
1910

▽1908, Renamed as Toda Group

Keio University 50th Anniversary Library, 1912

1920

Tokyo Taisho Exposition dyeing and weaving hall, 1914



1960

▽1963, Renamed as Toda Corporation

TODA BUILDING, 1961

1980

Expo 1970 Swiss Pavilion

1990

Yokohama Grand Intercontinental Hotel, 1991

Tsushima Airport Expansion, 1983

Kindaich Tunnel of JR East, 2001

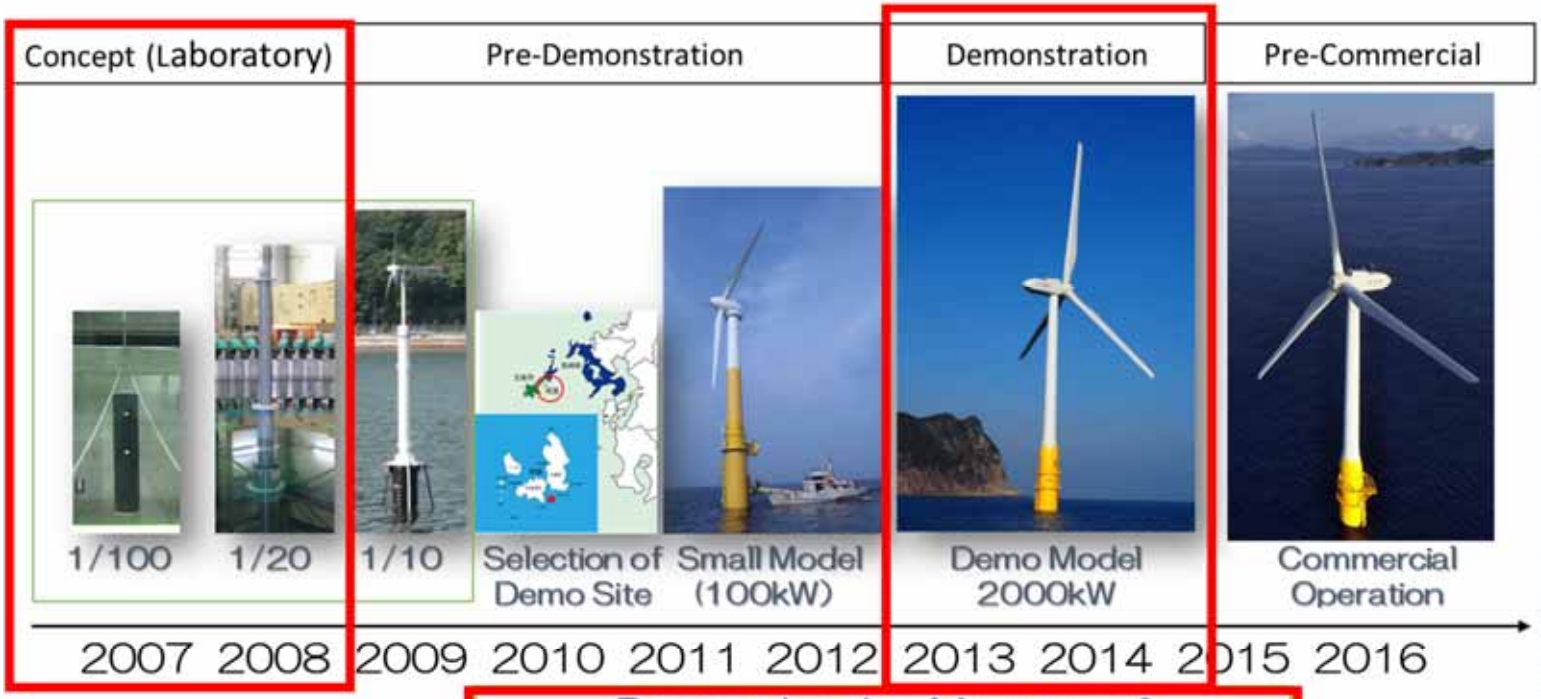
2000

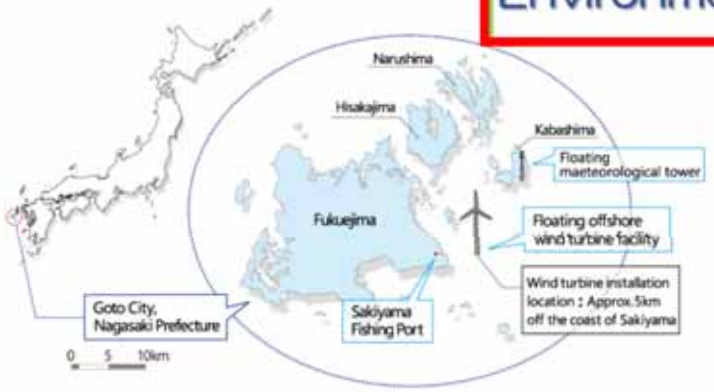
▽2007, Started Wind Business

Demonstration Plant of 2MW, 2012

Demonstration Project of Floating Wind

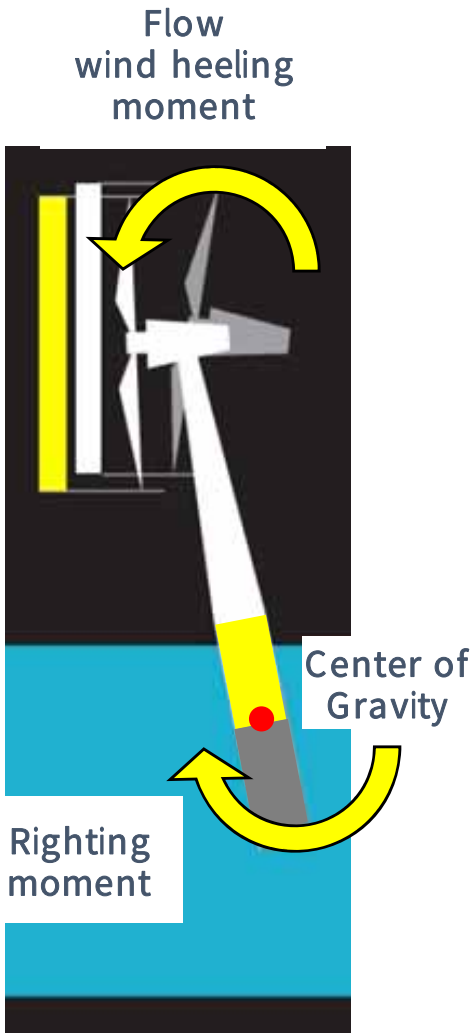
Progress in Hybrid-Spar Project





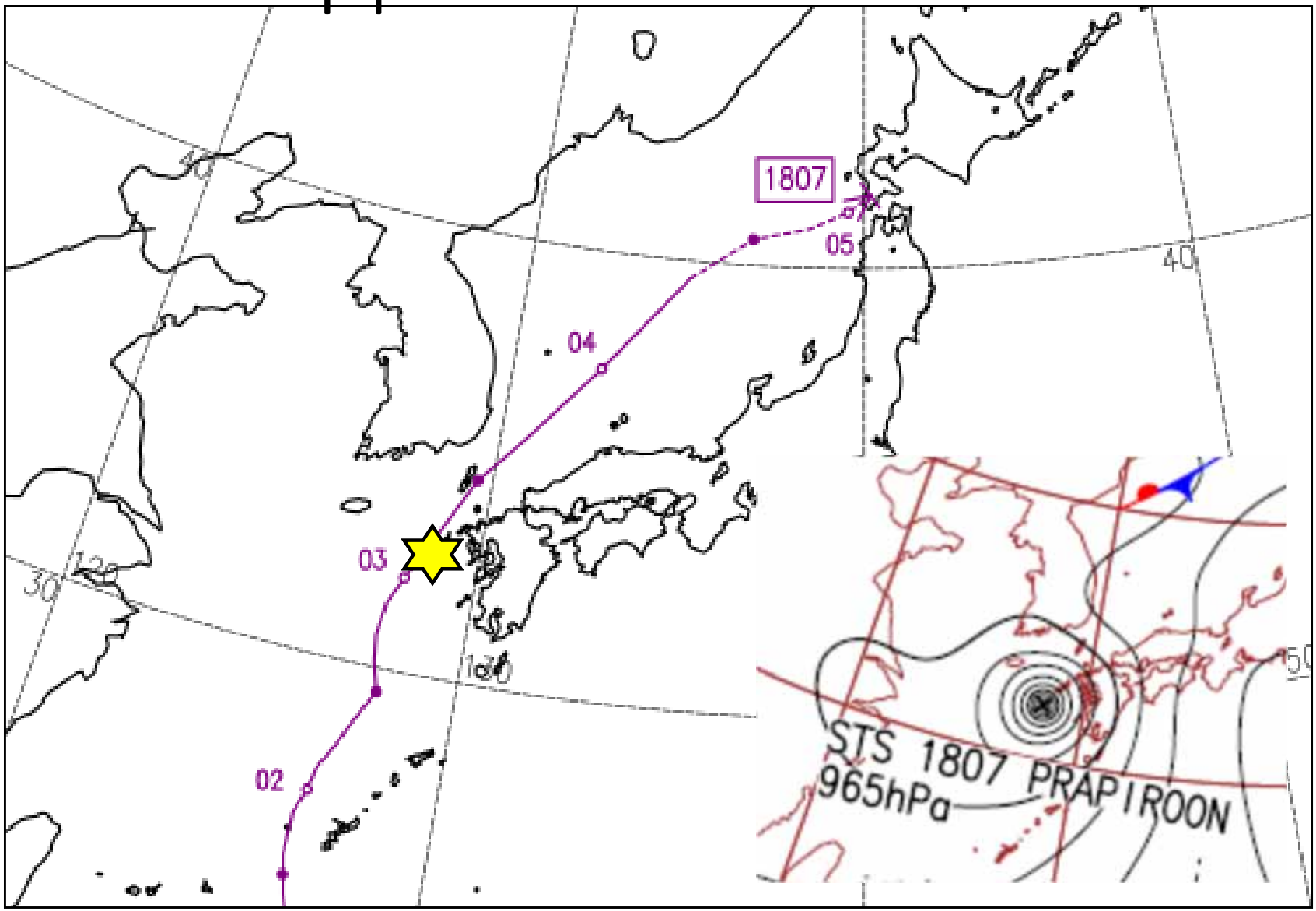
Strengths and Weaknesses

Typology	Strengths	Weaknesses
Semi-submersible	✓ Flexible application due to the ability to operate in shallow water depths ✓ Low vessel requirement – only basic tug boats required ✓ Onshore turbine assembly ✓ Amenable to port-side major repairs	× High structural mass to provide sufficient buoyancy and stability × Complex steel structures with many welded joints can be difficult to fabricate × Potentially costly active ballast systems
Spar-buoy	✓ Simple design is amenable to serial fabrication processes ✓ Few moving parts (no active ballast required) ✓ Excellent stability	× Constrained to deep water locations × Offshore turbine assembly requires dynamic positioning vessels and heavy-lift cranes × Large draft limits ability to tow the structure back to port for major repairs
Tension leg platform	✓ Low structural mass ✓ Onshore turbine assembly ✓ Few moving parts (no active ballast required) ✓ Excellent stability	× High loads on the mooring and anchoring system × Challenging installation process × Bespoke installation barge often required

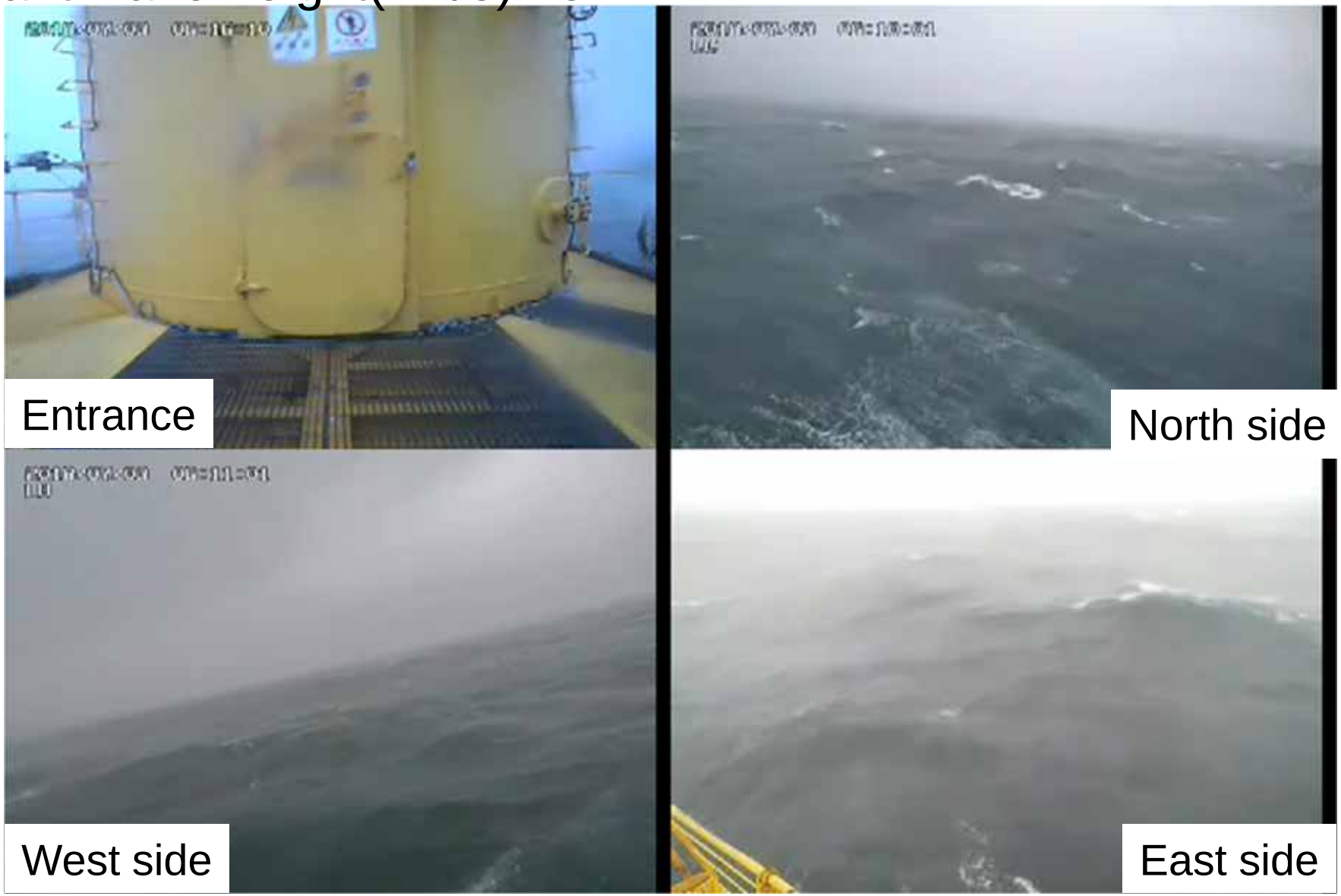


Floating Offshore Wind Market and Technology Review Prepared for the Scottish Government June 2015

Typhoon Approaches

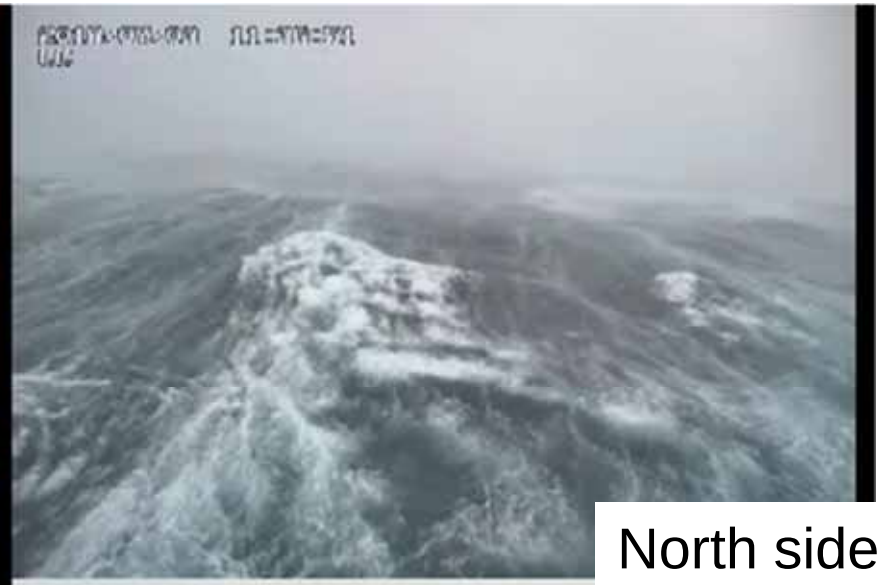


2018/7/3 6:10 AM Wind speed (10-min average) :22.4 m/s 1,988 kW
Significant wave height(H1/3) : 5m



2018/7/3 11:40AM Wind speed (3-sec average) :52.2 m/s
Significant wave height(H1/3) : 7m

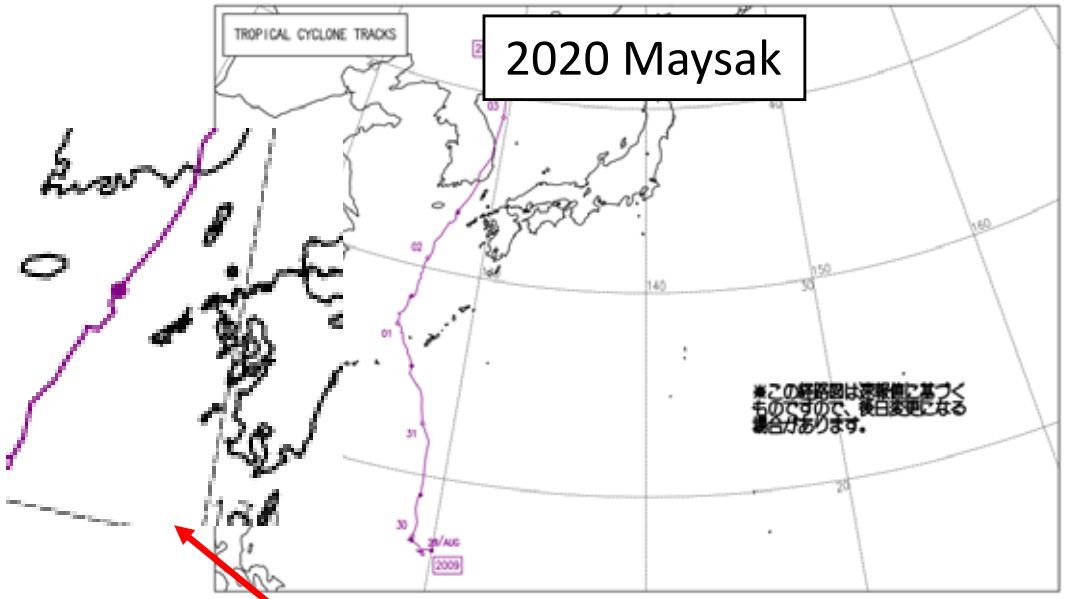
Entrance

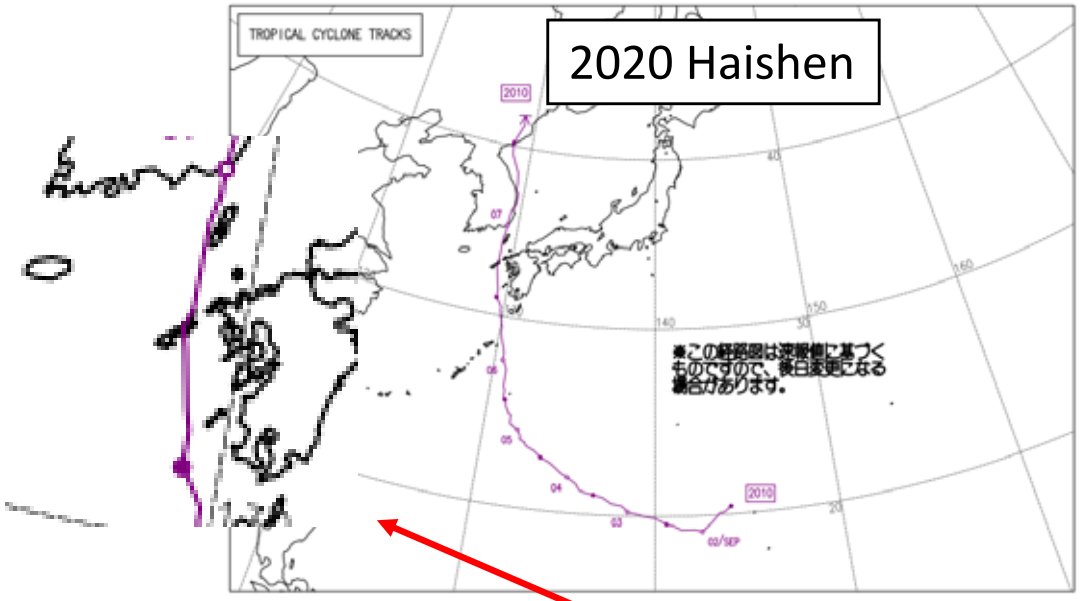


North side

West side

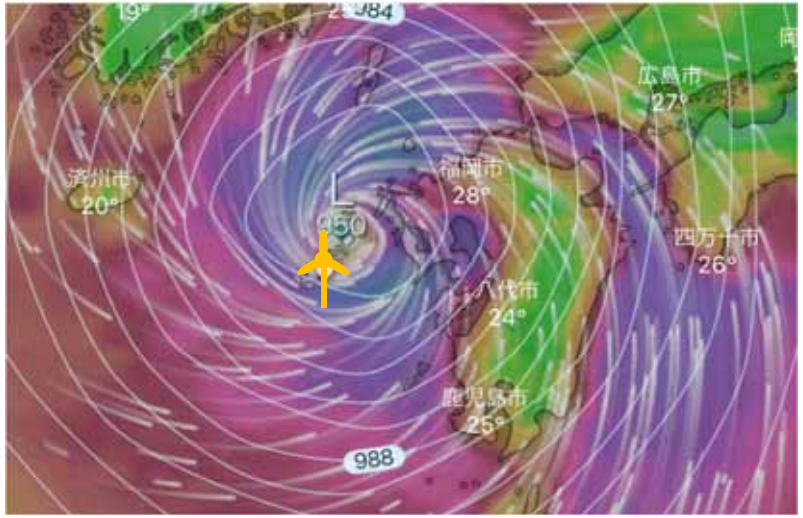
East side





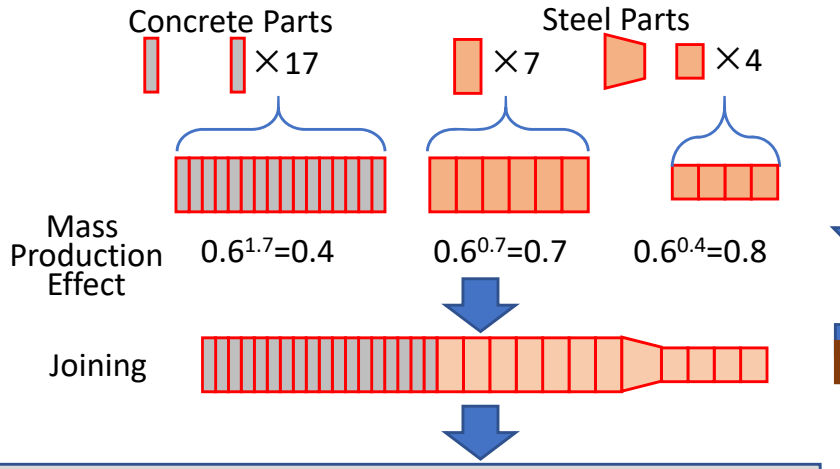
Sep 2 21:00 950hpa
40m/sec(10min ave. at sea level)
Very Strong Typhoon

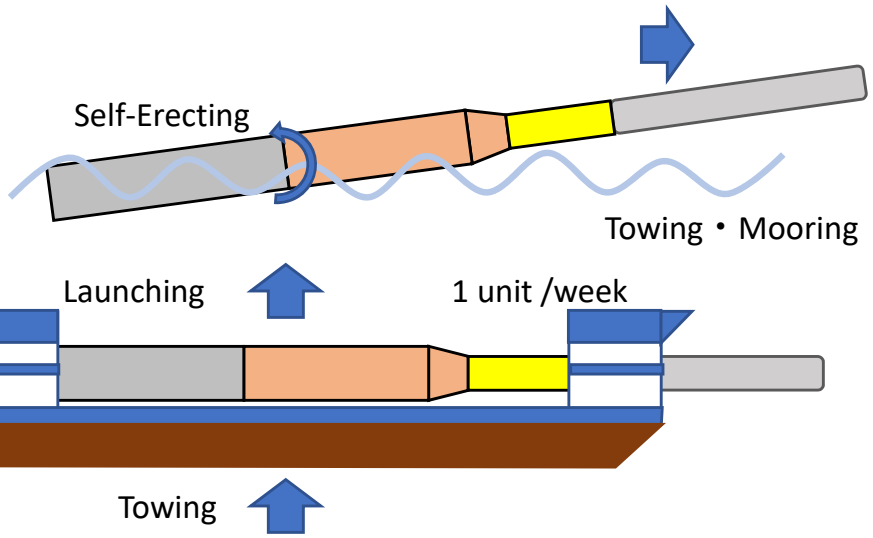
Sep 7 2:00 945hpa
45m/sec (10min ave. at sea level)
Very Strong Typhoon

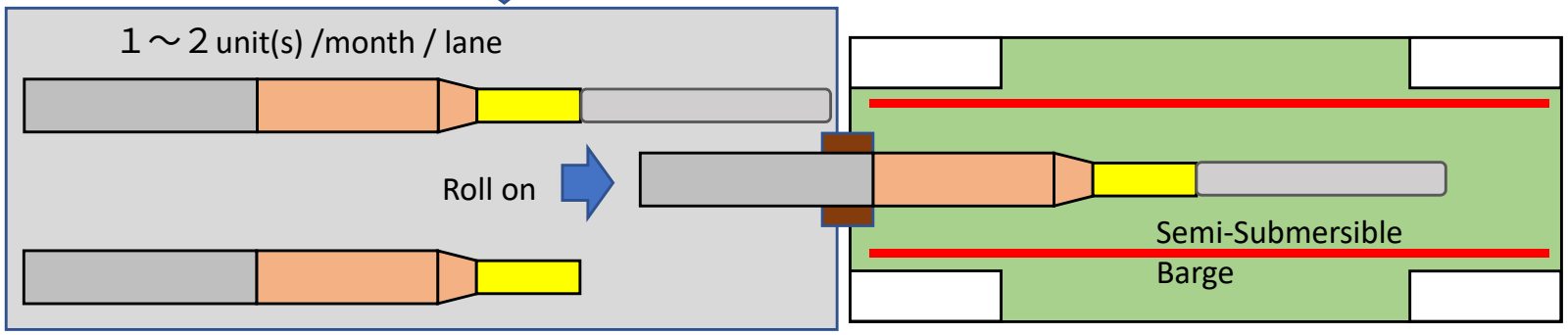


Challenge to reduce cost of Hybrid Spar

Non-disclosed installation method








2021/03/12 11:21:38

Our Perspective for the ScotWind and Future

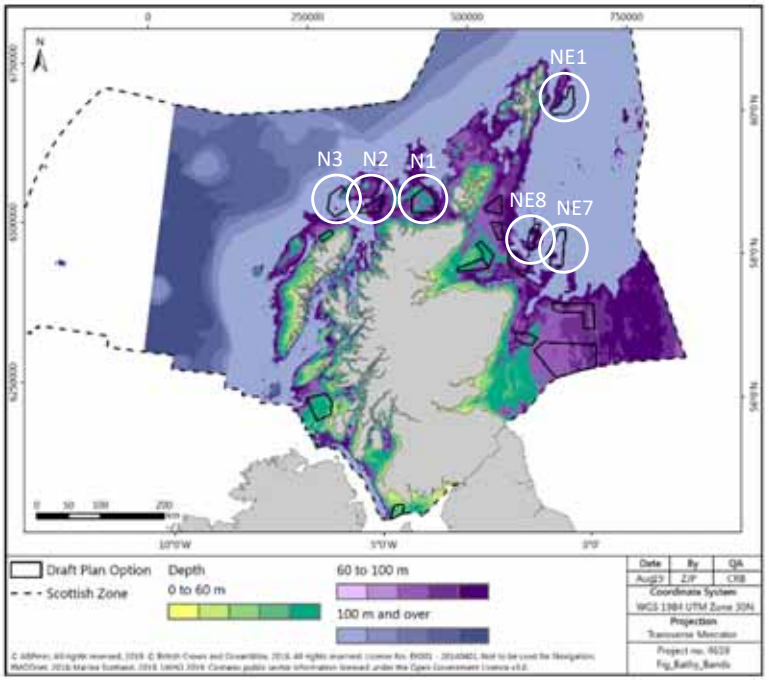
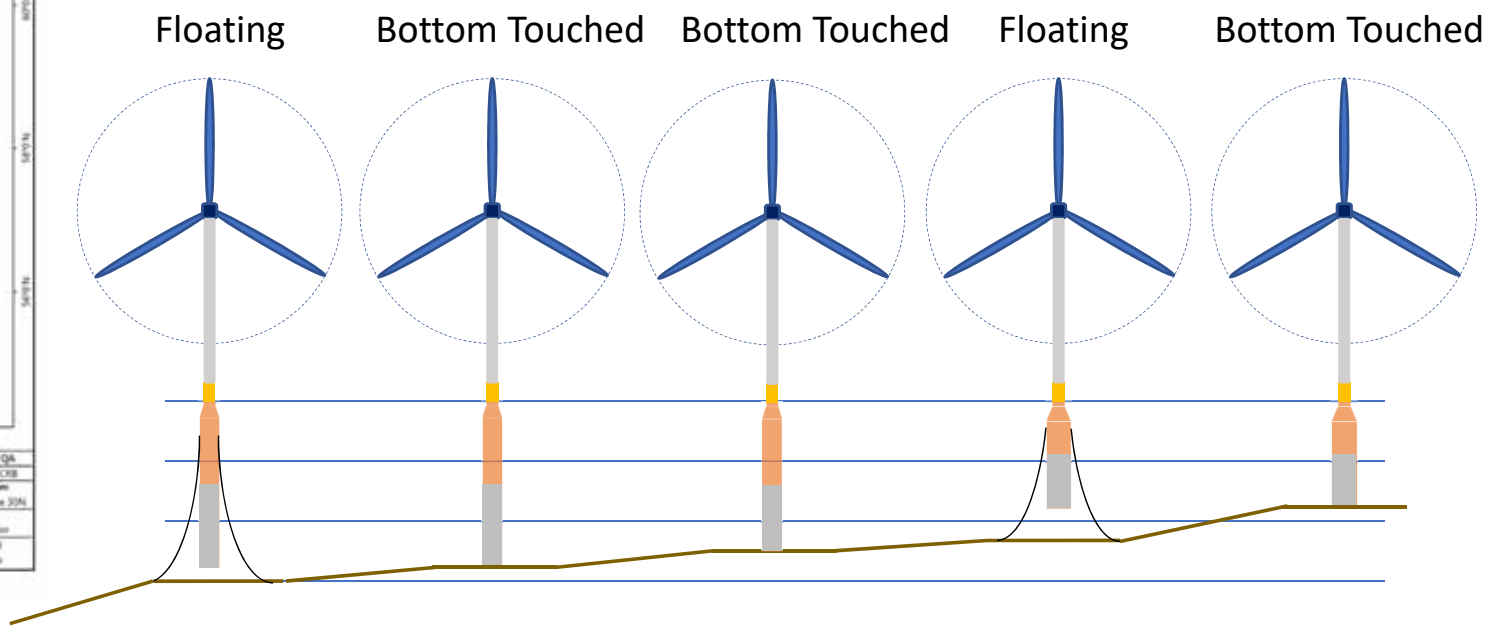


Figure 6 Banded water depths in Scottish waters

Variation against Water Depth



Reduction of Concrete Rings

Chubby One

Same Designed Spar

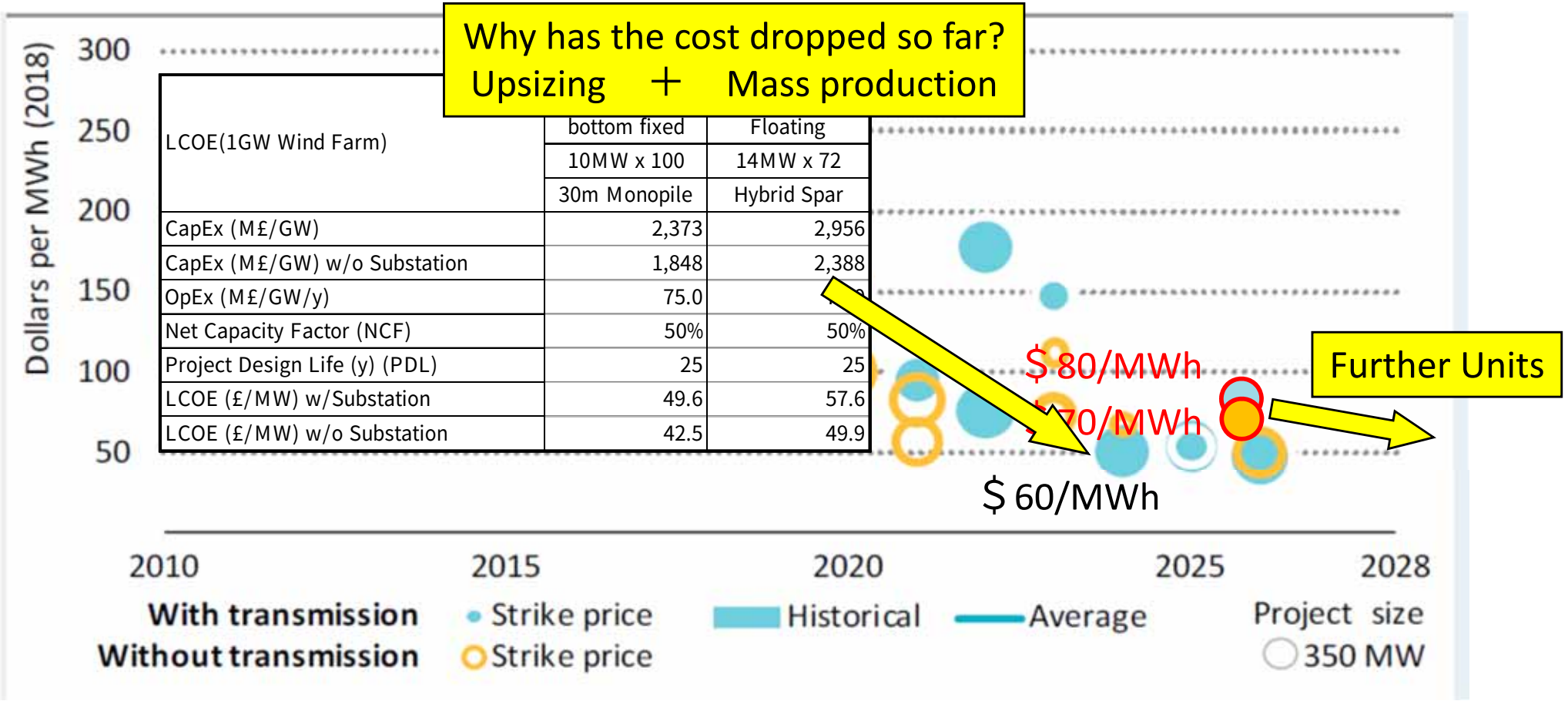
Same Designed Spar

Historical LCOE

Historical LCOE of offshore wind and strike prices in recent auctions in Europe

Why has the cost dropped so far?
Upsizing + Mass production

LCOE(1GW Wind Farm)	bottom fixed	Floating
	10MW x 100	14MW x 72
	30m Monopile	Hybrid Spar
CapEx (M£/GW)	2,373	2,956
CapEx (M£/GW) w/o Substation	1,848	2,388
OpEx (M£/GW/y)	75.0	
Net Capacity Factor (NCF)	50%	50%
Project Design Life (y) (PDL)	25	25
LCOE (£/MW) w/Substation	49.6	57.6
LCOE (£/MW) w/o Substation	42.5	49.9



Offshore Wind Outlook 2019: World Energy Outlook Special Report

Contribution to the ScotWind

1. Site
   - Deeper water is preferable, but available for the water less than 100m depth

2. Need from the local Scottish/UK supply chain
   - Partners on civil engineering at the port, marine works and maintenance
   - Everything except for the floater design

3. Gaps in the local Scottish/UK supply chain
   - Found no gaps on the survey for trial in 2016

4. Local content opportunities
   - Potentially 100% localized

“Anyone Anywhere AS required”

- Anyone
  - Simple design
  - Simple manufacturing process
- Anywhere
  - Less than ideal condition
- As required
  - Any turbine
  - Adapting wide range of water conditions