Stiesdal Offshore Technologies

Tetra foundation concept

Industrialized Offshore Wind Turbine Foundations

Scott Urquhart, April 10, 2019
Founder – Henrik Stiesdal

Former CTO of Siemens Wind Power, retired end 2014

Key Achievements

• Wind power pioneer, built first test turbine 1976, and first commercial turbine 1978; licensed wind turbine design to Vestas 1979, kick-starting modern Danish wind industry
• Served as technical manager of Bonus Energy A/S from 1988, ran company together with CEO until Siemens acquisition 2004, then took position as CTO of Siemens Wind Power
• Installed world’s first offshore wind farm (1991) and world’s first floating wind turbine (2009)
• Invented and implemented key technologies, including Siemens proprietary blade manufacturing, low-weight direct-drive turbines, variable-speed operation, energy storage, etc.
• Holds more than 800 patents

Post-Siemens activities include work on low-cost offshore infrastructure, high-capacity energy storage and carbon-negative fuels
Framework

Company Structure
• Climate technology company with focused subsidiaries

Purpose
• Combat climate change by developing and commercializing solutions to key challenges

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Offshore wind is competitive and the market develops accordingly

Source: WindEurope
But there is a snag -

Offshore wind as we know it is only applicable in selected locations

• Maximum water depth of fixed foundations 40-50 m
• Can be applied in Northern Europe, off China and off US East Coast
• Most other population centers have much too deep nearshore waters

Source: NOAA
The solution – floating offshore wind power

Source: Statoil, Principle Power, Hitachi, MHI

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But again – there is a snag: Floaters are not industrialized

Shared characteristics

- Very heavy – from 2500 tons to 10,000 tons for 7 MW class turbines
- Construction methods from shipbuilding and offshore oil and gas sector
- Fabrication typically at port of floater launch
- Build times typically measured in months
- Tens of thousands of man-hours per foundation for steel cutting, fitting, welding, handling, etc.

Picture credits: Siemens, Principle Power, Hitachi, U.Maine, MHI, Mitsui
Taking advantage of a world champion …

The humble wind turbine tower

• Probably the world’s lowest cost per kg of any large steel structure
• High quality welds and surface protection
• More than 20,000 towers manufactured annually in highly industrialized processes

How did we get there?

• Separation of fabrication and installation
• Modularization and standardization
• No IP of any significance – costs kept low through open competition

Picture credit: Danish Wind Turbine Manufacturers’ Association
Enter TetraSpar – floating wind power industrialized the onshore way

Mindset

- Conventional thinking
  - We have designed this structure – now, how do we build it?
- TetraSpar thinking
  - We need to manufacture this way – now, how do we design it?

Concept

- Modular – all components factory-made, transported by road
- Components assembled at quayside, just like the turbine is assembled
- Turbine mounted in harbor and towed to site, no installation vessels
- Less than 2000 t for 8 MW turbine
The fundamental choice on the supply chain thinking

The learning curve

Relative cost

100%

10%

Total number of units produced

1 10 100 1000 10000 100000 1000000

We can start here ...

Or we can start here ...

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Tetra floating foundation is available in several configurations

- The keel arrangement of TetraSpar enables the spar configuration.
- However, the keel is not the defining feature of the concept. Other configurations are available also, including a TLP and a semisubmersible.
- The defining feature of the concept is the industrialized manufacturing.
2017 model tests, carried out by DTU in DHI wave basin
2019 model tests, carried out at FORCE Technologies wave basin
TetraSpar Project stages

Stage 1 - 2016
- Concept
- Initial validation

Stage 2 - 2017
- Design
- Tank test OK

Stage 3 - 2020
- Prototype
- Full validation

Stage 4 - 2021
- Pilot project
- Release

Prototype
- Siemens SWT-3.6-130, 3.6 MW rated power, 130 m rotor diameter
- Status: Final design close to completion, installation scheduled for 2020
- Foundation contractor: Welcon
Thanks for your attention

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