

DGF/DONG Seminar – Geotechnical Engineering in Offshore Wind

- From a certification perspective

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Offshore Wind - Combining DNV competences



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25 years of hands-on
experience with wind
turbines

40+ years of offshore
oil & gas experience

Global leader in project
risk and certification of
offshore wind projects

Merger of DNV & GL: Combining two major players



- Founded 1864
- Hovik, Norway
- 10,400 employees

Dedicated competences in:

- Tankers
- Offshore Classification
- Power & Transmission
- System certification

DNV GL Group

- Shared ambition for quality and innovation
- Head office in Hovik
- 16,000 employees

A leading company in:

- Classification
- Oil & Gas
- Energy
- Business Assurance

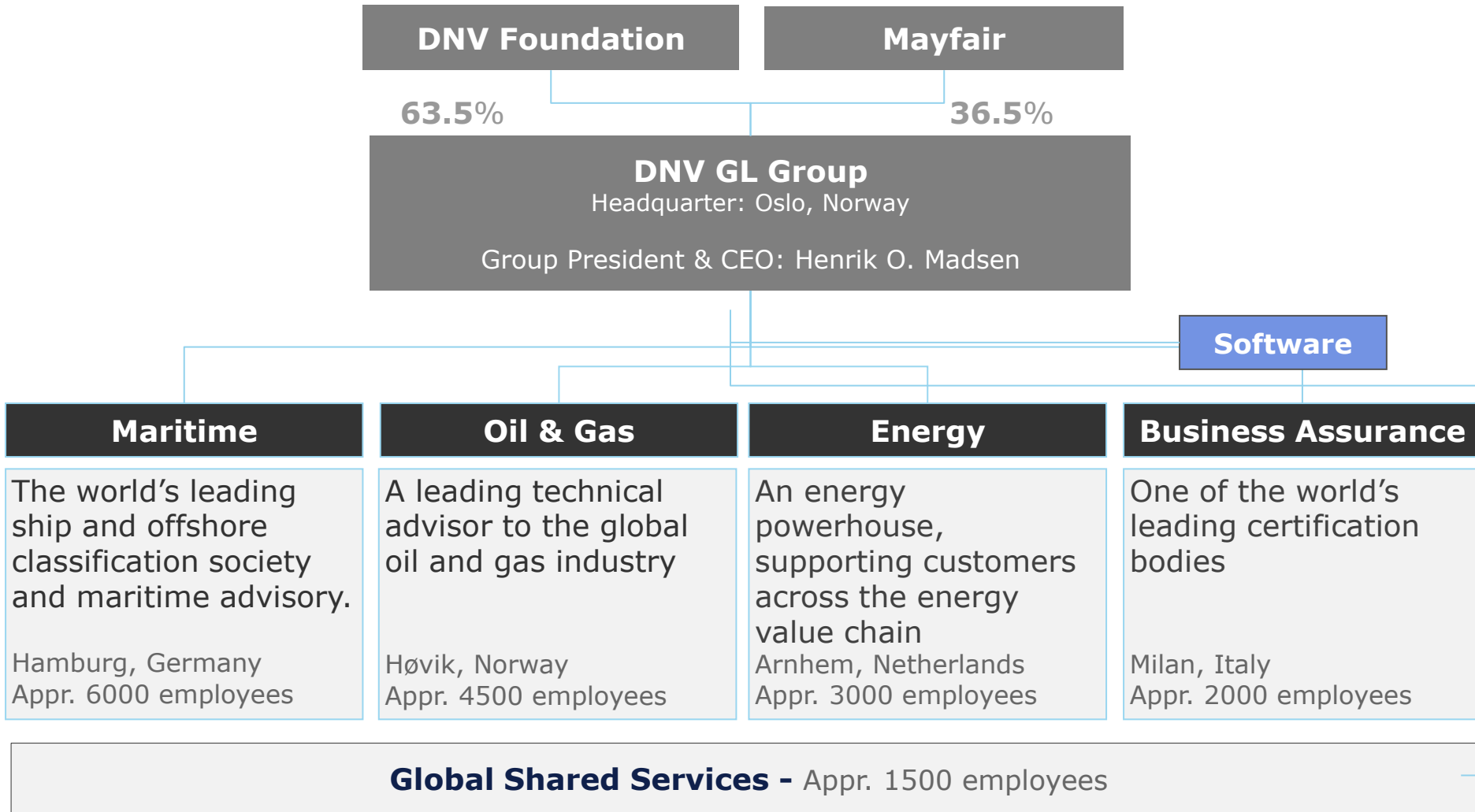


- Founded 1867
- Hamburg
- 6,700 employees

Dedicated competences in:

- Container ships
- Energy efficiency
- Marine warranty
- Renewables

DNV GL Group - operating from Sept 12



World's largest certification body for renewable energy

Services:

- Component Certification
- Type Certification
- Project Certification
- Training & Seminars
- Standards & Guidelines

Clients:

- Manufacturers
- Project Developers
- Owners / Operators
- Investors
- Government / NGOs

Industries:

- Onshore Wind
- Offshore Wind
- Wave + Tidal
- Solar



Guidelines and accreditation strategy

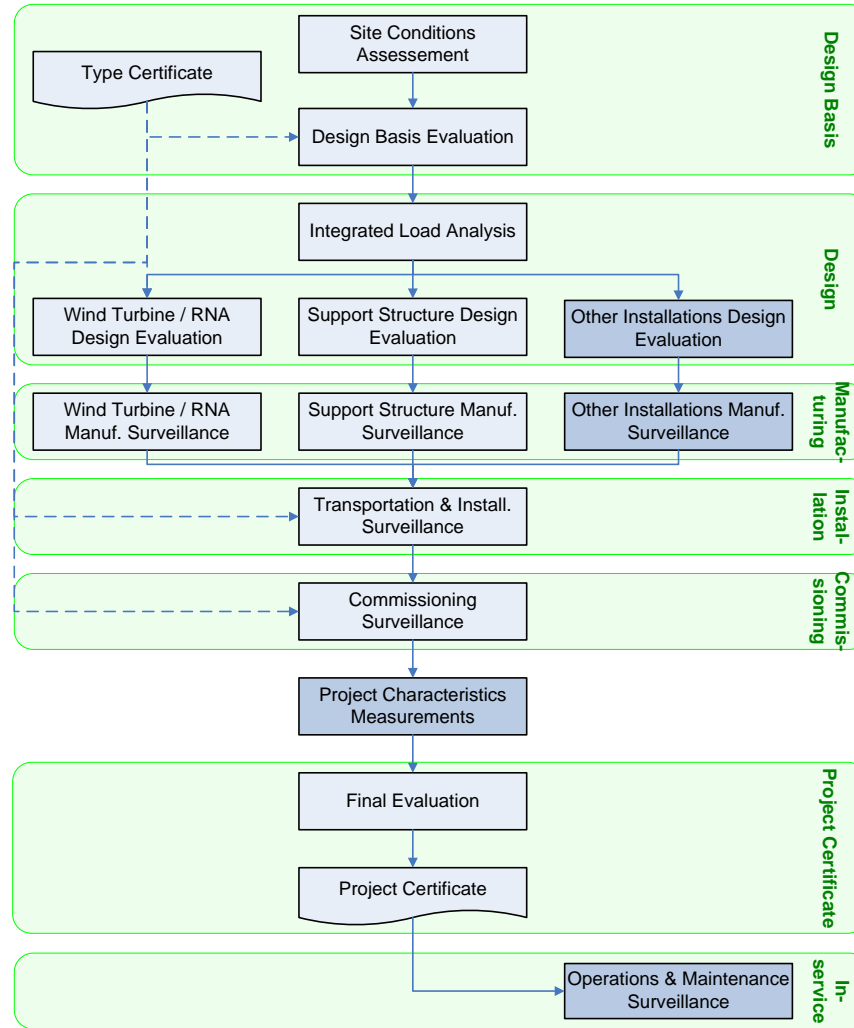
Harmonize 6 accreditations and 25 guidelines

Focus on IEC interpretation



1. All guidelines remain valid
2. All guidelines will be continued
3. Harmonization of 25 guidelines by DNV GL
4. Harmonization of IEC interpretation
5. Equal services worldwide, regardless of location
6. Certificates will remain (subject to client demand)

Wind farm certification



Onshore Wind Farms

- Covered by national standards
- In European Countries, Eurocode is governing
- Eurocode 7 part 1 – Geotechnical Design
- Eurocode 7 part 2 – Ground Investigation and Laboratory Testing
 - Gives requirements to amount of testing and calculations for different design categories
 - According to the German regulations, a WTG structure is geotechnical category 3



Offshore Wind Farms

DNV-OS-J101 – Design of Offshore Wind Turbine Structures
DNV-OSS-901 – Project Certification of Offshore Wind Farms



Pre-certification work



- In addition to the verification activities necessary for project certification DNV may evaluate or verify technical documentation prepared prior to the project design and implementation. Such verification activities may include:
 - **Audit of geotechnical field operator and geotechnical laboratory**
 - **Soil investigation and laboratory test program**
 - **Concept / model evaluation**

Geotechnical Site Investigations

- The extent of soil investigations and the choice of soil investigation methods shall take into account the type, size and importance of the wind turbine structure, the complexity of soil and seabed conditions and the actual type of soil deposits.
- The area to be covered by soil investigations shall account for positioning and installation tolerances.
- For multiple foundations such as in a wind farm, the soil stratigraphy and range of soil strength properties shall be assessed within each group of foundations or per foundation location, as relevant.



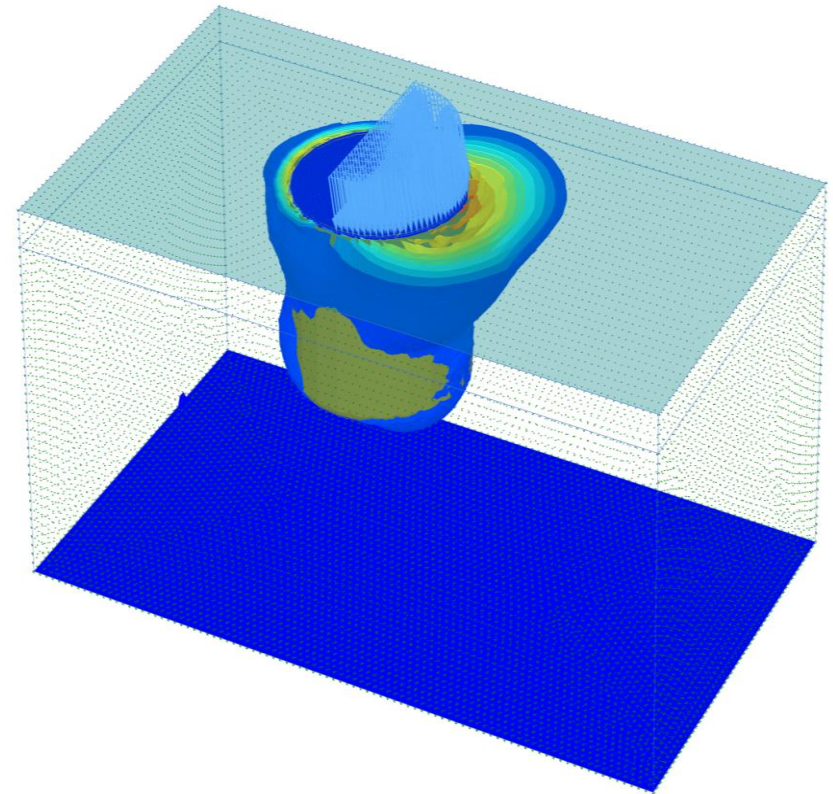
Design Basis

- **The geotechnical input to the design basis can consist of:**
 - **Factual data**
 - field and laboratory test results
 - or
 - **Derived parameters**
 - design shear strength profiles and angles of internal friction
 - design soil stiffness parameters
 - or
 - **Derived parameters and methodology**
 - design shear strength profiles and angles of internal friction
 - design soil stiffness parameters
 - skin friction and tip resistance profiles for axial pile design
 - P-Y curves for lateral pile behaviour

- In all cases, it is important that all principles are agreed upon before the detailed design of the wind turbine foundation starts

Geotechnical Design

- Risk based verification
- Guidelines in the standard – it is allowed to carry out more detailed analyses!
- The verification may contain independent calculations if
 - The foundation type is novel
 - The designer is unexperienced
 - The soil data are limited or of poor quality
 - The documentation is of poor quality



Incremental displacements – indicates failure mode



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SAFER, SMARTER, GREENER