



- 1 Surveying with the Micro GI gun.  
 2 Digital streamer, depth controllers (birds),  
 air buffer supply bottles.

## GEOPHYSICAL SITE INVESTIGATION FOR OFFSHORE WIND FARM DEVELOPMENT

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Proper, precise knowledge of the local subsoil situation is crucial to the planning and development of offshore wind energy plants. Geophysical explorations provide a comprehensive overview of geological soil conditions as well as extensive insights into the deeper subsoil. Fraunhofer's multi-channel seismic system makes it possible to look at depths of down to 50 meters – an essential advantage as the support structure of a wind turbine may be fixed to the seabed at this level.

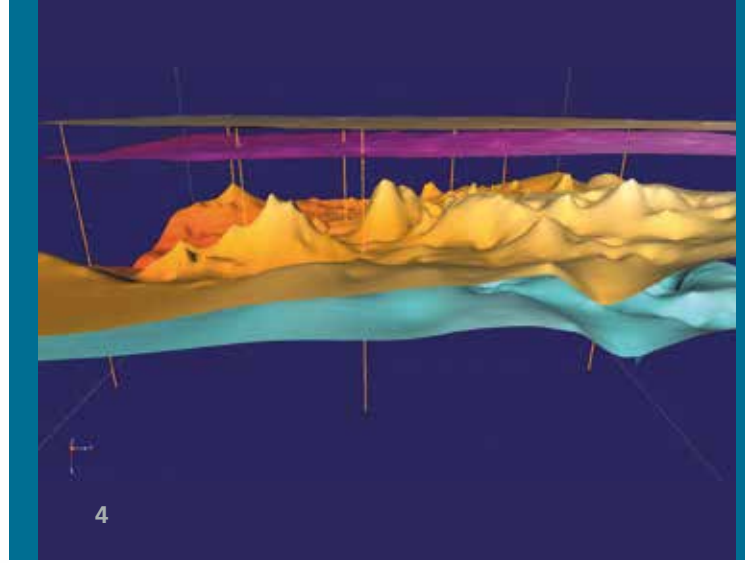
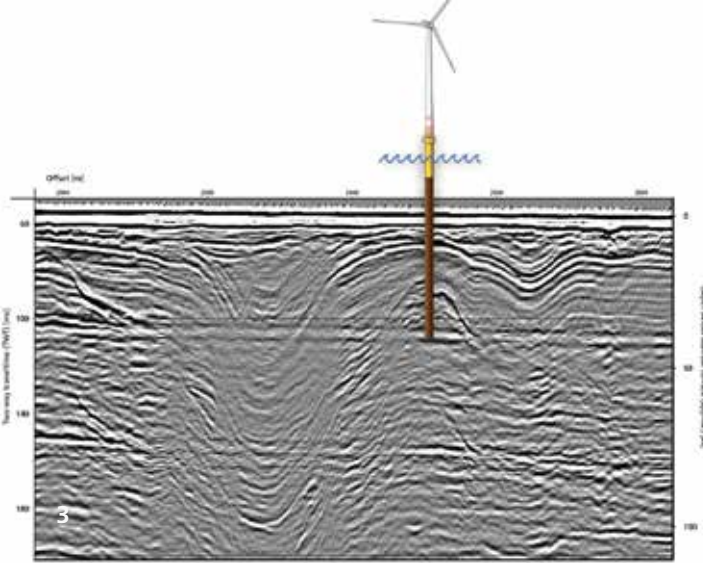
Geophysical information provides a basis for the planning of the main geotechnical survey in the course of the wind park planning procedure. By correlating geological and geotechnical information with seismic profiles, it is possible to develop subsoil models for the entire planning area. The design and dimensions of wind energy turbine foundations can then be further optimized on the basis of this data.

### Increasing flexibility in wind park development

By working up a 3D model of the seabed, experts at Fraunhofer IWES can also contribute to the design approval of offshore wind energy plants. Following a rearrangement of offshore wind turbine locations – which had already been geotechnically explored – in later stages of the planning process, the challenge arose of transferring geotechnically investigated data within the entire planning area.

Using a close-profile, high-resolution 3D layer model enables easy and instantaneous generation of subprofiles at any location in the planning area. This procedure has been overseen by geotechnical experts and certifiers and is accepted by the Federal Maritime and Hydrographic Agency of Germany (BSH).





IWES' seismic and the establishment of a 3D model of the subsoil in wind park areas offer therefore a convenient flexibility in wind farm development, including rearrangements in the wind farm layout – without the need for cost-intensive geotechnical post-surveys.

### Seismic equipment

#### Recording system (HTI digital streamer)

- Fully digital, customized streamer, capable of delivering good quality data in fair and suboptimal weather
- 96 highly sensitive hydrophones separated by 1 meter (one per channel) → high fold/resolution
- Streamer specially designed for shallow water conditions (< 100 m)
- High signal-to-noise ratio → sharp image
- Depth controlled by ION Geophysical depth controllers (birds)

#### Source (Sercel Micro GI)

- High performance, high resolution, and penetration
- Robust and reliable in field conditions
- Adaptable to different sediment conditions (volume reduction)

### Results

Geological 3D subsoil model of the entire wind energy plant (acquisition, processing, and interpretation)

- Comprehensive overview
- Focused planning of sites (site

optimization on the basis of geological conditions at a very early stage)

- Optimized planning of expensive corings / Cone penetration tests
- High flexibility throughout the entire planning phase, e.g., when offshore wind turbine locations are changed at a later stage
- Risk mitigation
- No additional geophysical surveys required subsequently
- Easy and instantaneous generation of subsoil profiles at any position in the farm

### Explored offshore wind energy plants

The system has been in practice since 2011 and has repeatedly demonstrated its unique capabilities.

- Arcadis Ost 1 (Baltic Sea)
- Skua (North Sea)
- Innogy (North Sea)
- Arkona Becken Südost (Baltic Sea)
- Plus several smaller investigations at offshore wind farms (e.g., Kaikas, Riffgat, Godewind, AlphaVentus, MEG Offshore 1, ...)

### Services

- Multi-channel seismic surveys with the innovative, high-performance system with guaranteed penetration down to the foundation depth
- High-resolution, extensive geophysical seafloor surveys (side-scan, echosounder, magnetics)
- Consultancy services for ground truthing and planning of subsequent geotechnical surveys
- Acquisition of geotechnical and geological information and integration of all survey data in a consistent, three-dimensional subsoil model; subsoil maps
- Rapid identification of relevant, possibly critical subsoil structures
- Scientific support up to approval phase

3 The Micro GI gun allows high resolution and penetration simultaneously. The fully digital HTI streamer enables high quality recordings.

4 The combined soil investigation program consisting of seismic and sampling measurements was accepted by BSH