APPLICATION FOR AUTHORIZATION

Temporary test anchors and measurement equipment on the seabed

(August 2015 to August 2016)

General description

Hereby NEMOS GmbH is kindly asking for permission to install three temporary test anchors in the waters of Hanstholm. These anchors are used to gain experience on the installation process of a wave energy converter prototype, which is planned to be installed at the same location in 2016. These test anchors shall be screwed into the sediment in August/September 2015. The anchor's forefront will dig into the seabed by maximum 12 meters and their tail will emerge the seabed by less than 0.5 meters. It is planned to attach underwater wave measurement equipment (ADCP) at one of the anchor shafts for 12 months and remove the anchors in August 2016.

Location and geometrical setup

The three screw anchors are planned to be installed in the field "V1" which is described in the following sea chart (figure 1). The area is defined by positions 1, 2, 3 and 4 which have the following coordinates:

Position 1: N57° 06' 58.82" E008° 33' 43.42"
Position 2: N57° 06' 37.14" E008° 33' 20.22"
Position 3: N57° 06' 50.45" E008° 32' 37.43"
Position 4: N57° 07' 12.42" E008° 33' 00.94"

Figure 1: Sea chart showing the desired location of the test anchors at „V6".

The three screw anchors will have a maximum distance of 50 meters and will reach into the seabed to a depth of maximum 12 meters. Their (single) helix will have a diameter of less than 1 meter. Picture 2 shows the dimension of the anchors.

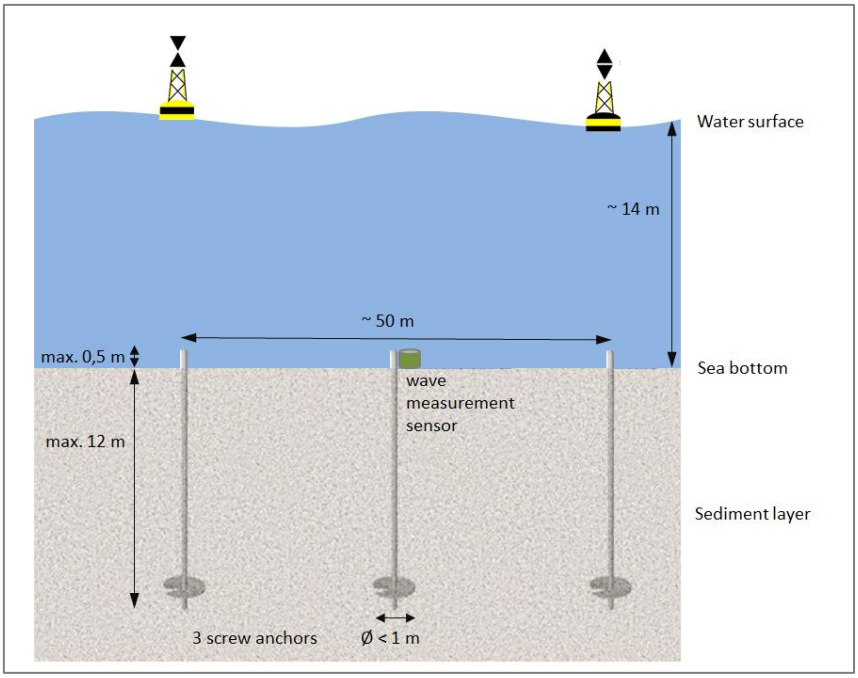

Figure 2: Geometrical setup of the three screw anchors.

After the installation of the anchors it is planned to attach a wave measurement device to the anchor in the center position. This will be an “AWAC Profiler” ADCP produced by Nortek. According to the “IALA Recommendation O-139” on “The Marking of Man-Made Offshore Structures” two cardinal buoys will be installed at the outer anchors: one at the most western anchor, one at the most eastern anchor. For the purpose of holding the buoys, the anchors are having an over-dimensioned holding capacity (more than 15 tons).

Installation process and decommissioning

The anchors will be *installed* by a special purpose apparatus, which will be lowered down to the seabed by a ship. As it is shown in picture 3 by the example of a similar system, it consists of a tower structure, which is supported by three feet. These feet are equipped with small anchor plates which allow them to connect the structure to the seabed and provide the installation torque. Inside the tower there is a hydraulic torque drive, which is connected to the anchor shaft. While turning the anchor it slides down on a rail system inside the tower, which transmits the torque to the tower. When the anchor reached its desired depth it will be decoupled from the drive system. The entire process was

Figure 3: Installation device

successfully tested in a scaled experiment at Nissum Bredning Wave Energy Test Site (DanWEC).

For *decommissioning* the same process is applied in opposite direction, which was also tested successfully at Nissum Bredning. In order to gain information on the anchor's holding capacity there is also an alternative way of decommissioning: pulling out the anchors by a buoyancy system. If required, a bank deposit can be established to secure the costs of decommissioning in advance.

Impact on the environment

The described installation process does not contain any hammering. That's why there will be no relevant underwater noise. Furthermore there will neither be dump of chemical substances nor negative mechanical impact on the sea life around.

Background information on the company NEMOS

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Central Business Register number:	HRB 24455
Contact person:	Dipl.-Ing. oec. Jan Peckolt, CEO
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NEMOS was founded in 2012 to develop the innovative system for generating electricity from ocean waves. It consists of an elongated floating body which is connected to the seabed by three ropes. Excited by the waves, mechanical energy is transmitted to a generator positioned protected from sea water at a monopile using rope kinematics. For protection from extreme wave loads in heavy storms, the system can be lowered to calmer water.

The aim of the NEMOS project is the development of the technology to be energetically and economically viable. The development work is carried out in cooperation with various industrial and academic partners. The described project on test anchors will be realized in cooperation with the Geotechnical Institute of University Duisburg-Essen. Most of the results will be included into the final report of a public funded project and in a doctoral thesis which will be both available in public.

ORGANISATIONAL STRUCTURE AND OWNERSHIP STRUCTURE

The following chart gives an overview about the organizational structure of the company:

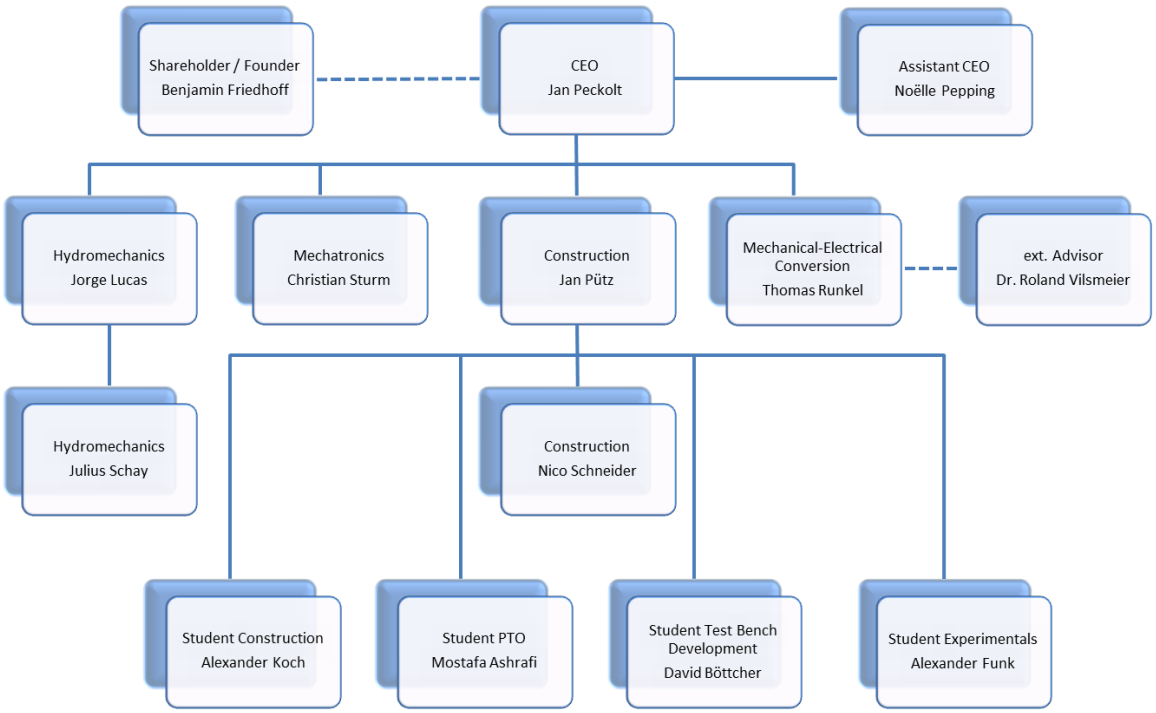

Figure 4: Organizational Structure of NEMOS GmbH

Furthermore the following chart gives an overview about the ownership structure of the company:

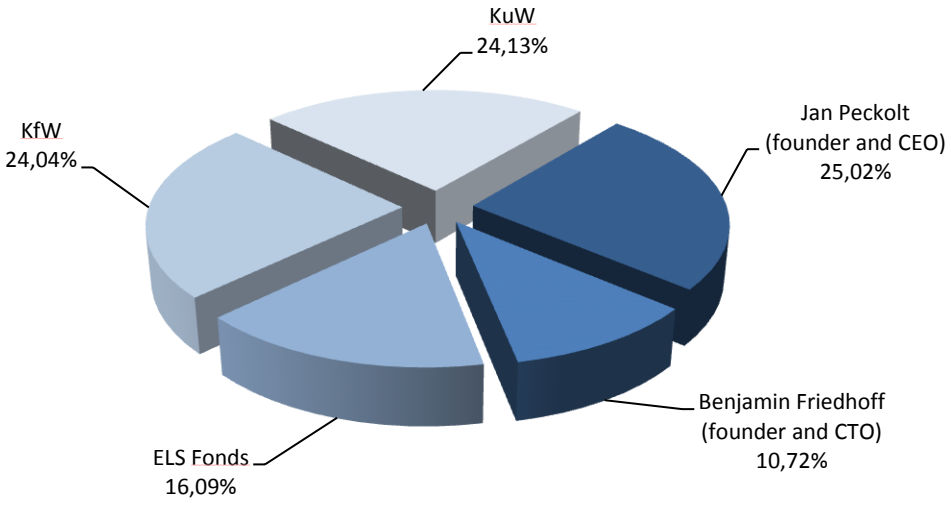

Figure 5: Ownership structure of NEMOS GmbHFINANCIAL CAPACITY

NEMOS is financed by private equity investments of 3.6 Million Euros and around 2 Million Euros of public funding. The private Stakeholders are „Emscher-Lippe-Seedfonds“, „KfW Bankengruppe“ and „KuW Vermögensverwaltungsgesellschaft“. The total financial resources

are covering the realization of a full-scale prototype in 2016 and extensive testing in 2017 and 2018.

References

NEMOS GmbH has gathered experiences in developing, deploying and running various scaled systems in the Danish Wave Energy Centre (DanWEC) at Nissum Bredning.

Proof of concept in natural waves	
Name of system	DK1.0 – proof of concept
Year of installation	2013
Location	DanWEC, Nissum Bredning
Dimensions	floater diameter: 250 – 550mm scale: 1:8
company`s role	owner
Contribution	project development and management, construction, setting up, running and dismantling

Design as a “Stand-Alone-System” in natural conditions	
Name of system	DK2.0 – stand alone
Year of installation	2014
Location	DanWEC, Nissum Bredning
Dimensions: Floater	floater diameter: 750mm floater length: 3,500mm scale: 1:5
Dimensions: Support Structure	tower diameter: 355.6mm tower height: 6,000mm triangle beam length: 4,000mm total mass: 1,100kg scale: 1:5
Company`s role	owner
Contribution	project development and management, design, construction, setting up and running
Proof of automization	
Name of system	DK3.0 – automization
Year of installation	2015
Location	DanWEC, Nissum Bredning

Dimensions: Floater	diameter: 750mm length: 3,500mm scale: 1:5
Dimensions: Support Structure	tower diameter: 355.6mm tower height: 6,000mm triangle beam length: 4,000mm total mass: 1,100kg scale: 1:5
Company`s role	owner
Contribution	project development and management, design, construction, setting up and running

External references

In collaboration with various external partners NEMOS GmbH is developing key technologies for the full scale prototype. These companies are e.g. LIROS GmbH and Schaeffler AG. Both are involved in a national funding project financed by the Federal Ministry of Economic Affairs and Energy. Further the Development Centre for Ship Technology and Transport Systems (DST) is an important partner with distinct references in hydromechanics of ocean energy converters and floating bodies.

Rope Development in collaboration with LIROS GmbH	
Company	LIROS GmbH Sieggrubenstraße 7 95180 Berg www.liros.com
Role	Developing a rope system for large diameters with huge amount of bending cycles and high loads
Project leadership	Dipl.-Ing. Peter Fleischmann (LIROS GmbH) Dipl.-Ing. Jan Pütz (NEMOS GmbH)
Further information	

Bearing Development in collaboration with Schaefller AG	
Company	Schaeffler AG Industriestraße 1-3 91074 Herzogenaurach

	www.schaeffler.com
Role	Developing innovative bearing for an underwater application
Project leadership	Dipl.-Ing. Jan-René Aust(Schaeffler AG) Dipl.-Ing. Jan Pütz (NEMOS GmbH)
Further information	

Design of the floater in collaboration with the DST	
Institute	Development Centre for Ship Technology and Transport Systems (DST) Oststr. 77 47057 Duisburg
Role	Design of the floater in a scale of 1:1
Project Leadership	Dipl.-Ing. Benjamin Friedhoff
Further information	

ContiTech AG	
Company	ContiTech AG Vahrenwalder Straße 930165 Hannover
Role	Supplier for belt systems for high loaded belts for huge amounts of load cycles
Project Leadership	Henning von der Haar (ContiTech AG) Thomas Runkel M. Sc. (NEMOS GmbH)
Further information	

Siemens AG	
Company	Siemens AG Kruppstraße 16 45128 Essen www.siemens.com
Role	Supplier for electrical power take off and steering components, soft-/hardware
Project Leadership	Jörg Osterburg, Sales (Siemens AG) Thomas Runkel M. Sc. & Dipl.-Ing. Christian Sturm (NEMOS GmbH)

Further information	

Company	Universität Duisburg-Essen Fakultät für Ingenieurwissenschaften Abteilung Bauwissenschaften Fachgebiet GEOTECHNIK 45117 Essen www.uni-due.de/geotechnik
Role	Academic Project Partner on geotechnical aspects
Project leadership	PD Dr.-Ing. Kerstin Lesny
Further information	