

RAVE Workshop 2024 – End of Life Strategies - a New Phase of RAVE ?

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Gefördert durch:



aufgrund eines Beschlusses
des Deutschen Bundestages



Welcome!

- A few words about RAVE
- Which measurements are available and how?
- End of design life strategies - a new phase of RAVE ?

Offshore test field alpha ventus



First German offshore wind farm – built 2009

Test field with support from the German government

60 km distance to coast, 30 m water depth

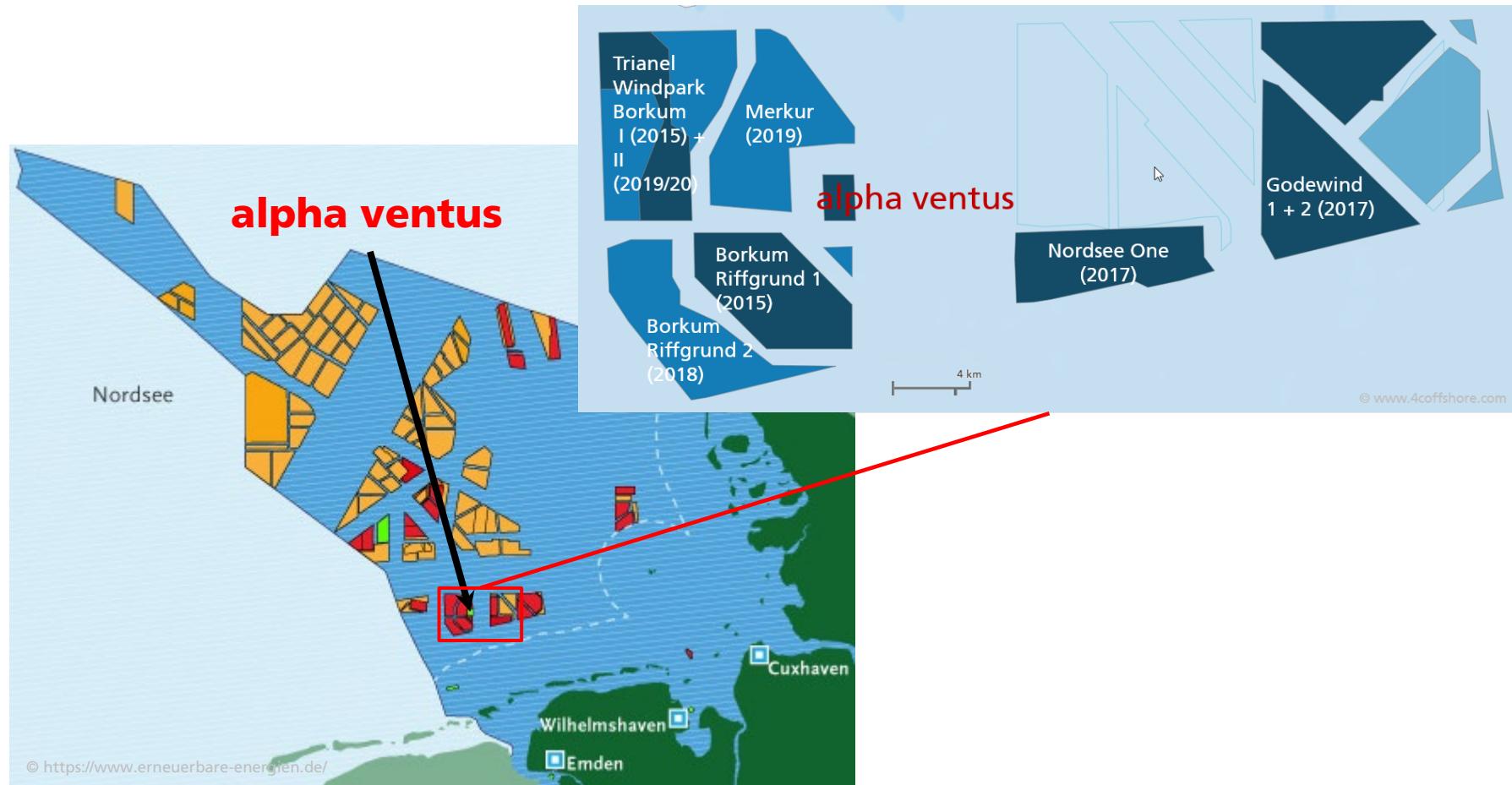
12 Wind energy converters

- 6 Adwen M5000 on tripod foundations
- 6 Senvion 5M on jacket foundations

CAPEX: 250 M€

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Offshore test field alpha ventus



RAVE – Research at alpha ventus

- Accompanying research at the alpha ventus test field
- Funded by the Federal Ministry for Economic Affairs and Climate Action (BMWK)
- Running since 2008

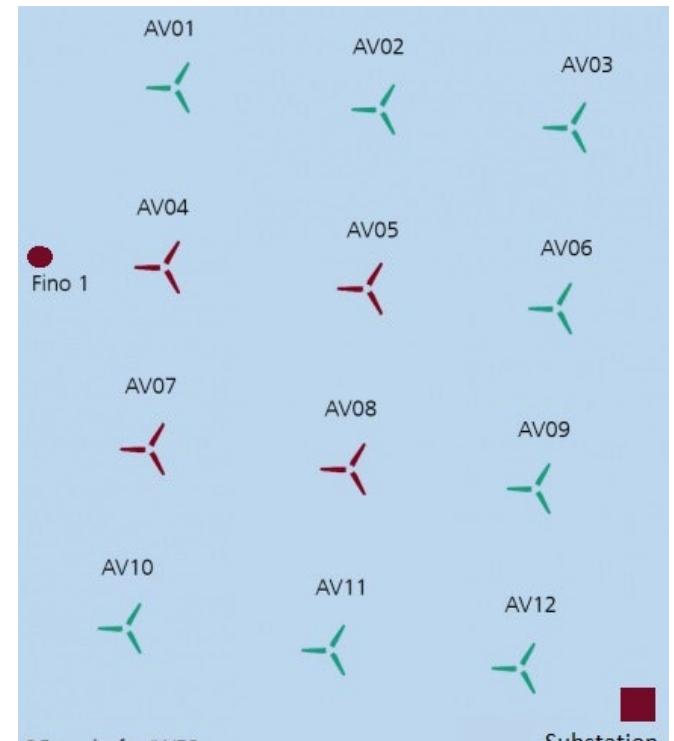
> 120 million € research funding
>> 35 R&D projects funded by BMWK
>> 60 project partners
>> 100 R&D projects supported with data
≈ 200 data users



RAVE measurement program

- 4 turbines instrumented
- 100m met mast FINO 1 in direct vicinity
- Oceanographic measurements at different locations
- Electrical measurements on offshore and onshore substations
- SCADA and turbine controller data
- Special measurements (noise, water pressure, Lidar,...)

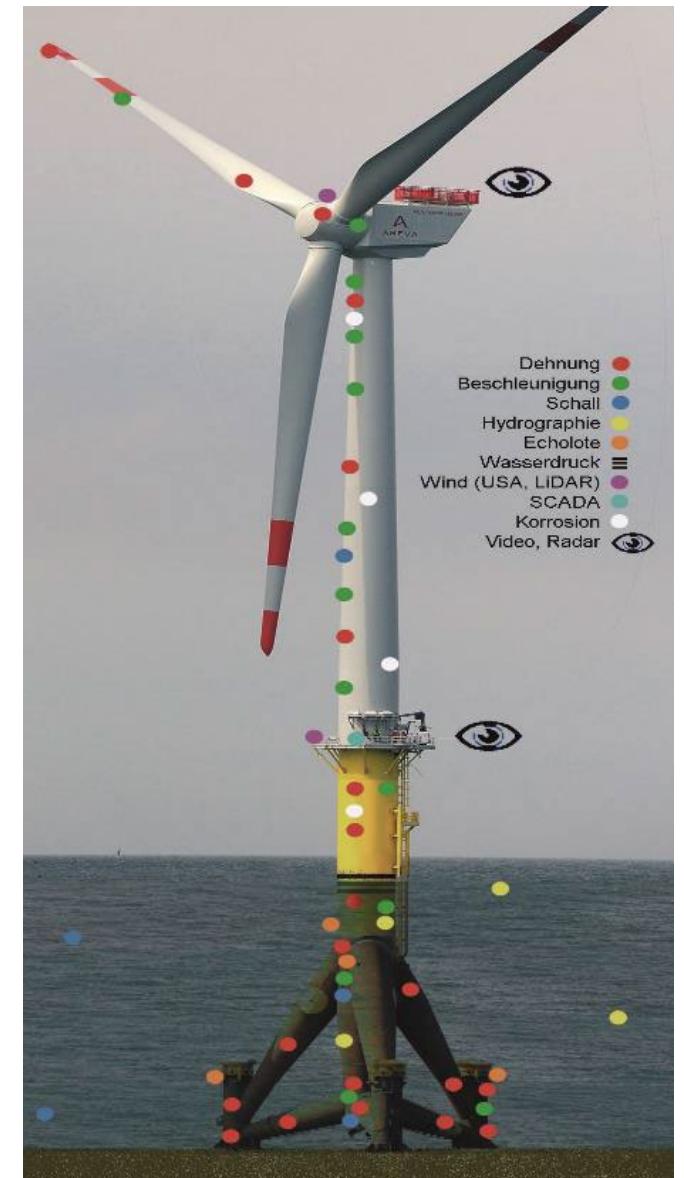
Long-term time series of up to 14 years, up to 1400 data channels ... ongoing



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Example: AV07

- strain gauges
- acceleration
- acoustic sensors
- hydrographic sensors
- met data (sonic, lidar)
- sonars
- water pressure sensors
- SCADA
- corrosion
- video cam, radar



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Turbine design data for Senvion turbines

- For the Senvion turbines, full design data for load calculation are available
- Controller algorithm as black box model
- Available in Flex 5 format
- Additionally, the met-ocean design basis is provided

Data access

- RAVE is funded by the German government with the aim of supporting the development of offshore wind energy through research
- Measurement data is stored in the [RAVE data base](#) hosted by BSH
- Quality control is in place with QC flags
- Documentation for sensors and sensor installation integrated in the data base
- Data is available for research with a standard data usage agreement



RAVE objectives - Phase I (ca. 2007-15)

Objectives formulated 2007 at the start of RAVE:

- Prove the offshore-capability of the 5 MW turbine class
- Demonstrate the feasibility of offshore wind with large distance to coast and deep water
- Investigation of open questions to offshore wind power utilization

R&D projects Phase I (ca. 2007-15)

BMWK funded RAVE research projects:

- Foundations 2007-13 / BAM
- LIDAR 2007-14 / SWE & Uni OL
- REpower blades and components 2007-12 / Repower
- OWEA 2007-15 / SWE
- AREVA Wind M5000 Improvement 2007-13 / Areva Wind
- Ecology 2007-14 / BSH
- Offshore WMEP 2007-11 / IWES
- Grid Integration 2008-12 / IWES
- GIGAWIND av 2008-12 / LUH
- VERITAS and TUFO 2008-14 / KIT
- Operational noise 2008-11 / Fh FL
- Sonar Transponder 2009-11 / LUH
- Little bubble curtain 2009-10 / LUH
- Acceptance 2009-13 / Uni Halle
- GW Wakes 2011-14 / Uni OL
- UFO 2011-14 / fk-wind
- SOS 2012-14 / TMCC
- Smart Blades 2012-16 / Uni OL

Example: Little Bubble Curtain

Research and testing of "Hydro Sound" at the offshore test site alpha ventus

Partners

- University of Hannover
 - Menck GmbH
- +7 associated partners

Aims and methods

- Conceptional design and development of the little bubble curtain
- Testing and subsequent evaluation regarding the capability of the little bubble curtain under offshore conditions with respect to the major building process.
- Determination of the influence of drift velocity and direction on the sound reduction of the bubble curtain in progress.
- Investigation of the influence of air pressure and volume flow on the sound reduction in the surrounding area.



RAVE objectives – Phase II (ca. 2015-25)

Operational questions became the focus:

- Operation and monitoring of offshore wind farms
- Optimisation of operation logistics
- Turbine and wind farm control
- Forecasting of power output
- Effects between neighbouring wind farms

R&D projects phase II (ca. 2015-25)

BMWK funded RAVE research projects:

- PreIno 2013-16 / BIBA
- GIGAWIND life 2013-18 / LUH
- ANWIND 2016 – 20 / SWE
- LeikLine 2016-19 / IWES
- OWP Control 2017-20 / SWE
- ParkCast 2018-21 / SWE
- X-Wakes 2019-23 / IWES
- FlexiWind 2022-25 / IWES
- MOUSE 2022-26 / Uni OL

Other German publicly funded R&D projects:

- OTELLO 2024-26
- WindStore 2024-26
- STRAIGHT 2023-26
- MEDAILLON 2023-25
- LogReview 2021-25
- H2Mare 2021-25
- WINDOW 2021-24
- TrilaWatt 2022-24
- SFB 1463 Offshore Megastructures 2021-24
- NorthSat-X 2021-24

R&D projects phase II (ca. 2015-25)

German R&D project data users:

- Energynautics,
- Weprog,
- Project Engineer ONP Management GmbH,
- Hochschule für Technik und Wirtschaft des Saarlandes (htw saar),
- Fraunhofer IEE,
- ForWind,
- Omexom,
- Bundesanstalt für Wasserbau,
- Universität Osnabrück,
- Leibniz Universität Hannover,
- Hochschule Emden/Leer,
- IPU Ingenieurgesellschaft Braunschweig mbH,
- UL International GmbH,
- Universität Oldenburg,
- Fraunhofer IWES,
- Friedrich-Alexander-Universität Erlangen-Nürnberg,
- Universität Stuttgart,
- Technische Universität Hamburg,
- Jörss-Blunck-Ordemann GmbH,
- Alfred Wegener Institut,
- Motion Intelligence Technologies GmbH,
- Siemens Energy Global GmbH & Co. KG

R&D projects phase II (ca. 2015-25)

European R&D project data users:

- University of Bergen,
- NTNU (N),
- DTU (DK),
- Universidad Ramon Llull (E),
- Imperial Collage of Science,
- Technology and Medicine (UK),
- University of Stavanger (N),
- University of Southern Denmark (DK),
- UMONS (B),
- TotalEnergies SE (F),
- PropheSea (B),
- LICengineering A/S (DK),
- Universidad Pontificia Comillas (E),
- Universitat Politècnica de Catalunya Barcelonatech (E),
- Jan De Nul NV (B),
- IFP Energies Nouvelles (F)

R&D projects phase II (ca. 2015-25)

Non-European R&D project data users:

- Tufts University (USA),
- GE Research (USA),
- Jiujiang University (China),
- Southwest Petroleum University (China),
- University of Nevada Reno (USA),
- Wenchang Campus Xuzhou University (China),
- University of Western Australia,
- Shenzhen University (China),
- Federal University of Rio Grande do Sul (Brasilien),
- Tongji University (China)

Example: X-Wakes

Interaction between the Wakes of Large Offshore Wind Farms and Wind Farm Clusters with the Marine Atmospheric Boundary Layer

Partners

- Fraunhofer IWES (Coord.)
- Karlsruhe Institute for Technology
- ForWind – Carl von Ossietzky University Oldenburg
- Eberhard Karls University Tübingen
- Helmholtz-Zentrum Geesthacht
- UL International GmbH

Aims and methods

- Investigation of the interaction of the wake of several wind farms among each other
- Interaction of large scale wakes with the marine atmospheric boundary layer and coastal effects
- Various measurements, including LiDAR, unmanned and manned aircraft and satellites.
- Validate advanced tools for the accurate mapping of large wind farm areas



RAVE objectives – Phase III (ca. 2025 -)

Alpha ventus is 15 years old and approaches the end of its design lifetime of 20 years

Objectives for the next phase:

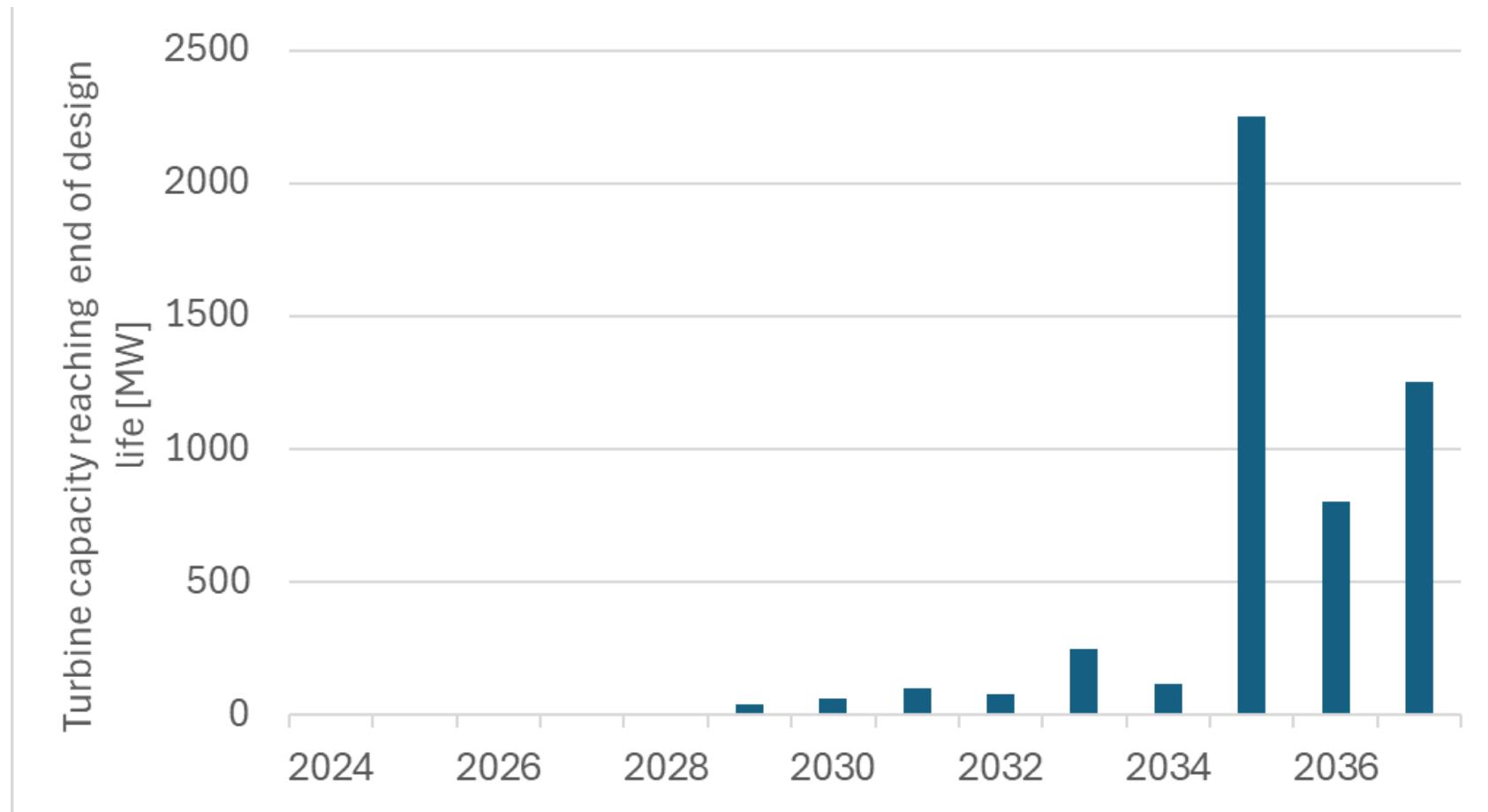
Continuation of measurements until decommissioning or repowering of alpha ventus

Research focus at:

- Lifetime modelling and lifetime extension
- Repowering including reuse
- Decommissioning including recycling

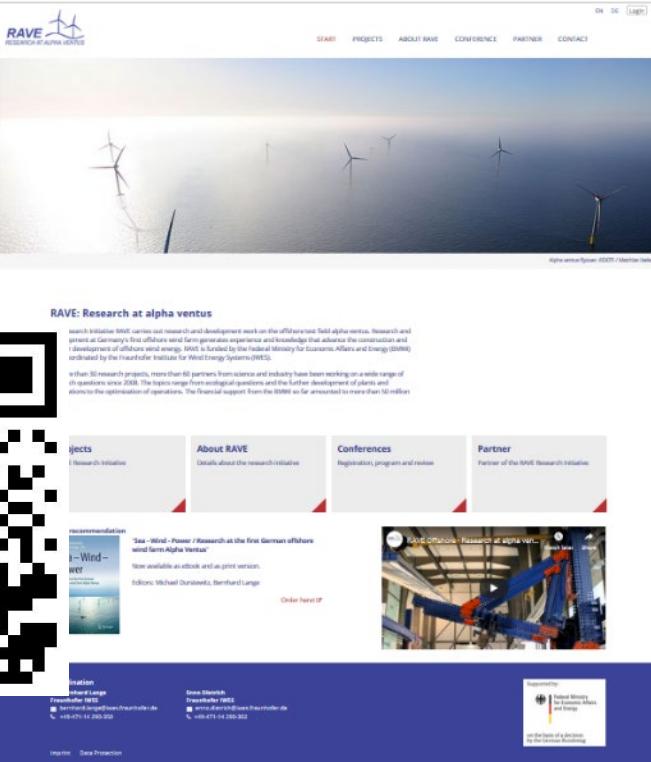
➔ Discussion at the end of the workshop

End of design lifetime of offshore wind turbines in Germany



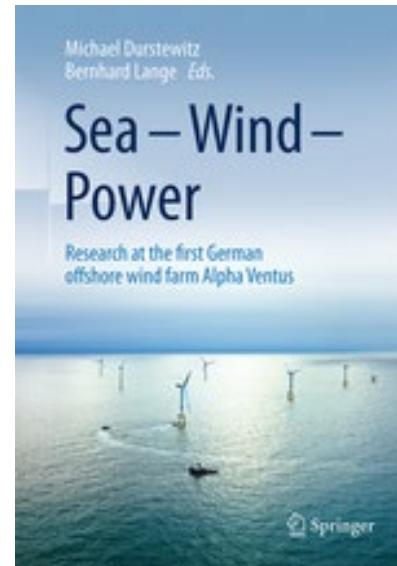
More information about RAVE...

RAVE Homepage:
www.rave-offshore.de



RAVE video:
DVD and youtube

RAVE book (Springer):
Sea – Wind - Power



International Conference
RAVE 2012
With simultaneous translation Mit Simultanübersetzung
May 8-10, 2012
Bremerhaven, Germany
Conference program Konferenzprogramm

offshore wind R&D conferences 2012, 2015
and 2018 and
workshops 2020, 2021, 2022 and 2023

Thank you...

...to the BMWK for the funding of RAVE:

Supported by:



Federal Ministry
for Economic Affairs
and Climate Action

on the basis of a decision
by the German Bundestag

... and to you for your attention!

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