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Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW)

Standort Stuttgart:
Industriestr. 6, 70565 Stuttgart

New WindForS project: Wind Energy Research in the Swabian Alps

The ZSW and its partners aim to set up and operate a one-of-a-kind wind power field-test site

Wind power is making headway around the world as a renewable, climate-friendly source of energy. Lately it has making inroads even into mountainous regions with irregular winds and air turbulence brought on by the rough terrain. Six partners from WindForS, a wind energy research cluster in southern Germany, are now investigating how wind turbines can best be operated at these locations. The collective is planning to set up a field-test research site with two systems and four meteorological measurement towers in the Swabian Alps. The scientists from Baden-Württemberg and Bavaria aim to improve the technology in many ways, for instance being quieter, lighter and more powerful rotors. The Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW) is coordinating this ambitious project. Its partners are the University of Stuttgart, Eberhard-Karls University of Tübingen, Technical University of Munich, Karlsruhe Institute of Technology and Esslingen University of Applied Sciences.

According to the Global Wind Energy Council, the worldwide installed base is growing every year with new power plants that collectively produce some 63,000 megawatts, around a fifth of which is generated in mountainous regions. Installations on flat terrain are easier to operate than plants erected in rugged terrain where yield forecasts are more uncertain, wear and tear are greater, and maintenance costs are higher. The WindForS research cluster now aims to answer the question of how to optimize these systems' performance and extend their service life. In a team headed up by ZSW, these wind energy experts are now planning a field-test research site in the Swabian Alps, at Stöttener Berg near Geislingen an der Steige.

An ideal location for a field-test research site

"This location offers the ideal conditions for our research," says project manager Andreas Rettenmeier. "The prevailing west wind is accelerated across the crest of the upstream escarpment, creating irregular flows and turbulence. What's more, the region has a high average annual wind speed," says the ZSW scientist. These factors are typical at wind turbine sites in complex mountainous terrain and perfect for developing and testing new technologies. WindForS carried out a project called KonTest to investigate the location and its prevailing conditions.

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Measurement sensors from the foundation to the rotor blades

Now this project is to be followed up by another named Wind Science and Engineering in Complex Terrain (WINSENT), the purpose of which is to set up a test site to serve as a platform for research and industry. It is to be equipped with two wind turbines that each generates around 750 kilowatts nominal output with 75 meters hub height, 50 meters rotor diameter and a total height of 100 meters. One of the project's USPs is that scientists will have unrestricted access to all control technology and engineering data. This way, they will be able to precisely analyze these systems' behavior. During their construction, the wind power plants are to be equipped with measurement sensors from the foundation to the rotor blades.

A 100-meter tower is to be installed in front of and behind each system to rapidly measure meteorological parameters such as wind speed and direction, temperature, air humidity and air pressure. State-of-the-art laser technology will also serve to measure the wind power plants' inflow and wake.

Fresh impetus for the industrie

"A wind energy field-test research site of this size and in such complex terrain is one of a kind worldwide, and of great importance to researchers and the wind power industry. The results of our analyses will be scalable to large commercial plants and provide fresh momentum for the industry, "says Andreas Rettenmeier.

The partners in this project aim to achieve technological improvements in follow-up projects, for instance, to design rotors that will be lighter, quieter and more powerful. Another goal of this project is to develop and test a new operating system that will enable plants to respond to changing wind conditions with intelligence and greater precision. New machine learning methods will also be used to improve forecasts of wind power feed-in and to optimize models for integrating power-to-gas, battery and other storage means into the future energy system.

Accompanying ecological research and info panels

Accompanying ecological research will be conducted to assess in detail the impact on animals and plants in the vicinity of Stöttener Berg. There are also plans to post info panels on a trail around the premises so interested citizens can learn more about the project.

The German Federal Ministry for Economic Affairs and Energy is funding the three-and-a-half-year WINSENT project (FKZ 0324129A-F) with around EUR 10.4 million. Also the Ministry of the Environment,

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Climate Protection and the Energy Sector Baden-Württemberg is funding the project with EUR 1.2 million.

To view a video of the projected field-test research site, visit:
www.windfors.de/testfeld.html

The **Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (Centre for Solar Energy and Hydrogen Research Baden-Württemberg, ZSW)** is one of the leading institutes for applied research in the areas of photovoltaics, renewable fuels, battery technology, fuel cells and energy system analysis. There are currently around 230 scientists, engineers and technicians employed at ZSW's three locations in Stuttgart, Ulm and Widderstall. In addition, there are 90 research and student assis-tants.

The **University of Stuttgart** is a research-intensive university which has its focus on Engineering and Natural Sciences, with a unique profile that concentrate on networking these disciplines with the Humanities and Social Sciences. Indicators of the excellent status are the two projects that were successful in the recent "Excellence Initiative" sponsored by both the Federal and the State governments. One project is the Cluster of Excellence "Simulation Technology" and the other, the Graduate School "Advanced Manufacturing Engineering". Around 27.000 students are enrolled in the courses of the university offered by 150 institutes in 10 different faculties.

Technical University of Munich (TUM) is one of Europe's leading research universities, with more than 500 professors, around 10,000 academic and non-academic staff, and 40,000 students. Its focus areas are the engineering sciences, natural sciences, life sciences and medicine, combined with economic and social sciences. TUM acts as an entrepreneurial university that promotes talents and creates value for society. In that it profits from having strong partners in science and industry. It is represented world-wide with a campus in Singapore as well as offices in Beijing, Brussels, Cairo, Mumbai, San Francisco, and São Paulo. Nobel Prize winners and inventors such as Rudolf Diesel, Carl von Linde, and Rudolf Mößbauer have done research at TUM. In 2006 and 2012 it won recognition as a German "Excellence University." In international rankings, TUM regularly places among the best universities in Germany.

The **Institute of Meteorology and Climate - Research Atmospheric Environmental Research (IMK-IFU)** is part of the KIT (Karlsruhe Institute of Technology). Common theme of research at IMK-IFU is the investigation of sources and sinks of biogenic greenhouse gases (and other atmospheric trace constituents), as well as their long-term trends, at a regional, high-resolution scale. Research activities are concerned

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with observation and modelling of exchanges and interactions at the land surface – atmosphere interface (soils, hydrology, vegetation, atmosphere), including the effects of global climate change and land-use / land-cover change (LUCC), and water availability in regions of enhanced climate-change sensitivity. IMK-IFU scientists are experts in measurements of eddy-covariance fluxe s, lysimetry, enclosure/cuvette techniques for soil efflux, and absorption laser spectroscopy. Results are linked to process models of VOC and greenhouse gas emissions, chemistry and hydrology modules of meso-scale climate models, as well as high-resolution boundary layer LES models. Moreover, IMK-IFU has long-standing expertise in ground-based atmospheric remote sensing (SODAR, LIDAR, FTIR).

The **University of Tübingen** is one of eleven universities given the title of excellent under the German government's Excellence Initiative, and ranks well in international comparisons. Tübingen is one of the world's foremost locations for neuroscientific research. Along with translational immunology and cancer research, microbiology and infection research, and molecular plant biology, it makes Tübingen a cutting-edge center of research in the Life Sciences. Further areas of core research are in Geoscience and Environmental Science; Archaeology and Anthropology; Language and Cognition; and Education and the Media. More than 28,400 students from Germany and around the world are currently enrolled at the University of Tübingen, enjoying a broad spectrum of some 300 different study programs.

Esslingen University of Applied Sciences provides academic training and education in the fields of technology, economics and the social sciences. Excellent teaching, combined with high practical relevance, has a high priority at Esslingen. The University of Applied Sciences is also strong on applied research and, thanks to its doctoral programs, is able to offer graduates an extended scientific career. It is no wonder, then, that Esslingen is consistently to be found among the best universities of applied sciences in Germany in numerous national ranking tables. At Esslingen University, around 6,200 students are enrolled on 24 Bachelor's and 13 Master's degree programmes.

The **WindForS** wind energy research cluster comprises seven universities and research institutions from Baden-Württemberg and Bavaria. They are pooling their competencies in the field of wind energy in research as well as in education, qualification, and advanced training. Currently the WindForS partners are: University of Aalen, University of Applied Sciences Esslingen, Karlsruhe Institute of Technology, Technical University of Munich, University of Stuttgart, University of Tübingen, and the Centre for Solar Energy and Hydrogen Research Baden-Württemberg. The expertise of the 23 institutes and university chairs making up WindForS covers the full range of wind energy research areas. These include meteorology, landscape architecture, soil mechanics and foundation engineering, rotor aerodynamics and noise reduction, design and calculation of structures and frames, materials, construction methods and manufacturing engineering, testing and measurement technology, quality assurance and maintenance as well as operational management, grid connection, and grid integration.

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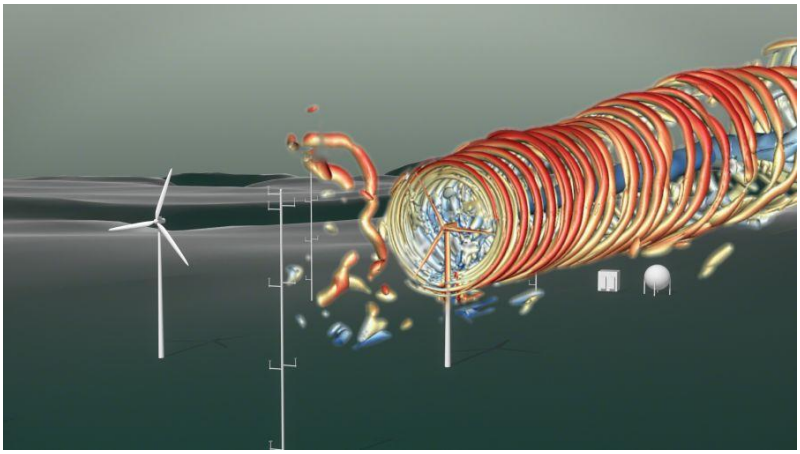
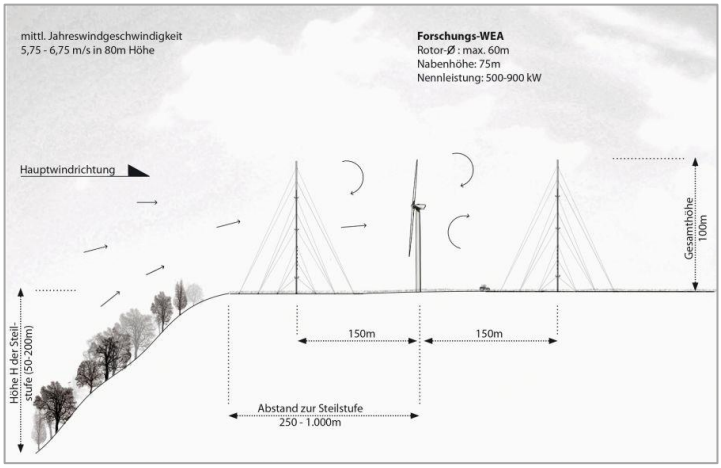
Media contacts

Alexander Del Regno, Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW), Industriestr. 6, 70565 Stuttgart, Tel. +49 (0)711 7870-310, Fax +49 (0)711 7870-230, alexander.delregno@zsw-bw.de, www.zsw-bw.de

Axel Vartmann, PR-Agentur Solar Consulting GmbH,
Emmy-Noether-Str. 2, 79110 Freiburg,
Tel.: +49 (0)761 380968-23, Fax: +49 (0)761 380968-11,
vartmann@solar-consulting.de, www.solar-consulting.de



The animation visualizes the wind currents of the plant. Photo: WindForS



The graphic shows the structure und dimensions of the field-test research site.
Graphic: TUM - LAREG