FVEE ForschungsVerbund Erneuerbare Energien
Renewable Energy Research Association

Ocean Energy Technology -

Research and Development

Fraunhofer IWES

Initial Position

The oceans can provide around 1/3 of today's energy demand from sources such as Waves, Tidal and Ocean Currents, Tidal ranges and thermal and Salinity gradients

Today, only the tidal range technologies based on conventional hydropower and applied in seawater have reached the commercial stage. All other technologies are undergoing extensive international R&D efforts covering more than 100 concepts worldwide. Due to huge natural resources providing domestic markets, the leading countries in the EU are the UK, Ireland, Portugal, Spain and Norway and outside Europe Canada, USA, Korea, Australia and New Zealand.

For Germany the sector mainly offers great technology export opportunities to the international markets for device manufacturers as well as component and supply chain providers from the wind energy and the conventional hydropower industries.

Consequently, Fraunhofer IWES started to develop ocean energy technologies in cooperation with German industrial partners under funding of the Federal government (BMU) in the year 2000.

Ocean Energy

- **Tides** 300+ TWh/y
- **Marine Currents** 1500 TWh/y
- **Waves** 12000 TWh/y
- **Salinity Gradient** 2000 TWh/y
- **Thermal Gradient** 10000 TWh/y

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Ocean Energy Technology -

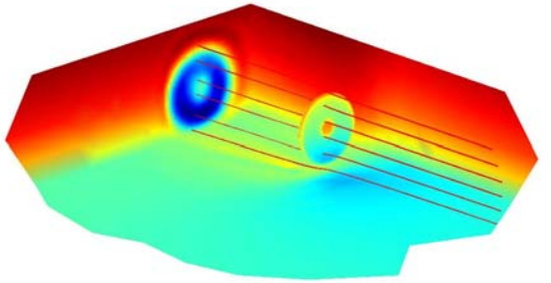
Supporting device and component developments

Fraunhofer IWES

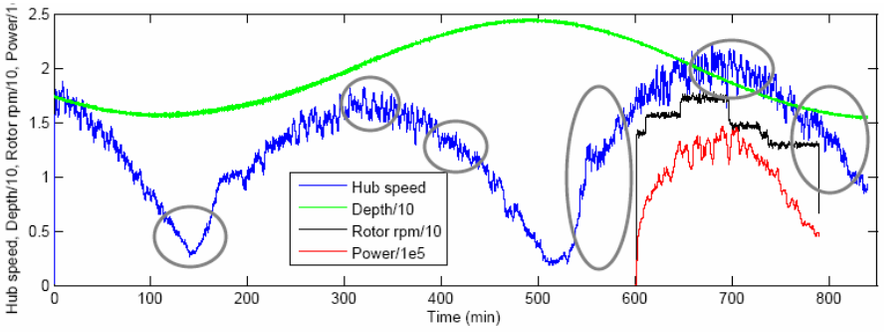
Research

In the context of National and European projects Fraunhofer IWES offers the following research activities:

- Measurement of offshore site conditions for wind, wave and currents
- Device performance measurements
- Modelling and simulation of currents and waves
- Modelling of ocean energy converters for dynamic simulation of
  - power output
  - dynamic loads on the structure and drive train
  - device operation
  - control algorithms
- development of control concepts
- structural analysis of ocean energy platforms
- grid connection and integration solutions
- laboratory scale component tests including real time HIL tests
- power take off concept development
- studies on resource and technology assessments



Flow field simulation for a current turbine



Analysis of dynamic effects on power output

Ocean Energy Technology -

Successful implementation and test of new concepts

Fraunhofer IWES

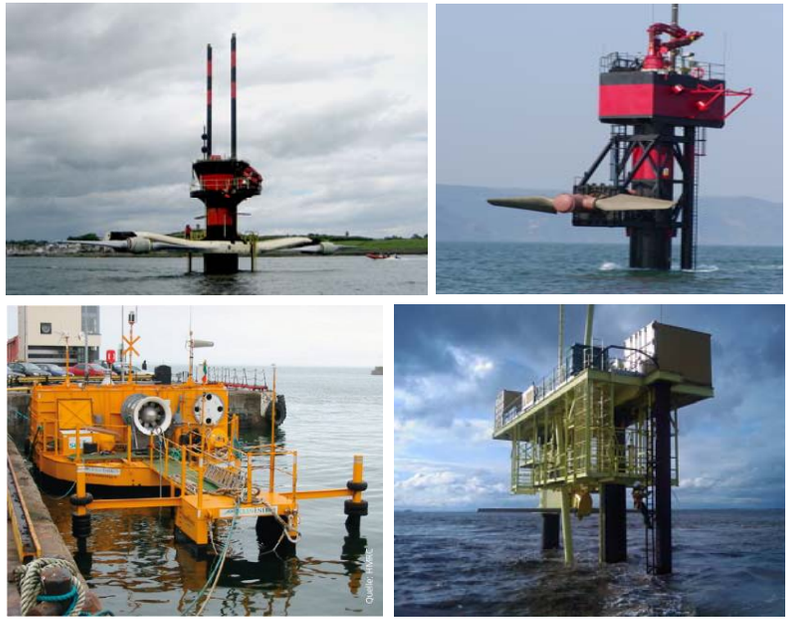
Results

Control of a Megawatt-Size Twin Rotor Turbines
As the first project world wide the 1.2 MW Seagen turbine has been deployed in Northern Ireland in 2008 and today produces more power than expected using a Pitch system developed by IWES and industrial partners.

Control and Power Take off for vertical axis turbines
The Kobold vertical axis turbine in the Straight of Messina has been equipped with a automation system and a new power take off concept is currently being developed fro the next generation device.

Component development for a floating OWC device
In the European CORES project new components for improved performance in a floating oscillating water column device are being developed, tested and installed in an Irish test site in Galway bay.

Demonstration project of 1 MW ocean current converter
The European Pulse Tidal demonstration project will install a 1 MW device using oscillating hydrofoils instead of a rotor. The development includes Simulations, component testing and demonstration at full scale.



Prototypes and demonstrators of wave and tidal energy converters: Seagen 1.2 MW 2008 (top left), Seaflow 300 kW 2003 (top right), OE buoy 2008 (bottom left), Pulse Tidal 100 kW 2009 (bottom right)

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WPMS – Wind Power Management System

Wind Power Forecast

Initial Position

Electricity generation from wind is variable and weather dependent.

To **know it in advance** is important for:
• system operators,
• traders and
• wind farm operators.

A **reliable forecast is needed** for decisions like e.g.:
• capacity planning,
• grid savety calculations and
• trading.

The **Wind Power Management System** provides generation forecasts based on numerical weather prediction for up to 96 hours ahead.

In many countries, Transmission system operators and wind farm operators rely on this system.

Large scale wind power integration needs reliable power forecasts

WPMS – Wind Power Management System

Wind Power Forecast

Fraunhofer IWES

Wind Energy & Oceanic Energy

2.

Wind Power Management System

- Initial Position
- ▶ **Research**
- Results

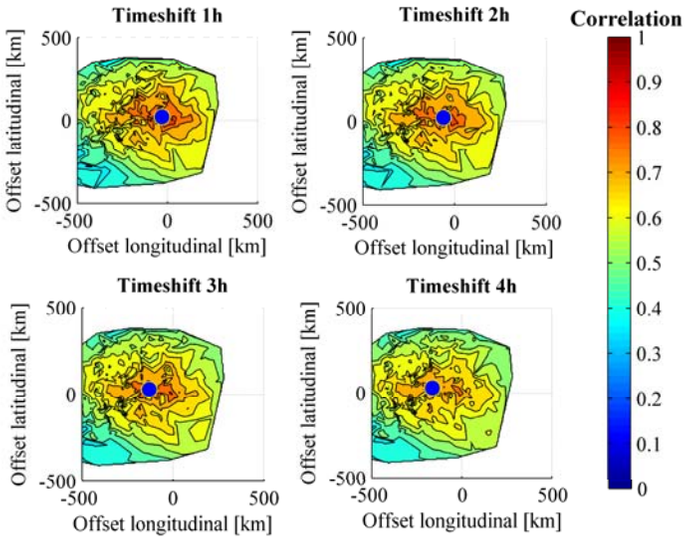
Research

Focus of the research is the integration of all available information in order to **increase forecast quality**.

Present **research activities** are:

- **Combination** of several weather predictions
- Use of **additional information** like power or wind measurements
- **Wind – wave interactions** for predictions offshore
- Prediction of **forecast uncertainty** for ensemble models

Research results will be **integrated into the operational systems**.



Example for present research - Integration of wind speeed measurements

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WPMS – Wind Power Management System

Wind Power Forecast

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Wind Energy & Oceanic Energy

2.

Results

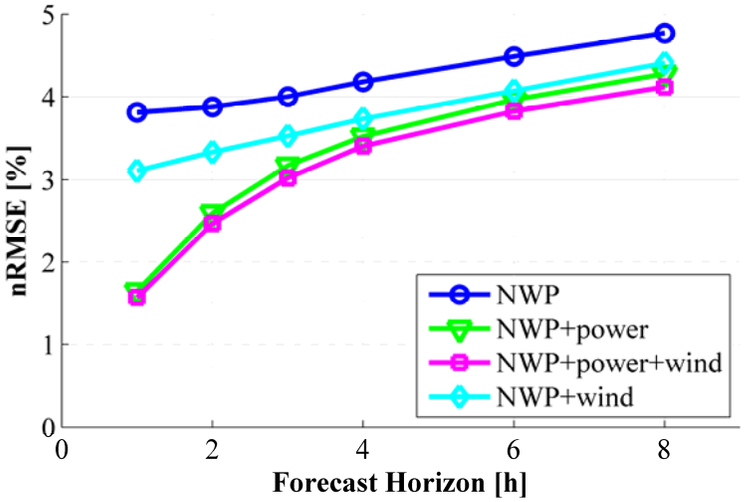
The WPMS predicts the **wind power in Germany** with an average absolute error of **5%** of the nominal power 24-48 hours ahead.

The **shortest term forecast** for 1 to 8 hours ahead shows much **smaller errors**.

Forecast errors have been **reduced constantly** over the years due to continous research.

Using numerical weather predictions in combination with **measured power and wind speed data** improves the forecast.

Combining numerical weather prediction models or using **ensemble models** improves the forecast.



Forecast error related to nominal power in the first eight hours

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Small Wind Turbines for Rural Electrification

Initial Position

Small wind turbines have an enormous potential to cover a considerable portion of the electricity demand in developing countries.

However, available small wind turbines in the power range of several kilowatts are not exclusively targeted to the emerging markets of developing countries, i. e. for applications in hybrid systems and mini-grids.

But, which requirements must be satisfied by small wind systems and what turbine design is appropriate to find widespread application in rural and remote areas?

Small wind turbines at Fraunhofer IWES test site near Kassel

Small Wind Turbines for Rural Electrification

Research

Fraunhofer IWES activities that are related to small wind turbines include the:

- analysis of operational experience regarding reliability, maintenance strategies, yields and costs
- evaluation of boundary conditions and system requirements for small wind turbines in hybrid systems and mini-grids
- study of small wind turbine design concepts
- assessment and test of small wind turbine system components

A small wind turbine at Fraunhofer IWES test site is lowered to the ground for maintenance

Small Wind Turbines for Rural Electrification

Results

Fraunhofer-IWES research outcomes and services related to small wind turbines include:

- identification of a design concept for rural applications
- field tests with focus on the integration and the optimisation of small wind turbines in hybrid systems and mini-grids
- development of a planning/exercise spreadsheet-tool “Small Wind Turbine Estimator”
- training and education on small wind turbine systems, e. g. Kassel University, European Master in Renewable Energy

Student workshop „How to build a wind turbine“ at Kassel University

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